TREE SELECTION METHOD OF HARVESTING TIMBER
IN THE DOUGLAS FIR REGION

by

Louis Blackerby

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Professor Kearns for his assistance in organizing this thesis, and no less for his criticisms.

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FOREWORD

In this thesis the author has attempted to indicate a more satisfactory method of cutting timber than is generally practiced— one more satisfactory to the individual operator because of an assurance of a positive marginal return from each tree cut; and more satisfactory to both industry and the public because the trees of insufficient size and/or grade to pay their own costs of manufacture are left standing in a growing condition, assuring a future supply of merchantable timber.

Other industrial problems deserving attention as much as the one treated herein have been purposely omitted. The need for cooperation between holders of inoperative timber and the operators who at present own only a short-time supply is faced by many operators. In some instances it is a problem which should soon be solved to prevent inoperation due to exhaustion of resources.

Per cent of volume to remove in each cut bears no enlargement in this paper. It is a problem involving individual managers on the one hand and local conditions on the other.
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Objective of Forest Management

"The whole aim of forest management is to obtain the greatest possible growth from our forest lands and at the same time leave the smallest amount of timber on the ground as a permanent capital investment."  

Maximum realization is the goal. It is the forest manager's decision that determines how this realization can be obtained. He may set for his objective, the maximum realization per acre or the maximum realization per thousand. Certainly this would not be extremely hard to determine in most cases, if only one cut were considered, but plans must also be weighed in view of future growth.

Where soil and climate are adaptive to tree growth, trees are going to grow, unless fire, plow, insects or disease keeps battling them down. Use of this land for growing anything other than trees results in poor economy of land.

The forest manager is confronted with "how can I get the

highest return from the present cut? . . . . leave the land in a productive condition without losing the margin of profit from the trees cut?"

Timber properties permitting of years of cutting are management problems distinct from properties of short lived cutting possibilities.

Carl Stevens and Donald Bruce say, regarding the situation:

". . . . if an operation is practically cut out and has a life of but one year or so, it may be best to secure the maximum realization per acre. On an operation of very long life on the other hand where almost all of the material abandoned can be left standing in a thrifty growing condition and where it is a good gamble that it can be logged later on during a second cutting cycle, the maximum realization per M is a better guide. But in most cases the line should be drawn somewhere in between."

What should be desired is not the greatest total realization, but the greatest possible present worth of all future returns. This is but a basic use of the principle of standard banking practice.

For example, suppose that cutting for the greatest possible realization per acre indicates a return of a half-million dollars per year for 40 years. Resulting in a total of $20,000,000. If it were possible, by leaving the poorer half of the timber in the woods, to raise the realization per M by 60%, the annual return will rise to $800,000, but

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2. Stevens, Carl and Bruce, Donald, The Timberman, Nov. 1931, "Selective Cutting", p. 4.
the length of the operation would be reduced to 20 years. The total return will thus be reduced to $16,000,000. But an annuity of $500,000 for 40 years has a present worth, when discounted at 6%, of $7,523,150, while one of $800,000 for 20 years has a present worth of $9,175,920. Instead of the apparent loss of $4,000,000 the lighter cutting system actually shows a profit of some one and one-half million dollars.

Private Industry

Since the industry must "count pennies" to gain its fundamental objective of profits, it is inducive to more economical management. Two primary ways to increase marginal returns would be: (a) lower costs; (b) increase sales returns.

Studies have shown that by cutting only certain trees and letting the others stand, greater margins for profit and stumpage are possible.

Quoting Axel J. F. Brandstrom:

"In Douglas fir, the maximum production per man hour, which is equivalent to minimum cost per thousand, is obtained in trees with a diameter of about 48 inches. The cost is three times as much for felling and bucking a 16-inch tree as a 36-inch tree. The cost is practically constant for trees from 36 inches to 60 inches and shows an upward trend for trees above that size."

Elimination of lower value (high cost) trees will tend to increase the sales returns. Operation of any timber pro-

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3. Brandstrom, Axel J. F., West Coast Lumberman, 1931, "Logging Profitable Logs; A Discussion of Economic Selection in Logging"
perty on an average cost and average selling price for all grades merely serves to cover up items which in themselves may be reducing the average profit through creating losses. The solution is to eliminate trees and logs from the cut which will not return the cost of manufacture.

Tree growth is generally accelerated by a partial cutting. The wood produced in a timber stand after thinning (partial cutting) is usually of a high quality. The new wood added to reserve stand trees increases the value of the stand materially as it is added to trees already of a near-merchantable size.

Public

In western Oregon and Washington communities are not hard to find which depend exclusively on the forest for their support.

"To maintain these social and economic benefits, continuing supplies of high-quality forest raw materials must be obtained. With the soil and climatic conditions prevailing in the region, the existing forests are capable of continuously renewable production, provided they are properly managed. The management practices that will assure this productivity are therefore of the utmost importance.

"If the forest lands of Western Oregon and Washington are to be lastingly productive and the support of a prosperous people, the industries and communities must be established on a permanent basis with continuous supplies of high quality raw materials." 4

Communities organized around certain timber areas find themselves set up with a normal capacity of manufacture in excess of producing capacity of the timber area, or even of combined adjacent areas, upon which the communities are dependent. A retirement of capacity must be observed or a "cut out and get out" technique will be the result, regardless of the original policy of the local industry.

Timber lands as a tax base are generally looked upon as an unsatisfactory solution of revenue to the states of the Pacific Northwest.

Ad valorem property tax results in making it more profitable to cut now than next year, and to find it advantageous to hold land for future cuts of timber is almost out of the range of profits. Areas suffering from this very thing are familiar to most foresters—one is the bond issue of some $4,500,000 which Astoria, Oregon has been juggling around for the last twenty years. Ad valorem property taxes were heaped on the people of Clatsop County to retire the bonds floated for the purpose of building the port of Astoria.

Taxes became so high on forest lands they could not generally be held at a profit. The result was rapid liquidation of forest lands, with a resulting disappearance of tax base.

Prospective forest crops are taxed each consecutive year—thereby taxing a crop time after time before it is harvested. This would be somewhat similar to taxing wheat, rye, barley, oats, etc., each month from the time of planting until after threshing.
Selective logging practice in accordance with a properly adjusted tax-base law could do much in reducing the problem of a diminishing tax base and communities stranded from industrial activity. David T. Mason analyzes the situation neatly:

"The application of selective logging to a given property, by rapidly liquidating the principal values, generally has the effect of decreasing the general property tax burden more rapidly than otherwise. The greater realization per thousand feet makes it easier to meet the property tax, and makes curtailed production economically more feasible. The larger income provides more funds for interest obligations and for debt retirement. In a given situation it usually about doubles the capacity to 'carry' timber. It has a strong tendency to lead directly into a sustained yield operation wherever there is sufficient timber available. It generally leaves a growing forest, which fosters public good will."

Foresters have been slow to recognize the use of forest lands for recreational purposes; they have been slow in recognizing the recreational dollars as a tangible income, as having the same value as dollars produced from any other forest uses. Clear cutting does not lend itself to the further propagation of wild life nor beckon the sportsmen and sportswomen asking aesthetic offerings of the outdoors.

A few trees left standing on a logged area are often the difference between forest land and denuded land; between protected land and unprotected land. Besides acting as sources of seed to re-seed the area, the growing trees leave

no doubt in the public's mind as to whether this is forest land or not. Denude the area of trees and it becomes a difficult task to convince John Q. Public that it is a forest land. Even though the land is fit for growing nothing else, John Q. is still inclined to think it is not forest land "because it has no trees".

**Amount of Timber Involved**

The Federal Forest Survey Report\(^6\) shows a total of 546,048 million board feet of Douglas fir west of the Cascade summit in Oregon and Washington. This is approximately one-third of the nation's total saw-timber supply. It is important to note that 48% of the timber of the Douglas fir region is privately owned.

"Saw Timber Volume by Ownership Classes"

**Western Oregon**

<table>
<thead>
<tr>
<th>Ownership Class</th>
<th>Board Feet (MM)</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Private</td>
<td>137,043</td>
<td>46%</td>
</tr>
<tr>
<td>National Forest</td>
<td>112,599</td>
<td>37%</td>
</tr>
<tr>
<td>Other Public and Indian</td>
<td>51,151</td>
<td>17%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>200,793</td>
<td>100%</td>
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**Western Washington**

<table>
<thead>
<tr>
<th>Ownership Class</th>
<th>Board Feet (MM)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private</td>
<td>123,678</td>
<td>50%</td>
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<tr>
<td>National Forest</td>
<td>88,488</td>
<td>36%</td>
</tr>
<tr>
<td>Other Public and Indian</td>
<td>33,089</td>
<td>14%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>245,255</td>
<td>100%</td>
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6. "Forest Resources of Douglas Fir Region—Summary of the Forest Inventory of Western Oregon and Western Washington", issued by Pacific Northwest Forest Experiment Station, July 17, 1934
"Total

<table>
<thead>
<tr>
<th>Category</th>
<th>Volume (MM Board feet)</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Private</td>
<td>260,721</td>
<td>48%</td>
</tr>
<tr>
<td>National Forest</td>
<td>201,087</td>
<td>37%</td>
</tr>
<tr>
<td>Other Public and Indian</td>
<td>84,240</td>
<td>15%</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>546,048</strong></td>
<td><strong>100%</strong></td>
</tr>
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Perspective of the whole forest problem has been distorted due to the seeming affluence of supply, and the prevailing assumption that the forests would perpetuate by natural means.

Certainly there will be perpetuation if (1) a seed supply is provided; (2) if favorable climatic conditions are maintained; (3) if fire, insects and disease are controlled.

7. Ibid
"Up to the present time most of the cutting in the Pacific Coast region has been clear cutting—that is, the removal of all of the supposedly merchantable material from large contiguous areas. Sundry infrequent instances of other practices, such as the selective cutting on the national forests in the pine region are, of course, exempted from this generality.

The reasons why clear cutting has become the usual procedure in the primeval forests of the Pacific slope, at least on private lands or on lands where the logger has freedom of action, are rather obvious, but not altogether satisfying on analysis."

1. It must be regretfully recognized that the timber land owner has no interest in continued productivity of the land he logs; he has no tradition of sustained yield and no faith that its practice would be an advantage to him. Hence, being on a liquidation basis pure and simple, he naturally wants to cut, in one fell swoop, every tree that would appear to yield a saleable board. Clear cutting or substantial clear cutting is the result.

2. The great size of the Pacific coast trees, particularly in the spruce-hemlock, douglas fir, and redwood types, induced the use of powerful donkey-engine machinery, the only means by which this timber could be profitably moved. This machinery in time seemed physically to necessitate clear cutting.

3. To widen the margin between production costs and returns, the lumberman has directed his attention chiefly to lowering production costs; this has taken the course of employing highly organized engineering technique and a great deal of expensive machinery, which in turn involved high-speed, mass-production methods. The large investment necessary to open up a virgin tract and log it by these means, seemed to call for maximum volume output. Had attention been directed more to increasing the average sale value of the product, i.e. quality production rather than quantity production, the tendency would have been less toward high-speed, mass-production, clear-cutting methods
and more toward selectivity as will be presently shown." 8

Of course the "tree selection" method of timber cropping is not new. The Northwest's first logging was carried on in this very fashion. Bullwhacks took only the best logs to the mill, because of the greater profit resulting therefrom. Trees left standing were unharmed and have since been cut by loggers operating on the same areas years later.

With the introduction of steam power logging equipment the tree selection idea of profitable logging declined. Years of logging followed with little indication of "tree selection". Areas were logged as units, all accessible trees going to the pond in form of logs.

The introduction of small mobile units for skidding has brought a right-about-face to the industry. Trucks and cats have conclusively shown a way of getting at trees which should be cut, leaving those which will not, under present conditions return a satisfactory margin of profit.

CHAPTER 3.

Changes Dictated by Evolution of Forest Practices

Industrial history of lumbering points glaringly towards the Pacific Northwest's principal forest problem, the "perpetuation of existing forest resources at a high level of continuous productivity". Further indications reveal general clear cutting as a system which seldom results in a satisfactory solution of this problem. Instead, it results in a depletion of the resources and a loss of most of the capital values dependent thereon.

Timber cuts should always be made with consideration given to the best method to obtain a second crop without recourse to artificial seeding or planting.

The U. S. Forest Service declared recently that if private ownership of vast timberland domains was to continue the owners must conform to the nation's forest policy. And recommendation was made to Congress that legislation extend to public regulation to curb wasteful production practices and to require replanting of cut-over lands.

F. A. Silcox, chief forester, making his annual report to Congress, said there must be a more permanent management and a better management of private timber lands or "more con-

trol over private lands",\textsuperscript{10} as the only alternative.

For more than 300 years, he said, American forests have been "chopped, burned and depleted; instead of being cropped they have on the whole been exploited and ravished. This must stop if the nation is to avoid a 'wood famine' and a flooded, eroded land".

Forest conservation movements have over-emphasized the need of saving the forests. The need is not to save the forests but to use them wisely. This conservation emphasis has been somewhat successful for it has built into public consciousness the use of substitutes for wooden products. Smelters, mines, and manufacturers of mined products have welcomed the "saving of the forests". It has increased the metals trade on each article substituted for wood. But this practice is a grave national mistake. Ores and minerals are limited in extent and amount, whereas trees are botanical in nature and keep on reproducing for any number of succeeding generations.

Wise use of forests will assure this nation of unending wealth of resources. Chemical wood utilization is regarded by many chemists as one of the principal undeveloped industrial fields.

\textsuperscript{10} The Oregonian, January 15, 1939
CHAPTER 4

Selection Methods as Possible Future Techniques

"The feasibility of selective logging depends upon there being recognizable differences in net realizable value per unit between different units (whether these units are areas, trees or logs) which the selective process may recognize and act upon. The greater the differences the more favorable the opportunity for selective logging. So far we have found in the course of our work no tract in any forest region in which there is not substantial recognizable differences. These differences may or may not be apparent on the surface, but even if not a careful analysis discloses them so that they are thereafter recognizable." 11

Public opinion has held selective logging to be a silvicultural technique, supported by some economic data, thereby fostering, through indirect methods, a primary silvicultural practice. But this is not in line with the profit motive of the timber industries at the present time, for silvicultural measures unsupported by favorable economic considerations defeats the very purpose which was to be embraced, namely: How can the most money be obtained from this particular timber property?

To be consistent "silviculture, if any, comes solely as a by-product or as a coordinated element to economics, and only to the extent that it is profitable. Oddly enough, it often happens that the resulting silviculture is better

than that employed when silviculture for its own sake is the end sought.\textsuperscript{12}

The major silvicultural problems are (1) measures designed to protect and develop the existing stands of reproduction to full timber crops at maturity; (2) practical cutting methods which insure a continuation of advance reproduction.

Trees of a weak or degenerate type in a stand will continue to be retarded after release or will actually succumb. Those surviving will be slow growing.

Trees in competition with each other for food and water respond with accelerated growth after a release cut. Those growing in less crowded stands are affected but little by a release cut. The per cent of increase in volume is highest when a light stand is left because the reserved trees are given more release. Too large a release cut fosters damage from windthrow.

A heavy reserve stand produces a larger volume than does a light stand.

The problem of the most productive method of handling slash is still one of the uncertainties of forest management. There seems to be no general consensus of opinion, even among leaders of the field. Systems agreed upon are very expensive operations, the others, even though disagreed

\textsuperscript{12} Ibid. p. 1.
upon, also have their disadvantages.

"The greatest benefit to the soil usually follows through a retention of all slash. Upon reproduction the effect of slash is so variable, being either beneficial or injurious, sometimes insignificant in its influence, in other cases being the primary factor controlling reproduction, that a generalization is impossible."

Broadcast burning when kept under control is one of the cheapest methods of slash disposal, but is destructive to reproduction and standing timber. On the whole, this type of slash disposal leaves fully as serious a problem as was present before burning. In a selectively logged tract broadcast burning can have no practicability.

Piling and burning the tops and limbs of trees is the method of slash disposal most widely used and approved. Properly applied this method results in only slight injury to advance reproduction. The fire hazard is eliminated as thoroughly as by any other method, but not so promptly as some because the piles are customarily fired during some later season of low fire danger period.

Expense involved in the process of piling and burning is the predominant disadvantage of the system.

Leaving slash lay on the ground could be advocated for its direct effect upon the forest soil in all except the colder climates. The effect of slash on reproduction is a

13. Hawley, Ralph C., *The Practice of Silviculture*, p. 236
14. Ibid. p. 226
different matter; it may be beneficial, it may be detrimental.\textsuperscript{15} As a benefit slash is conducive to sprouting of seeds and early development of reproduction by: (a) conservation of moisture in the surface soil; (b) creation of desired seed-bed conditions through shading and through the increase of humus and litter; (c) the protecting shade afforded young seedlings; (d) mechanical protection of seedlings against browsing and trampling of animals.

Detrimental effects resulting from slash are caused by the following: (a) influence of competing vegetation; (b) mechanical impediment of reproduction started previous to the cutting; (c) allowing insufficient solar radiation to pass to the ground to provide sufficient heat for seed germination; (d) seed-bed created by slash may be unfavorable to forest regeneration.

Bunching slash with "cats" equipped with bulldozers would take the exorbitant cost out of the previous method. Under favorable conditions the soil would be improved by the presence of a small amount of twigs, needles and other parts of limbs removed by bunching. This small accumulation would not increase the immediate fire hazard, and would be incorporated into the soil within a few seasons.

Of the systems of slash disposal mentioned, the latter is recommended wherever topographic and climatic conditions

\textsuperscript{15} Ibid, p. 220
Selective logging in a given operation consists of selecting and logging trees which, for any propose, should be removed and at the same time protecting the unremoved trees from avoidable injury. At present "several different kinds of selective logging may be distinguished. For a number of years the U. S. Forest Service has been carrying on selective logging in the national forests. Here the selection usually consists in picking the younger, thrifty trees and seed trees to be reserved from cutting; all of the remaining trees are then cut; the emphasis is on the trees to be reserved."16

Such a cutting technique would have small application in an industrial set-up, where the primary objective is a resultant marginal profit. Although this "improvement" type of cutting may be used by private timber holders to improve the coming timber crop, it is not the selective cutting and logging system herein advocated except in diseased or over-mature stands, which are resulting in a negative annual increment or bear indication of stagnation before the next cutting period.

Industrial application of selective cutting "aims at obtaining and maintaining the highest tangible values from the forest property including therein income of the immediate future and the capital values remaining to produce future in-

come. Any cutting methods which create undue fire risk, deteriorate the growing stock or fail to provide suitable regeneration are in gross violation of these principles. 17

Since the object of the whole system is designed with the view of marginal returns the economic and silvicultural sides of the problem will be kept in harmony to the extent that recommendations will remain within the realm of practicability.

17. Kirkland and Brandstrom, op. cit., Preface
CHAPTER 5.

Objective of Economic Selection

A simple example might illustrate the practicability of economic or tree selection:

Consider owning a timber operation with any of various trees growing on the area. If the going interest rate is 3%, figure which trees are producing less than 3% growth each year and if the sales return of the tree will be greater than the cost of marketing it, the most profit will be realized through cutting and selling.

Trees showing a higher increment than 3% are netting a greater margin than could be obtained, were this marginal value in the bank drawing interest. Certainly it is wise business policy to cut the former and leave the latter stand.

Selective cutting is on the verge of becoming a hackneyed term from the loose usage it has received. In this thesis it is considered as a system of cutting based on a careful predetermination of the net realization values in different types of stands and trees and a removal of only those having a value in excess of some rationally established base. It will be apparent that this interpretation would not include those logging operations which leave only
culls or small trees that obviously would not return a positive marginal value.

Minimum marginal value to be logged is calculated by computing the greatest possible present worth of all future returns. Although the minimum marginal value is usually above zero even for a single cutting cycle, it is generally larger when return cutting cycles are anticipated.

Mr. Mason\(^1\) points out some seven industrial conditions where a selective logging analysis is indispensable to the most efficient management:

1. To secure the best possible financial results from the utilization of a given forest property.
2. To determine the justification for the development of an undeveloped tract of timber.
3. To assist in determining the best plan of development for an undeveloped tract.
4. To test the value of properties prior to purchase.
5. To aid in the selection of the best of several properties under consideration for purchase.
6. To make much more accurate timber appraisals than can be made otherwise.
7. To prevent serious operating mistakes and to solve various internal problems of operation.

\(^1\) Mason, David T., op. cit., p. 4.
CHAPTER 6

Scope

The purpose of this report is to demonstrate the practicability of a change in cutting practice by the private timber operator. Under the "tree selection" system of cutting and with adequate provisions for seed supply and fire protection, the Douglas fir region will provide abundant and continuous supplies of high quality timber products.

Continuous supplies of timber can be obtained under a properly executed clear-cutting system. But a greater proportion of high grade timber growth can be expected from the tree selection cutting system, for trees released from a dense stand increase the rate of growth some 15%. Growth increases the value of trees through increased volume, improvement of quality and a decrease of logging expenses. The growth characteristics are especially productive when applied to the younger, semi-mature trees which would not pay the expense of handling at their present size, whereas reproduction starting from seed or small trees after the area is cut requires years before even the least of lumber can be manufactured from them.

A wide range of stumpage conversion values is the principal base upon which this treatise is founded. A cost-return analysis is a prerequisite to accurately determining
the marginal tree to log, and hence the answer to the ques-
tion, "will it pay to cut or hold?" Lumber cut from small
sized trees reduces the average selling price, for lumber
cut from small sized trees is inferior to that cut from ma-
ture trees. Not only is it uneconomical to cut small sized
trees for lumber but it is wasteful and reduces the margin
of profit from the larger trees.

Indications are that stumpage prices have reached a
plateau that will hold for many years before there are fur-
ther substantial advances. Carrying charges have increased
until they absorb all or more than any gains in price which
can reasonably be expected. The industry as a whole must
resign itself to an era of small profits—only the excep-
tionally competent are going to be prosperous. The time has
come for careful figuring.2

To obtain a basic understanding of logging costs, it is
necessary to obtain an intimate knowledge of cost relations
and to study closely the extent to which the various factors
may affect costs. It is common knowledge among logging op-
erators that costs are affected to a pronounced degree by
such factors as size and density of timber, distances, ground
conditions, topography, efficiency of men and machines, and
by the methods employed.3 Almost all present day timber com-

2. Stevens, Carl and Bruce, Donald, op. cit., p. 1
3. Brandstrom, Axel J. F., Analysis of Logging Costs and Op-
erating Methods in the Douglas Fir Region, p. 12
panies operate under a bookkeeping system of a few grand averages, which may conceal high return or high cost factors.

The cost analysis should be used to disclose and segregate each return and cost detail. As the unnecessary costs are eliminated greater profits result; a further step should be a plan whereby profitable material may be removed from the forest in such an order with respect to time as to yield for the entire property the maximum present worth of future income, taking into consideration the effect of discount.  

PART III. DEVELOPMENT OF ECONOMIC SELECTION OF TREES

CHAPTER 7.

Inventory

Forests are made up of low and high quality trees, a number of different age classes, and scattered over every soil and topographical type. The industrial forester's problem is to obtain the greatest marginal value and still maintain the stand.

Before a practicable plan can be formulated, cognizance must be taken of all factors having any effect upon the timber operation, whether of a constructive or destructive nature. All of the elementary physical data and economic data pertaining to the management of a timber tract is compiled from the field into an inventory.

Physical

Type Map--A map prepared for purpose of determining the most profitable plan of selectively logging the stand. It is a matter of sound judgment and is built to prearranged standards--what makes a "type" and what types are to be recognized.

In some cases it is preferable to differentiate between species and base the report on the vol-
ume per acre of the most important species. The ever important aim is to distinguish between timberlands of different values.

**Stand Tables**—An amplification of the type map is the next step; determining more exactly each of the types. After splitting the area into working circles of a near-homogeneous nature a representative stand table is prepared for each type. This includes species, diameter classes, and number of trees per average acre.

The recommended procedure is to measure each tree on a number of scattered, representative plots of each type. In fact many operations demand an actual measuring and mapping of every tree of the stand. The more heterogeneous the stand, the more samples that should be used.

**Stock Tables**—From the stand tables the stock tables are made, showing the average volume per acre for each type in trees of each diameter class and species.

Volume tables showing the average volume of each diameter class for each species of that particular growing area are used in determining the volumes. Needless to say, the resulting totals should agree with volumes per acre of each type as shown by the cruise data of each type.
Site Quality—The relative producing capacity of land, determined by height of dominant and co-dominant trees, is an indicator of future growth and yields that can be expected. Classifications should be divided into separate species or combinations of species as site quality irrespective of species is of little value.

Disease and Insects—Enemies of trees will reduce the future yield of a stand and must be investigated to assure the accuracy of computed future returns.

Wild Life—Species of animal life present on a timber area and their likelihood of propagation should be investigated, to determine possibilities of income from grazing or sports use.

Accessibility—Location of roads (private, county or state) are of prime importance to market selection and indispensable for fire control.

Recreation Possibilities—As a possible multiple use of timberlands, sports offer a prime source of auxiliary income. Hunting, fishing, camping, resorts, picnicking and winter sports offer opportunities.

Topography—Field data should include notes as to the character of the ground surface, amount of rock and brush, and upon all points that will
affect the cost of construction of logging roads and the cost of operations.¹

**Economic**

The economic inventory is composed of all cost or return items to be encountered in pursuit of harvesting and marketing of timber products of the area.

**Road Costs**—Building and maintaining of primary and secondary roads is one of the most important factors of a "show" in determining whether it will "pay or not". Some of the more successful operators have found it the best policy to charge road building costs against the first cut.

**Market Price**—Primary consideration should be given to market prices—not only prices for the quality of product available immediately, but also the quality of products available at future dates. A market trend may be determined to one's own satisfaction by an analysis, but a more accurate result might be obtained from professional business guides.

Production of quantity and quality need be closely correlated with the market trend to maintain returns in excess of costs.

Taxes—Trends in taxation can sometimes be ascertained by observation of future and immediate building plans which are to be foisted onto the public. Further possible disclosures come from analyses of the number of business units affected by a specific tax and upon the increase or decrease in the number of firms.

Secondary Incomes—Secondary returns from properties have become of primary nature in some sections of the Douglas fir region—sometimes due to deficiency of merchantable trees, while in other instances it was brought about by constructive development and sales technique. Other instances of this are those brought about by taking advantage of the natural conditions of which the public is willing to pay for the use.

Usual supplemental incomes to timber operators are among the following: grazing, recreation and sale of cull-down material for fuel purposes.

Fire Protection—Fire protective organizations are customarily recipients of funds from the owners of the property protected. This is collected by and allocated through the state.

On a long time basis the trend is towards a sound fire protection program preserving the for-
est climate, maintaining a fire resistant stand, establishing and maintaining a permanent road system to fully utilize matured timber and salvage timber killed by fire, insects, and other destructive agencies.²

Insurance—Timber investments are hampered by the general absence of insurance. One hundred percent risk is imposed on timber owners because insurance companies have not invaded the forest domain.

Farmers are encouraged to insure crops; banks require business buildings to be insured before they will lend money on their security; automobiles bought through a finance corporation are subject to a mul-tifold compulsory insurance; yet timber owners are bearing one hundred per cent risk.

Labor—One of the sore points of Pacific Coast industries in the past years has been labor. Strikes with ensuing shut-downs have not been infrequent.

Preliminary surveys should reveal an adequate labor source, not too remotely removed from the operation, before the final management program is determined. To overcome adverse labor supply conditions timber companies may even build and maintain a municipality. A most recent example is the town

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² Kirkland and Brandstrom, op. cit., p. 117
of Gilchrist, Oregon—built and maintained by the Gilchrist Timber Company.

**Capital**—Ample initial and operative capital must definitely be available for any assurance of a successful program of operation. A detailed calculation of investment in plant and equipment is made to prevent investment out of line with the productive capacity of the tract.

**Interest Rate**—Use of money is a service rendered much the same as a physical service and should demand a monetary premium the same as does any of various forms of labor. From this simple derivation it follows that interest should be charged for the use of capital regardless of the source from which the capital is drawn. It is true that owned capital may fail of obtaining a fixed or standard rate of interest return for its use, owing to the fact that a negative profit or loss results when interest charges on that capital are changed into costs.  

Rates of interest are determined by a combination of risk and time involved in the investment. Longer periods of investment commanding a lower rate than short time investments. Forest investments are of such a nature as to afford low risk on capital

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3. Matthews, Donald Maxsell, op. cit., p. 228
investment and payment over long periods of time—hence, a low interest rate.

_Slash—_Costs accruing against slash, either for its presence or for its removal, often constitute charges of major importance, but are usually dependent upon local conditions.
CHAPTER 8.

Procedure

**Sales Value for Log**—A simplified evaluating method would be the application of log market price to the sizes and grades of logs in question. Resulting values are subject to the same range of error of actual worth as is characteristic of the log markets. The market fluctuates with, and is dependent upon, competitive production and consumption of logs; not directly based upon the sales returns of the manufactured products.

To obtain value measures of a more objective nature, it is desirable to determine log values in terms of dollar returns on the finished products, less the cost of manufacturing, transportation, storing, bucking, and all costs incidental to the process of converting trees into lumber.

**Log Grades and Diameters**—Rules for determining log grades should, for mill-scale studies, base the grading on external indications, rather

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# R. W. McIntyre's log rule is, perhaps, the most objective of any commercial log grading rule in use in the Douglas fir region, but is not herein recommended as it is not limited to surface characteristics in determining the grade.

No. 1 Douglas fir Logs—No. 1 logs shall be logs which will be suitable for the manufacture of lumber in the grades of No. 2 clear and better or (B) and better to an amount of not less than 50% of the scaled contents and shall not be less than 16 feet in gross length and shall be not less than 30 inches in gross diameter inside the bark at the small end.
than leave leeway for personal opinion on "how it will open up". The indices used should coincide with those available for use of the observer of the log while still in the standing tree. This gives the cruiser and bull-buck opportunity of making decisions upon the same basis as mill-scale results are obtained.

Diameters of logs shall be measured at the small end of the log, inside bark. Deviations in shape from a near circle shall be measured as the average of two calibrations, either at right angles (90°) to the other. Fractional inches are rounded off to the nearest inch while those coming just half way in between are staggered; one to the next higher inch, the next to the lower inch.

(continued)

No. 1 logs shall be old growth logs and shall contain not less than eight annual rings to the inch in any part of the outer portion of the log equal to one-half of the scale content, ring count and measurement to be taken at the top end of the log, and shall be straight grained to the extent of a variation for a space of 6 lineal feet equidistant from each end of the log of not more than one inch per foot in logs to and including 35 inches in diameter, 1 1/2 inches per foot in logs 36 inches to 40 inches in diameter, 2 inches per foot in logs 41 inches to 60 inches in diameter, 2 1/2 inches per foot in logs 61 inches and over in diameter.

Rings, rot, or any defects that are deducted in the scale are permitted in a No. 1 log providing their size and location to not prevent the log producing the required amount of No. 2 clear and better of (B) and better lumber.

Visible pitchpockets, rings, solid pitch and knots must be so located that they do not prevent the production of the required amount of No. 2 clear and better or (B) and better lumber.

No. 2 Douglas Fir Logs—No. 2 logs shall be not less than 12
Mill-Scale Study--In mill scale studies each log is assigned a code number to facilitate observation of its progress through the mill and to facilitate identification of lumber from each log by tallymen on the green chain. Records bearing corresponding code numbers are kept for every log during the study. (Figures 13, 14). All pertinent information available is kept in concise form; it includes: mill number, log number, date, method of sawing, amount of time consumed in sawing, gross and net mill deck scale, species, grade, diameter, the amount, size and grade of lumber sawed from the log.

Stop-watch studies reveal the time consumed in sawing each log on the head-rig. If the content

(continued 3)

feet in length and not less than 16 inches in diameter, below the grade of a No. 1 log but which will be suitable in grade; (a) for the manufacture of lumber in the grades of at least 65% merchantable and better grade. (b) for the manufacture of lumber in the grades of 25% No. 2 clear and better or (B) and better or an equivalent value in combination of grades.

No. 3 Fir Logs--No. 3 logs shall be not less than 12 feet in length, having defects which prevent their grading No. 2, but which will be suitable for the manufacture of the customary common grades of lumber. Logs in this class should be scaled down to and including a 10-inch diameter; small logs less than 10 inches in diameter when sold for manufacture in a gang mill shall be scaled down to 6 inches in diameter and a minimum length of 16 feet.

Any logs so rough that the side cut will not produce a No. 2 common or better lumber shall have deduction in scale of a sufficient amount to eliminate the No. 3 common lumber in squaring up the log.

Logs having excessive slope of grain and/or logs having
of each logs follows approximately the same course of flow the head-rig time would be sufficient. The cost of each machine could be charged directly to the cost of the head-rig. In fact the total milling costs can be computed in cost per minute and charged against each log; the amount of charge is dependent upon number of minutes consumed at the head-rig.

Charging all of the milling time, and hence all milling costs, against time consumed in sawing at the head-rig, implies proportionally equal time consumed in the other manufacturing processes throughout the mill. Mills sawing more than a small percentage of structural material can obtain more accurate results by timing contents of each log through every manufacturing process throughout the plant. Combinations of the two ways of making the time studies may be worked out to conveniently fit individual mills.

Lumber passing out of the mill is transferred to the green chain where it is graded and tallied. The tallyman uses one form sheet for each log (Fig-

(continued 4)

an excessive number of visible pitchpockets will be included in this grade.

Cull Douglas Fir Logs--Cull logs when not sorted separately shall be any logs whose net scaled contents is less than 50% of the gross scale. This percentage may be reduced to 33 1/3% where the grade of lumber to be recovered is principally clear, such logs shall have a maximum grade of No. 2. 7/

7. McIntyre, R. W., Log Scaling in the Douglas Fir Region
ure 13), recording the number, species, and diameter of the log, the grade, width, thickness, and length of each piece.

Green chain tally is used rather than shipping or other tallies to simplify the procedure and to standardize the results. Prices are based on the rough, green lumber as it comes from the mill.

The sales return from each log is determined by multiplying the volume of each grade of lumber produced from a log by the respective price per thousand of the resultant grades.

Prices to be applied to the various grades should be on a predetermined basis. If the study is confined to a concern having records of price returns of the various rough lumber grades, these may be applied to determine selling values. Tributary areas of central wholesale markets find it advantageous to use the central wholesale price.

**Milling Costs**—Costs of milling are of two types—(1) those varying with log diameter and (2) those of a fixed charge on every thousand board feet of lumber manufactured.

Milling costs varying with log size are based on amount of time required to saw logs in the headrig. Average time required to saw a thousand feet of lumber is determined by weighting the sawing time per thousand feet in each log diameter by the per-
percentage of volume made up by logs of this diameter.

After determining the average time required for sawing one thousand feet of lumber it is necessary to know the cost per minute of expense items varying with log size. The average cost per thousand feet board measure of items varying with log diameter is obtained from the usual cost sheet. This average cost per thousand of items varying with log diameter is divided by the number of minutes required to produce the average thousand feet of lumber. The result is a variable cost per minute, which, multiplied by the sawing time per thousand feet for a log of any diameter gives the variable cost per thousand feet for a log of that size.\(^8\)

The total milling cost of each log is the sum of the variable costs per thousand feet for a log of that size and the costs fixed per thousand feet regardless of size of log. Fixed charges include all of the milling expenses on lumber after leaving the head-rig plus the overhead charges. This total (for a year's time) divided by the number of thousand board feet per year results in fixed charge per thousand feet of lumber.

**Pond Conversion Value**—Values of logs in the

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pond are computed two ways: (a) net future return value, (b) past cost value.

Past cost value is determined by summing the costs charged against each log for felling, bucking, yarding, loading, transportation and dumping into the pond.

Net future return value is the difference between cost of manufacture and sales returns of the log.

A log in the pond having a positive net future return should be run through the mill to be manufactured. Logs in the pond with a negative net future return will result in less loss if disposed of other than by manufacture, providing the cost of disposal is of a lesser direct cost than was the indicated negative future net return.

The marginal log value is determined by graphically locating the point where future net return is just equal to the past cost value.

The marginal log is of just such nature that costs of all operations from tree to the lumber consumer just offset the sales returns.##

This varies with each grade and each diameter class. A smaller grade 1. log can be manufactured

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## In some instances felling costs are not charged against a log and will be mentioned in more detail subsequently.
without loss than can a grade 2. log; as can a smaller grade 2. log be manufactured without loss than can a grade 3. log.

Wide differences of costs exist between lumber mills as also exist between different woods operations. Obviously cost analyses cannot be obtained from one operation and applied to another with any consistency of accuracy. Differences in size of the marginal log exists, not only between different logging tracts, but the marginal size may vary considerably over one logging area, due to location, accessibility and the like.

Cost of Selling Lumber—Sales price as applied to rough, graded lumber on the green chain includes, among other cost charges, a charge for selling costs. Each grade of lumber bears a different market price. Sales of high priced lumber are rated as a preference over the cheaper grades and since more effort and money is spent in attempts to market grades of highest yield a graduation of average selling costs in relation to sales value is charged against each grade.

Total costs of lumber sales over a period of a month or year can be obtained from existing company books, as can the amount, price, and grade of each sale. The grades are segregated into homogen-
eous grade groups and the selling price for each grade group is determined from the records. These group prices are added together, the total representing the sum received from a sale of one thousand feet of each grade lumber. This sum divided by the number of grade groups represents the average price received for the thousand-foot lumber units sold.

Total cost of sales divided by the number of thousand-foot units sold gives an average cost per thousand. Division of this average selling cost per unit by the average price received for the units equals the per cent of the selling price of each grade of lumber going to make up the selling cost charges.

Selling price, per thousand-foot unit of lumber, times the percentage charge just determined indicates the charge per unit of that particular grade at that particular price. The rate per unit of any one grade times the number of thousand-foot units sold yields total selling costs charged against the one grade over the period of time considered. Gross charges of all the groups should be equal to the total costs of sales.

**Stumpage Conversion Value**—As the difference between selling value and cost of milling is the
pond conversion value, so is the difference between sales value and cost of production (including milling costs, logging and transportation costs) the stumpage conversion value. The margin available for stumpage may be either negative or positive; negative when the costs of the finished products exceed sales returns, and positive when the value of the products exceeds the costs.\(^9\)

Misconceptions of stumpage conversion includes the owner's investment, with or without compound interest; the relative bargaining power of buyer and seller; and the value of the timber as assessed for taxation purposes.\(^{10}\)

A logging cost analysis must be made, the same as a milling cost study, to determine charges borne per log. Cost per thousand board feet for logs of any one diameter are then determined by dividing the cost of the log by the scaled contents of the log (thousand feet board measure).

Costs of logging are itemized in relation to log diameters. All costs for felling, limbing, bucking, yarding, loading and pond can be reduced to a fixed sum-per-minute of effective time, irrespective

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9. Rapraeger, E. F., Results and Application of a Logging and Milling Study in Western White Pine Type of Northern Idaho p. 28.

10. Kirkland and Brandstrom, op. cit., p. 6
of output during that time. The cost to be charged against a particular log will depend on the number of minutes required to complete the operation for that log. The product of time in minutes multiplied by cost per minute is the log cost. This cost divided by the scale (in thousand feet board measure) gives the cost per thousand board feet.11

Yields of lumber from small logs are much more costly per thousand board feet than larger logs (figures 3, 5), one of the reasons is that small logs result in a lesser number of board feet per cubic foot of content, due to slabbing, i.e. a greater per cent of the small log is converted into slabs.

Procedure of studying various logging activities consists of taking stop-watch observations of all principal time elements of the logging operation, and of measuring the amount of work performed in terms of distance transported and volume produced. The time required in yarding, loading, etc., for logs of various sizes and for different distance segregations is thus determined for each machine. From these data is calculated the time in minutes per-thousand-board-feet units of logs, which re-

presents the ultimate answer in the time studies proper.

In order to translate time in minutes per thousand into cost per thousand, it is necessary to set up the cost of operating each machine. From this is derived the operating cost per minute, which is multiplied by the time in minutes per thousand-foot units of logs.\(^{12}\)

Fixed annual charges including insurance of equipment, depreciation of equipment, maintenance of camp buildings, taxes and capital charges may be placed on a per-thousand-feet unit basis by dividing the total sum by the number of thousand-feet units produced yearly.

By the techniques outlined cost per thousand-board-feet units can be obtained for the entire woods operations, divided into the following: woods costs (falling, bucking, spur construction, etc.), camp overhead, railroad operation, general logging expense.

Tree Value—Cost value or sales value applied to a log in the woods gives no indication as to whether or not it is sub-or super-marginal. Marginal values for logs indicate the net difference between

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\(^{12}\) Brandstrom, Axel J. Fl, Analysis of Logging Costs and Operating Methods in the Douglas Fir Region, p. 15
sales realization and costs. To determine tree value, marginal values of the various 32-foot logs to be cut from the tree\# are added together. This sum, minus felling cost represents the gross marginal value of the tree. By dividing this value by the board foot volume (in thousand-foot units) of the tree the quotient will represent the average marginal value of each thousand-board-foot units to be cut from the tree.

After a tree has been felled it is necessary to keep in mind, when determining the top cutting limit, that none of the felling charges need be borne by the smallest log. The first log, the first two logs, or the first three logs are the determining factors as to whether the tree should be felled or not. But the smallest log shall be of sufficient size and grade to offset all future handling and manufacturing costs by its sales return value, else it is more profitable to leave it in the woods.

Practical use of the study is conveinced by graphical analyses, prepared as shown below:

1. Acquire basic data on costs from bucking to green chain by log diameters.

\# Taper tables are necessary to determine the size and volume of the logs to be cut from the tree. The tables can be prepared from measurements of down timber.
2. Acquire basic data on costs of felling by tree diameter breast height.

3. Acquire basic data on gross value recovery for various log grades and/or species by log diameters.

4. Construct set of curves showing net value of logs after felling and before bucking for different grades and/or species, by log diameter. (This is done by subtracting from each curve of gross value recovery (#3) the curve of bucking to green chain costs (#1)).

5. Construct a table indicating net tree value after felling and before bucking for various tree diameters and various log grade combinations. (This is done by adding together the appropriate net log values from #4 as indicated by taper tables.)

6. Correct table #5 for felling costs to get data for curve showing net value recovery by tree diameter and log grade combinations. (This is done by subtracting from each net tree value in table #5 the cost of felling that diameter tree as indicated in #2.)
PART IV. CONCLUSION

Each property is a multiplex problem of management. No two areas are alike; no set of conditions are ever duplicated. A forest manager's task is to obtain growth of trees and to protect them from destruction.

A selective logging analysis is a complicated study to determine just how the management's objective can best be achieved—what industrial systems or combinations of systems result in maximum returns? Success of the technique is dependent upon cognizance of the many variable factors and the accuracy of the application of these factors in obtaining a result. Certainly no one system should be rigidly advocated as the most practical system, as the success of any management system is dependent upon characteristics of the property at hand and the method by which the system is administered.

To keep such an analysis in adjustment it must be kept in attune to the economic variables which influence the accuracy of the conclusions. Among these can be listed the following: changes in markets, labor costs and supply costs.

Industrial operations are not primarily interested in restocking logged or burned areas, but occasionally find it a means to more fully achieve a prime business objective—obtain a super-marginal monetary return for goods, wares or services purchased by a public. In aiming to fulfill this
objective industrial forestry will find it expedient to keep the economic and silvicultural aspects of the problem in harmony with the practicability of the results.

Silvicultural success consists largely in taking advantage of the many favorable factors nature has already placed at man's disposal.

Harvesting of timber by the tree selection method has the advantages of avoiding the expense of logging in an economic vacuum, harvesting profitable timber in the order dictated by relative earning power, and by logging only those trees yielding super-marginal returns.¹

Individual operators, as well as the timber industry as a whole, will appreciably benefit by keeping the public's view in mind when determining the cutting policies. Better public relations may be fostered by small changes from the various techniques now being used and will result in small or no burden at all on the operators.

A cut leaving no standing timber and barren burnt-over land void of vegetation, or leaving a serious slash problem which will probably result in an absence of seedlings for several years, is a severe blow to the industry. Barren forest land is not forest land to the public. It must have trees on it! But the public is not prone to conclude that

¹ Brandstrom, A. J. F., The Timberman, 1930, "Application of Selective Logging in Douglas Fir"
forests cannot be profitably raised on a site if logging has spared a few standing trees. To be particularly appreciated these should be left along all roadsides and streams.
APPENDIX

Supplementary graphs and charts are herein included in hope of bringing to the reader a more thorough understanding of the techniques involved.

Figure No. 1 is a graphical representation of the amount and grades of lumber sawed from grade 2 logs; the logs ranging in size from 10 to 60 inches DIB.

A distinct increase in the proportion of clear content is characteristic of increase in size of logs.

Gross sales returns from logs of a given grade are determined by applying the corresponding market prices to each grade of lumber, in keeping with the volume of that particular grade, and totalling the amounts.

Computations made for every DIB of each log grade will indicate sales value of any merchantable log.

Figure No. 2 combines cost per thousand-board-foot units of bucking, yarding, loading, transportation, decking, unloading, pond, sawmill, seasoning, overhead and miscellaneous fixed per unit expenses, all on a mill-tally, mill-log basis, for each log diameter.

The line of demarcation between bucking-to-pond and pond-to-lumber-shipping costs have not been indicated but
adequate data are included for this analysis.

Selling curves for each log grade clearly show the relation between costs and values for every diameter.

**Figure No. 3**—The differences between Figure No. 2 (for logs) and Figure No. 3 (for trees) is that felling and limbing costs, along with a more detailed break-down of cost items, are included in the latter which are omitted from the former.

**Figure No. 4** indicates net values after falling and before bucking of various sized logs of different grades. Note that the left hand end of grade-curves two and three are below zero; showing that grade 3 logs smaller than 20 inches should not be bucked, nor should grade 2 logs smaller than 18 inches be bucked.

**Figure No. 5** indicates the total cost in relation to sales returns of logs of various diameters. The total costs are broken down into the various contributing costs.

Increase of the cost per thousand-foot units in trees of diameter breast height greater than 47 inches is attributable to increased damage by fungi and resultant breakage of the larger trees when felled.
Figure No. 6 is a break-down of total costs, to facilitate determination of marginal values at the pond, on the landing, and after bucking.

Figure No. 7 shows the results of an analysis of a property to determine the present worth and total realization to be obtained therefrom.

The present worth is read horizontally at the left, while the realization per M units can be determined by reference to the slightly curved lines which radiate from the lower left-hand corner and are marked $1, $2, etc., at the right and along the top.

The effects of cutting are depicted by the curve of wide sweep. Clean cutting is represented by the terminus (on the right hand side of graph) of this curve.

Figures No. 8, 9, 10, 11, 12, 13, 14 are forms to assist in gathering and compiling of data necessary to facilitate an effective tree selection program of harvesting timber in the Douglas fir region.
Figure No. 2
DOUGLAS FIR LOGS
COSTS & VALUES--PER 8' FOOT MILL TALLY

Grade 1 Value

Grade 2 Value

Grade 3 Value

Operating Costs Excluding Felling, Limbing, Slash Disposal and Fixed Acre Costs

Source: Bibliography #30

Costs for 8' Logs in Dollars per Foot Mill Tally

Diameter Mill Logs--Inches
Figure No. 2
DOUGLAS FIR TREES
PER 1000 FEET MILL TALLY—COSTS & VALUES

Margin for Spurts and Other
Fixed Acre Costs, Brush
Disposal, Stampage, Profit

Sawmill, Yard and
General Expense

Production Costs Exclu-
sive of Fixed Acre Costs,
Brush Disposal, Stampage

Selling or
Limbing

COSTS OR VALUES IN DOLLARS PER 1000 FEET MILL TALLY

DIAMETER BREAST HIGH—INCHES

Source: Bibliography #30
Figure No. 5
EFFECT OF TREE SIZE ON COST OF MAKING DOUGLAS FIR LOTS

Source: Forest Research Notes 6/13/31
Figure No. 7
PRESENT WORTH OF REALIZATION OBTAINABLE FROM FIRST CUTTING CYCLE

After deducting two dollars per M to pay 6 per cent interest on required operating capital. Arching curve indicates the results of different degrees of cutting.
### QUADRAT DESCRIPTION

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<td>Plot No.</td>
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**Forest Type**

Elevation, Absolute: Relative:

Slope, %: Aspect: Drainage:

Rock, Kind: % of quadrat covered:

Soil, Series: Type: Structure:

Humus, Depth: Character: Distribution:

Litter, Depth: Character: Distribution:

Grass, Species:

Density: Ave. Ht.

Herbs, Species:

Density: Ave. Ht.

Shrubs, Species:

Density: Ave. Ht.

Tree reproduction, Species:

Density: Ave. Ht.

Trees over in.d.b.h. (numbers)

Shade, high, % of quadrat covered Low, % covered

Slash, Species: Size

Condition: Amount

% of quadrat covered: Depth

Logging damage to quadrat:

Remarks:

Source: Bibliography #56
Figure No. 9
FELLING FORM

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<td></td>
</tr>
</tbody>
</table>

RESCALE

<table>
<thead>
<tr>
<th>L.B.</th>
<th>Dom. or Codom.</th>
<th>Int. or Sup.</th>
<th>Age (stump)</th>
<th>Fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>L B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
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<tr>
<td>4</td>
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<tr>
<td>5</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Felling
Limbing
Bucking
Brush Piling
Total Prod. Time
Start
Stop
Total Time (per tree)
Delay Time (per tree)

Rot Size
Stump
L.B.
1st. log
Ht. to base of Crown
Width of Crown
Increased Growth

Source: Bibliography #56
**Figure No.10**

**DAILY SUMMARY FELLING DATA**

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mill No.</td>
<td>Date_____________________________</td>
</tr>
<tr>
<td>Observer</td>
<td></td>
</tr>
<tr>
<td>Tree No. to No.</td>
<td></td>
</tr>
<tr>
<td>No. men in crew</td>
<td></td>
</tr>
<tr>
<td>Productive time</td>
<td></td>
</tr>
<tr>
<td>Recorded delay time</td>
<td></td>
</tr>
<tr>
<td>Unrecorded delay time</td>
<td></td>
</tr>
<tr>
<td>Total Hours paid</td>
<td></td>
</tr>
<tr>
<td>Gross scale</td>
<td></td>
</tr>
<tr>
<td>Net scale</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Bibliography #56*
### Figure No. 11
**HAULING FORM**

<table>
<thead>
<tr>
<th>Mill No.</th>
<th>Load NO.</th>
<th>Date</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Tree &amp; Log No.</th>
<th>Sm. Dia.</th>
<th>Lgth.</th>
<th>Scale</th>
<th>Gross</th>
<th>Net</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

#### LOADING

<table>
<thead>
<tr>
<th>No. of men</th>
<th>Prod. Time</th>
<th>Delay time</th>
<th>Total time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
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</tbody>
</table>

#### HAULING

<table>
<thead>
<tr>
<th>Leave landing</th>
<th>Bunch No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Return landing</td>
<td>Distance</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Total time</td>
<td>Kind of road</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Loading time</td>
<td></td>
</tr>
<tr>
<td>Hauling time</td>
<td></td>
</tr>
</tbody>
</table>

Source--

Bibliography No. 56
Figure No. 12

DAILY SUMMARY HAULING DATA

Mill No. __________ Date __________ Observer __________

No. Tractors or Trucks __________ No. trips __________

Capacity of equipment __________ Total distance __________

Average distance __________

Arrive woods __________ Leave woods __________

Productive time __________

Recorded delay time __________

Unrecorded delay time __________

Total hours paid __________

Gross scale __________

Net scale __________

Source—Bibliography No. 56
Figure No. 13
LUMBER TALLY

<table>
<thead>
<tr>
<th>Mill No.</th>
<th>log no.</th>
<th>Inspector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Species</td>
<td>Tallyman</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B &amp; Btr.</th>
<th>#3 &amp; C</th>
<th>#1 Box</th>
<th>#2 Box</th>
<th>#3 Dim.</th>
<th>Box bark strips</th>
</tr>
</thead>
<tbody>
<tr>
<td>T W L</td>
<td>T W L</td>
<td>T W L</td>
<td>T W L</td>
<td>T W L</td>
<td>T W L</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B &amp; B Bark strips</th>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>T W L Scale</td>
<td>T W L G Scale</td>
</tr>
</tbody>
</table>

Source: Bibliography #56
Figure No. 14
TIMERS' FORM

<table>
<thead>
<tr>
<th>Mill No.</th>
<th>Date</th>
<th>Observer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log No.</td>
<td>Method of Sawing</td>
<td>No. Resaw Cuts</td>
</tr>
</tbody>
</table>

Source: Bibliography #56
BIBLIOGRAPHY


2. Editorial, Timberman, October 1938

3. Rapraeger, E. F., Results and Application of a Logging and Milling Study in the Western White Pine Type of Northern Idaho.

4. Ryan, Walter J., Timberman, October 1938, "President's Address"

5. Richards, E. C. M., Forestry News Digest, October 1938, "A Challenge to the Forestry Profession"

6. Forestry News Digest, October 1938, "Tells About Forest Products Laboratory"

7. Manning, E. C., Chief Forester Province of British Columbia, Forestry News Digest, October 1938, "Forests of British Columbia Face Changing Conditions"

8. Woods, J. B., Forester National Lumber Manufacturers' Association, Forestry News Digest, October 1938, "Lumber Industry Stands Ready to Present Definite Program to Forestry Committee"

9. Forestry News Digest, October 1938, "State Foresters Meet"

10. Ebner, Dr. Adalbert, Munich, Forestry News Digest, October 1938, "Germany Reorganizes Field of Private Forestry"

11. Forestry News Digest, October 1938, "Private Forest Industries Look at Public Cooperation"

12. Welch, Fay, Forestry News Digest, October 1938, "The Place of Forest Recreation in Forestry"

13. Ickes, Harold L., Secretary of Interior, Forestry News Digest, "Conservation Can Best Be Served by Unity"

14. Wilson, Ellwood, Forestry News Digest, October 1938, "Some Recent Aspects of Forestry in Canada"

15. Forestry News Digest, October 1938, "Timber Prices Firmer Than Other Farm Crops"
16. Forestry News Digest, October 1938, "Companies Exhibit Pulpwood Cutting"

17. Fritz, Emanuel, Consulting Forester, West Coast Lumberman, November 1938, "How Much Forestry Is Needed in the Redwoods for Continuous Production?"

18. Schatz, L. W., West Coast Lumberman, November 1938, "Selective Logging"

19. Careers in Forestry, U.S.D.A. Miscellaneous Publication No. 249

20. Kirkland, Burt P. and Brandstrom, Axel J. F., Selective Timber Management in the Douglas Fir Region

21. Mason, David T., Timberman, October 1929, "Selective Logging and Its Application in the Douglas Fir Region"


24. Stevens, Carl and Bruce, Donald, Timberman, November 1931, "Selective Cutting"

25. Anderson, I. V., Timberman, November 1934, "Why Selective Cutting of Ponderosa Pine Pays"


27. Ashe, W., Southern Lumberman, 1925, "Cutting to Increase the Margin of Profit"

28. Ashe, W., Southern Lumberman, 1924, "Economic Waste in Cutting Small Timber"

29. Ashe, W., American Lumberman, 1926, "Relation of Size of Trees to Logging Costs, Stumpage Values and Profits"

30. Brundage, M. R., Krueger, M. E., Dunning, Duncan, The Economic Significance of Tree Size in Western Sierra Lumbering"

31. Ashe, W. Scientific Monthly, 1930, "The Tree That Does Not Yield a Profit"
32. Ashe, W. W., The Lumber Manufacturer and Dealer, "When and Where Can Small Top Logs Be Removed at a Profit?"


34. Brandstrom, A. J. F., West Coast Lumberman, 1931, "Logging Profitable Logs; A Discussion of Economic Selection in Logging"

35. Garver, R. D., Southern Lumberman, 1934, "Selective Logging" and "Article X"


37. Gibbons, W. H., West Coast Lumberman, 1930, "How Size of Tree Affects Cost of Production"


40. West Coast Lumberman, 1934, "The Hines Plan of Selective Logging"

41. Krueger, M. E., California University Agricultural Experiment Station Bulletin No. 474, 1929, "Factors Affecting the Cost of Tractor Logging in the California Pine Region"


43. Mason, D. T., and Bruce, Donald, Reply of Advisory Committee to Timber Conservation Board, "Sustained Yield Forest Management as a Solution to American Forests Conservation Problems"

44. Zon, Raphael, United States Department of Agriculture Yearbook, 1927, "Timber Cutting by Selective Logging Replacing Old Way"

45. Madigan, F. H., West Coast Lumberman, 1934, "Selective Logging in the Douglas Fir Region"
46. Madigan, F. H., Timberman, 1933, "Tractors Ideal in Selective Logging"

47. Woods, J. B., American Forests, 1931, "Selective Cutting in Western Yellow Pine"


49. Munger, Thornton T., Ex-Director Pacific Northwest Forest Experiment Station, U.S.F.S., "Practical Application of Silviculture to Overmature Stands now Existing on Pacific Coast"

50. Matthews, Donald Maxwell, Professor of Forest Management, School of Forestry and Conservation, U. of Michigan, Management of American Forests.

51. The Oregonian, newspaper, January 15, 1939

52. "Forest Resources of Douglas Fir Region—Summary of the Forest Inventory of Western Oregon and Western Washington", issued by Pacific Northwest Forest Experiment Station, July 17, 1934.

53. Hawley, Ralph C., The Practice of Silviculture.

54. McIntyre, R. W., Log Scaling in the Douglas Fir Region.


56. "Plan of Work for an Industrial Forestry Investigation Among the Band Sawmills of the South Central Atlantic Coastal Plain Cutting Loblolly Pine," Forest Products Laboratory, Madison, Wisconsin.