THE RELATIONSHIP BETWEEN LOG CHARACTERISTICS AND LUMBER GRADE RECOVERY IN SECOND-GROWTH DOUGLAS FIR

by

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THE RELATIONSHIP BETWEEN LOG CHARACTERISTICS AND LUMBER GRADE RECOVERY IN SECOND-GROWTH DOUGLAS FIR

INTRODUCTION

Objectives

A major problem confronting the forest products industry of the Pacific Northwest today is the determination of the product values obtainable from logs which vary in size and quality. Additional information is needed to determine the best utilization of various classes of logs. Log grades alone are not always a sufficient measure of log value. Often they are so broad in classification as to include profitable and unprofitable logs in the same grade, regardless of the method of utilization.

The present study is an attempt to provide additional information on the value of second-growth Douglas fir logs for lumber production. The study attempts to segregate small, second-growth logs into three classes based on anticipated recovery values. It is hoped that this study may supplement other investigations of log quality and log values in order to provide the forest products industries with more critical measures of raw material value.

Specifically, this study is an attempt to correlate the surface characteristics of knot diameter,
and rate of growth (as measured by annual rings per inch) to the lumber grades recovered from second-growth Douglas fir logs. It is hoped that this study will indicate the desirability of further study in this direction. A recommended procedure for conducting the mill studies necessary to gather data is included.

**Scope**

The study was limited to second-growth logs for the following reasons:

1. The amount of defect occurring in second-growth logs is generally less than that occurring in old-growth timber. Defects such as rot and shake obscure the effect of knot size and ring count on lumber value.

2. The types and sizes of lumber cut from second-growth are fewer than those cut from old-growth, thus making the compilation of data a simpler matter.

3. Second-growth timber has received much less attention than old-growth in regard to quality and value.

4. The approach of a second-growth economy should prompt increased study of this class of material.

The present study started with logs at the mill pond. It may prove desirable, later, to record data in the woods; following the logs from the growing site to the mill green chain.
The lumber cut from the logs studied was graded and tallied at the green chain, without consideration of losses or degrade that might occur in subsequent handling.

**Background**

Second-growth Douglas fir, as defined by the Douglas Fir Second-Growth Management Committee, refers to forest stands not older than the 160 year age class (3, p. 1). This definition does not mention economic maturity, but with present lumber prices the marginal tree is about one-half the above age on the good sites. The term "second-growth", as used in this paper, will follow the above definition.

A considerable amount of this smaller timber is being cut today in the Pacific Northwest. In the state of Oregon 27 percent of the total cut in 1945 was classed as second-growth (3, p. 3). In 1945, 48 percent of the commercial forest land of the Douglas fir region was covered with second-growth timber (10, p. 357). Present plans call for cutting rotations of 80 to 100 years, which will make available a continuous supply of second-growth timber.

The first problem to confront the forest products industry of the Pacific Northwest, in its use of second-growth fir, concerned the strength of this wood as
compared to wood of old-growth fir. The primary factor affecting strength is specific gravity, as indicated by rate of growth. Schrader, and others, working with second-growth Douglas fir in Washington found that the strength of second-growth, if it contains 6 or more annual rings per inch, is equal to or superior to that of old-growth in all respects (7, p. 18). The studies of Wangaard and Zumwalt (8, p. 23) have shown that second-growth Douglas fir with a specific gravity comparable to old-growth has equivalent strength values.

These studies show that the retention of the 6 rings per inch and 4 rings per inch rules applied to stress grades of Douglas fir are essential to good lumber grading practice. The fast growth rate of young stands in the Pacific Northwest will cause increased application of these provisions of the grading rules.

The log grading rules of the Columbia River Log Grading Bureau were changed in 1949 to include a log grade for second-growth Douglas fir. This new sawmill log grade includes those logs in which more than 10

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1. The rules referred to are the No. 14 grading rules of the West Coast Bureau of Lumber Grades and Inspection (9). They are used almost universally in grading Douglas fir lumber.
percent of the diameter is sapwood. The grade also includes those logs which contain less than 4 annual rings per inch in the outer portion of the diameter at the small end. The grade has been designated as second-growth Douglas fir sawmill logs.

Second-growth fir also can be placed in No. 2 or No. 3 sawmill log grades as defined by the Columbia River Log Grading Bureau. The principal difference between these two grades lies in the anticipated lumber grade recovery. No. 2 logs must produce 65 percent of No. 1 Common or better lumber, while No. 3 logs must produce 50 percent of the net scaled contents as No. 2 Common or better lumber. These grades are assigned by the scaler primarily on the basis of his own judgment. A maximum knot diameter of 2\frac{1}{4} inches for No. 2 logs, and of 3 inches for No. 3 logs has been designated by the Bureau. Number 2 sawmill logs must be at least 12 feet in net length and 12 inches in diameter (2, pp. 69-72). This log grading procedure provides a partial basis for the open market log prices.

An indication of the lumber grades obtainable from second-growth Douglas fir logs is contained in a study conducted by the Pacific Northwest Forest and Range Experiment Station and reported by N. P. Worthington (11). This study included observations at
four small mills in western Washington. These mills were representative of many small mills cutting second-growth fir, being equipped only with a circular head saw, edger, and cutoff saw. Utilization in mills of this type is generally rather poor and often accompanied by inaccurate sawing. Worthington states that little difference was found between the lumber grades recovered from No. 2 and No. 3 sawmill logs. Only a very few rough logs over 12 inches in diameter cut less than 65 percent of No. 1 Common lumber, which is the requirement for No. 2 sawmill logs.

Mill studies conducted with old-growth Douglas fir have shown that a relatively high percentage of logs graded as No. 3 sawmill actually produced over 65 percent of No. 1 Common and better lumber (4, p. 88).

The U. S. Forest Products Laboratory has reported several studies in second-growth Douglas fir. One study related lumber grade recovery to site quality of the stand from which the logs were taken. It was shown that the quality of lumber recovered from site II was lower than the quality recovered from site IV. The principal reason for this was that the trees grown on site II contained larger knots and more loose knots than the trees grown on site IV (6, p. 2).

A companion study conducted at the same time
analysed the knots in second-growth Douglas fir (5). This associated study provided much needed information on the character and development of knots in logs from different sites and the effect of these knots on lumber quality.

Some studies have been conducted on log value classification in other species. One example of the use of quality estimation in timber cruising has been shown in hardwoods in the South. The tree grading procedure used was based upon percentage of clear cuttings on the next-to-the-poorest face of the butt log (1, p. 245). Studies such as this have demonstrated the practicality and need for quality log and tree grading.

PROCEDURE

Preliminary mill studies

The process of gathering data for mill studies of the type reported here is a relatively new one. Mill studies in second-growth Douglas fir have been comparatively few in number and little precedent for procedure has been established. Two preliminary mill studies were made in order to establish a procedure that would supply the desired information.

A small mill, in this investigation, is considered to be one whose daily cut is less than 35,000 board feet.
These sawmills are generally equipped with a circular head rig, edger, and swing cutoff saw. Any sawmills containing resawing equipment would require a more complicated procedure than that described here.

1. Rose Brothers' mill study. The first mill study conducted in this investigation was made at Rose Brothers' Lumber Company, located near Philomath, Oregon. This mill was selected for its accessibility, large log pond, and the cooperative spirit of its owners.

The logs were studied prior to the actual day of cutting and then stored in a pocket in one corner of the log pond. A copy of the study form used is included in the Appendix. Study logs were selected within the diameter range of 8 to 24 inches.

On the day of the study, two men helped the pond man move the study logs into the mill. The head-sawing time for each log was recorded. The lumber produced from each log was marked in the mill and then tallied at the green chain by size and grade. The reason for the grade was noted. This study revealed several mistakes in study methods and procedure.

The first problem encountered was that of segregating logs already studied from those study logs that had not been charted. This could be avoided by using a log pocket for charted and for uncharted study logs.
The second problem was that of marking the logs properly so the numbers could be read easily after several days of storage in the pond. Investigation of this subject showed that a numbering hammer or special paint stick are the best marking tools. The numbering hammer will permanently indent the log study number in the end of the log. It was found that yellow Markal "B" paint stick, made by the Markal Company, 3052 W. Carroll Avenue, Chicago 12, Illinois, worked well on logs which were stored for several days. Logs stored longer than this should be marked with the hammer.

Several errors were made by the lumber marker in the mill because of confusion on log sawing numbers. A blackboard placed in full view of all markers should be used to display the sawing number of the log on the carriage at that particular moment. The man doing the timing can keep the log numbers posted on the board.

The last problem occurred during the tabulation of data. It was observed that the method used to take ring count measurement was not satisfactory. Further study was needed to determine a practical measure of rate of growth.

2. **School mill study.** A second preliminary study was conducted at the School of Forestry sawmill,
Oregon State College, to secure a satisfactory measure of ring count. This problem was worked out and sufficient data taken on other variables to determine those which seemed to affect the lumber grade recovery. A shortened log study form was designed on the basis of this information.

**Recommended procedure**

As a result of these preliminary studies, an outline of all factors to consider in conducting this type of mill study was drawn up. This outline is included in the Appendix. It should furnish a definite guide to those making similar investigations. A mill study, in which this outline was followed, is described below.

**Dog Face mill study**

The third mill study made in this investigation was conducted at the Dog Face Lumber Company, Corvallis, Oregon. The purpose of this study was to gather the necessary data and to test the recommended procedure, using the outline in the Appendix. The following report of procedure used in this third study will serve as an example of applying the recommended procedure to a specific problem.

The preliminary studies had shown several external
log characteristics to have little effect on lumber quality. Therefore, by eliminating some of these characteristics and condensing other information, it was possible to study the logs on the day of cutting. As the logs entered the mill, they were observed and all the pertinent data recorded. The preliminary studies had also produced an effective measure of rate of growth. The log study form and lumber tally sheet are shown in the Appendix.

Mill selection in this case was simplified by the continuous method of studying the logs, making log storage provisions unnecessary. The mill was selected primarily on the basis of accessibility, efficiency of cutting, and cutting practices, that is, the sizes and type of products cut. The mill had to be one whose lumber cutting practices were typical of the many small mills cutting second-growth Douglas fir. These mills cut dimension lumber primarily, with timbers coming from the heart of some logs. One inch boards are usually limited to the outside of the larger logs.

The owners of the mill were contacted and their interest and cooperation insured. The results of the timing study were made available to them in appreciation of their cooperation.

A visit was made to the mill prior to the study
for the purpose of determining the distribution of man-
power and the presence of any complications to the study.

The men were stationed in the mill in the manner
shown in Figure 1, which is a mill floor plan. Each
cross denotes the position of one man, a total of 10 being
necessary.

1. At the log pond. As the logs were bucked at
the pond saw, the lengths were marked on the logs by the
pond sawyer. Pike poles were used to pull the study logs
against the floating walk. Two men handled the logs and
the third recorded the information in an engineer’s field
book. These data were later transferred to the study
forms. One of the men held the log against the walk with
a pike pole and turned it over in the water, to enable the
man measuring knots to see all surfaces. The latter
scaled the log and took the knot measurements. Knot
diameters were measured as the average diameter of the
actual branch base, neglecting the distorted and swollen
portion surrounding the actual knot. Knot indicators
were measured as the diameter of the hole in the bark.
Not all knots were actually measured, because the
diameter could be estimated ocularly with frequent checks
of estimates by measurement. The log observer called out
the information as he determined it. The third man wrote
Legend

+ Study van

1 Pond saw
2 Log slip
3 Log deck
4 Carriage
5 Circular head saw
6 Edger
7 Trimmer
8 Trimmer
9 Green chain
this down. After the logs were studied, the log number was marked on the end facing the mill head saw, using the special paint stick. After the logs left the water, the recorder took the measurements of ring count at the small end, using a Biltmore stick. The diameter of the core containing less than 4 rings per inch and the diameter of the core containing less than 6 rings per inch were recorded.

2. In the mill. The timer was located behind the off-bearer in the mill. He was equipped with a stop watch, and paper on which to record the sawing times. He also had chalk, and a blackboard displayed in full view of the lumber marker.

As a log was placed on the carriage, this man wrote the number of the log on the blackboard. The lumber markers could then refer to this number to determine the proper color crayon and log number to use in their marking.

The logs were timed from the point where the carriage started its return for the next log until the last board was dropped off in preparation for the next log. This procedure was necessary because the timer could not see the carriage when it was loading. It also insured that high loading time due to a small size log was charged to that log.
The markers were equipped with 4 colors of lumber crayon. These were used in a continuous sequence. By pre-arranging the color sequence to be used, the men on the green chain were able to draw up a list of log numbers with the proper color to be used for each log.

One of the lumber markers was stationed beside the edger. As the boards emerged from the edger, he held the crayon on the board, giving the board a mark, in proper color, along its length. Lumber not going through the edger was also marked by this man.

A marker was stationed farther along the roll case. As the boards dropped onto the transfer chains going to the trim saw, he was able to write the actual log number on many of them. This further insured accuracy of log numbers.

3. At the green chain. As the lumber came out on the green chain it was graded by a grader supplied by the West Coast Bureau of Lumber Grades and Inspection. Two men were available for tallying the lumber by size, grade, and reason for degrade. These men alternated on each log, with one tallying as the other prepared for the next log. An additional man should be available here for smooth operation. Because of sudden pile-ups of lumber, the tallymen often fell behind in recording.
This additional man could catch information that might otherwise be lost and in general aid the grader and tallymen.

4. **Log summary.** The data recorded at the green chain was summarized on a form designed for this study. This form showed the totals and percentage of each grade recovered and the reasons for the grade assigned. A copy of the form is shown in the Appendix.

A complete picture of the study logs and the lumber recovered from them was shown on the log study form and lumber summary sheet. It was from these data that the analysis was made.

**Additional data**

Considerable data can be gathered during a mill study of the type described. The primary purpose of the study should receive first consideration, but other data can be collected with little extra effort and manpower. An example of this additional information, which may be of particular value to the mill owners, is the timing of the head sawing operation.

The head saw of most small mills determines the mill production rate. As a result, the amount of time a log is on the carriage is a good measure of the mill
production time for that log. The cost of production for each log may be calculated by multiplying the cost of operation per minute by the time (in minutes) taken to cut the log on the head rig. Subtraction of this production cost from the value of the lumber recovered from the log, will give the marginal pond value of that log. A lumber summary sheet, devised for this study, that can be used to find this marginal pond value is shown in the Appendix.

A record was kept of the sawing time of nearly all logs cut during the Dog Face mill study. The logs were then grouped according to diameter and length classes. The diameter classes were these: 9 and 10 inch logs; 11 and 12 inch logs; 13 and 14 inch; 15 and 16 inch; and 17 and 18 inch logs. Sawing time per thousand board feet for each length and diameter class was computed by dividing the total sawing time for the class by the board feet of lumber contained in that class and then multiplying by 1000. These sawing times per thousand board feet were then plotted over the diameter classes for each length of log. The family of curves resulting were so close to each other that sawing time, in this study, proved to be independent of log lengths between 12 and 22 feet, inclusive.

Since sawing time was found to be unaffected by log length, the sawing time per thousand board feet for
all log lengths was plotted over log diameter. The resulting curve is shown in Figure 2. This curve shows that the sawing time per thousand board feet increases rapidly with decreasing log diameters, over the range of diameters studied. This increase in time also increases the cost per thousand of sawing the smaller logs. The lack of cost data, at present, prevented the computation of marginal log value, but such a procedure could easily be followed. The information could be furnished to the mill owners in appreciation of their cooperation.

ANALYSIS OF DATA

Measure of lumber quality

Before a correlation of log surface characteristics and lumber recovery could be established, a satisfactory measure of lumber quality had to be devised. One measure of lumber quality was the percentage of Select lumber, including Clears, contained in the lumber recovery of each log. The other measure used was the percent of No. 1 Common and better lumber contained in the lumber recovery. Another measure of lumber quality is the dollar value of the lumber tally for each log. This measure is a possibility for future studies, although it may not be too satisfactory at some small mills because of the practice of selling all grades at a flat price for the
Sawing time and log diameter

Figure 2
mixture.

Log selection

Study logs were selected over the diameter range of 8 to 24 inches. Any logs which obviously contained rot, shake, split, or crook were not included, because these defects obscure the effect of knots on lumber quality. For example, if a board contained knots of a size limiting it to No. 1 Common and shake which brought it down to No. 3 Common, the knot relationship was not recorded on the lumber tally sheet. Defects such as rot, shake, splits, crook, etc. should be considered in arriving at the net scale and not in determining log quality.

Analysis of the lumber degrade showed considerable degrade in some cases for mismanufacture. This too obscured the effect of knots and other natural characteristics. Therefore, those study logs which contained more than 10 percent degrade for mismanufacture were discarded. Some mismanufacturing degrade is inevitable in mills of the type studied, so logs which did not contain an excessive amount of miscut lumber were included in the analysis.

Maximum knot size

The study logs were divided on the basis of
maximum knot size into inch knot size classes. It was found that the quality of lumber recovered varied inversely as the size of the largest knots on the log. Although the number of knots of maximum size was recorded, this variable was found to have no apparent relationship to the lumber quality recovered. The probable reason for this is the manner of grading dimension Douglas fir lumber. This lumber is used primarily for construction purposes and as such is graded for strength, rather than appearance. Strength of lumber is primarily affected by knot size rather than number of knots.

Table 1 shows the average lumber grade recovery and log diameter by knot size classes.

<table>
<thead>
<tr>
<th>Knot Size Class</th>
<th>Log Dia. (inches)</th>
<th>Percent No. 1 &amp; Selects</th>
<th>Btr.</th>
<th>Logs</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0-1&quot; inc.)</td>
<td>12.53</td>
<td>29.32</td>
<td>85.76</td>
<td>107</td>
</tr>
<tr>
<td>(1²-2&quot; inc.)</td>
<td>12.88</td>
<td>18.03</td>
<td>69.00</td>
<td>61</td>
</tr>
<tr>
<td>(2²-3&quot; inc.)</td>
<td>13.15</td>
<td>15.04</td>
<td>73.77</td>
<td>27</td>
</tr>
<tr>
<td>(3²-4&quot; inc.)</td>
<td>16.00</td>
<td>12.33</td>
<td>73.00</td>
<td>9</td>
</tr>
<tr>
<td>(4²-5&quot; inc.)</td>
<td>17.40</td>
<td>10.40</td>
<td>84.20</td>
<td>5</td>
</tr>
<tr>
<td>(5²-6&quot; inc.)</td>
<td>18.46</td>
<td>0.50</td>
<td>47.04</td>
<td></td>
</tr>
</tbody>
</table>
This table includes some of the log data taken during the preliminary studies, because of the shortage of logs in the higher knot diameters. There is still an evident lack of logs in these classes. Therefore, conclusions drawn from this table should be only tentative until additional data are available.

**Log diameter**

Worthington (11, p. 64) reported that there was a slight decrease in the quality of lumber taken from logs of the larger diameters in second-growth Douglas fir. He stated that this may be due to the smaller logs having smaller limbs and correspondingly higher quality lumber.

Paul, in his study of knots in second-growth Douglas fir, found this to be the case (5). The present investigation shows an increase in knot sizes with increasing diameters, as evidenced by Table 1. This increase in knot size has been shown to cause a decrease in lumber quality recovery. Therefore, since knot size and log diameter are apparently correlated, any decrease in lumber quality due to either of these causes would be taken care of by knot size measurement.

**Total knots**

No apparent relationship was found between the
In nearly all lumber grades of Douglas fir the allowable size of loose knots is smaller than that of intergrown knots. Therefore, it would be logical to assume that dead knots would degrade lumber more than live knots of the same size. This was found to be true, but only if all or nearly all of the knots were dead. Even under these circumstances the additional degrade was very little. Paul (5, p. 10) found that the radial length of dead knot portions of branch bases in timber of the same size as that studied here was about 3 inches. It varied with the diameter of the tree, but 3 inches seemed to be the average. In sawmills of the type studied, the sawyer will usually slab off a good share of the dead knot
portion. This study showed the character of the knots to have slight effect on lumber grade recovery.

Clear quarters

Those occasional second-growth fir logs which do contain one or more clear quarters, due no doubt to density of stocking, definitely show an improved lumber quality. A clear quarter is defined as one face of the four log faces which is completely free of knots. Nearly all logs containing clear quarters are found in the 1-inch knot diameter class. Those logs which are in the higher knot classes and contain clear quarters show a quality of lumber recovery high enough for recognition in classification.

There were 6 logs, in this investigation, which contained one or more clear quarters and knots larger than 1 inch. The lumber recovered from these logs averaged 36 percent Selects and 89 percent No. 1 Common and better. Thus, it would seem that any log containing a clear quarter should be placed in the highest log quality class.

Rate of growth

Rate of growth, as measured by the number of annual rings per inch, is an important factor in determining the
grade of Douglas fir dimension lumber, because of its recognized effect upon strength.

The grading rules have defined three classes of grain or rate of growth. These classes are: close grain, 6 or more annual rings per inch; medium grain, 4 or 5 rings per inch; and coarse grain, less than 4 rings per inch.

Select structural material, the highest grade of dimension lumber, must have close grain while No. 1 Common, the next highest grade, must have medium grain in most items. Since, in this study, the percentage of Selects and the percentage of No. 1 Common and better were used as measures of lumber quality, it might be expected that differences in rate of growth would be reflected in lumber quality.

The quality of lumber recovered from logs in this study did not show the expected relationship to rate of growth, as measured by ring count. For example, a group of nine logs with coarse-grained cores amounting to approximately one-half the log diameter (6.6 inches in 14 inch logs) produced lumber averaging 91 percent No. 1 and better. Although the lumber produced from a coarse-grained core should fall below No. 1 Common in quality, the methods of sawing may obscure the effect of the coarse grain. Even 2-inch pieces cut from the coarse-
grained center of logs may contain enough medium grain to raise the grade to No. 1 Common.

Several measures of growth rate were tested, but none gave a completely satisfactory correlation with lumber grade recovery. The percent of log diameter containing medium plus coarse grain (less than 6 rings per inch) did appear to have a partial relationship to lumber quality. Even in this case, the correlation did not apply over the complete range of logs, that is from logs containing no close grain to logs containing all close grain. The logs in which more than 65 percent (roughly 2/3) of the diameter, small end, contained less than 6 rings per inch, did show a definite drop in lumber quality, but those with less than 2/3 of the diameter as medium plus coarse grain showed no definite trend. Table 2 illustrates this point. Stated another way, a log in which more than 1/3 of the diameter was close-grained (6 or more rings per inch) yielded lumber of better quality than logs which did not meet this specification.
TABLE 2. Relationship of Growth Rate To Lumber Grade Recovery (as measured by the percent of medium plus coarse-grained wood in a log and the percent of Select lumber recovered).

<table>
<thead>
<tr>
<th>Diameter of core with less than 6 rings per inch as a percent of log diameter at the small end</th>
<th>Select grades of lumber as a percent of total lumber recovered</th>
<th>No. of logs (Average) (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 to 40</td>
<td>53</td>
<td>16 to 80</td>
</tr>
<tr>
<td>45 to 60</td>
<td>28</td>
<td>0 to 71</td>
</tr>
<tr>
<td>65 to 80</td>
<td>7</td>
<td>0 to 17</td>
</tr>
<tr>
<td>85 to 100</td>
<td>5</td>
<td>0 to 10</td>
</tr>
</tbody>
</table>

RESULTS OF ANALYSIS

The data from the limited number of logs studied indicate that second-growth Douglas fir logs might be divided into three quality classes based on maximum knot size, presence or absence of clear quarters, and the amount of coarse plus medium grain present as measured on the small end of the log. These three variables were the only ones found which could be correlated with the quality of lumber recovered. These three variables are also rather easy to measure and therefore practical in their use.
The data gathered are limited and thus the dividing line between classes may be less distinct than desired. However, from these data, the suggested specifications are as follows:

**Class A logs** are all those containing clear quarters. This class also includes those logs having knots no larger than 1-inch in diameter, providing that more than 1/3 of the top diameter is close-grained wood.

**Class B logs** are those logs with knots between 2 and 5 inches, inclusive, in diameter, providing that more than 1/3 of the top diameter is close-grained wood. This class also includes logs with 1-inch knots in which 1/3 or less of the diameter is close-grained wood.

**Class C logs**, the poorest class, are those logs having knots over 5 inches in diameter and those logs with knots larger than 1 inch but in which 1/3 or less of the diameter is close-grained wood.

The limited data gathered thus far indicates the following average lumber grade recoveries from each of the three log classes:
### TABLE 3. Average Lumber Grade Recovery By Tentative Log Quality Classes For Second-Growth Douglas Fir.

<table>
<thead>
<tr>
<th>Log quality class</th>
<th>No. of logs</th>
<th>Select grades of lumber as a percent of total lumber recovery</th>
<th>No. of No. 1 Common &amp; Btr. lumber as a percent of total lumber recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A</td>
<td>75</td>
<td>36</td>
<td>94</td>
</tr>
<tr>
<td>Class B</td>
<td>58</td>
<td>17</td>
<td>76</td>
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<tr>
<td>Class C</td>
<td>30</td>
<td>5</td>
<td>57</td>
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</tbody>
</table>

### RECOMMENDATIONS

1. This study has shown that there are definite classes of second-growth Douglas fir logs, based upon the quality of the lumber contained in those logs. These classes have been tentatively defined from a limited number of logs. It is, therefore, recommended that further investigation of this subject be made, particularly in logs with large knots, to more exactly determine the class limits and grade recoveries.

2. The procedure, outlined in the Appendix, has been tested and is recommended to those desiring to conduct further study.

3. There is a possibility that the dollar value of the lumber recovered from study logs would be a
better measure of quality than percent Selects or percent No. 1 Common and better. This should be tested in future studies. Use of these data and mill production costs, based on head sawing time, would provide the mill operators with a more complete picture of the profit margins for various classes and sizes of logs.
BIBLIOGRAPHY


APPENDIX
**PRELIMINARY STUDY FORM**

<table>
<thead>
<tr>
<th>Log No.</th>
<th>Log Grade</th>
<th>Sawing No.</th>
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<tr>
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<table>
<thead>
<tr>
<th>Log length</th>
<th>Top dib</th>
<th>Butt dib</th>
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<tr>
<th>dob</th>
<th>deb</th>
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<table>
<thead>
<tr>
<th>Gross scale</th>
<th>Deductions</th>
<th>bd. ft. for</th>
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</table>

<table>
<thead>
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<th>Net scale</th>
<th>bd. ft. for</th>
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<table>
<thead>
<tr>
<th>Cu. vol. of log</th>
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<table>
<thead>
<tr>
<th>Type of defect and size</th>
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</table>

<table>
<thead>
<tr>
<th>Rings per inch</th>
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</table>

**Exterior characteristics:**

- **Slope of grain:**
  - excessive
  - not excessive

- **Worm holes:**
  - pin, limited
  - large, scattered

**Knots:**

```


```

**Legend:**

- Live knot
- Knot indicator
- Dead knot
- Burts

**Top**

**Butt**

**Remarks:**

```
OUTLINE OF MILL STUDY PROCEDURE

I  Mill selection

A. Suitability of mill for data desired
   1. Raw material - is it of the proper size
      range and quality to
      provide desired data
   2. Cutting practices - are the cutting
      practices representative
   3. Manufacturing standards
      a. Efficiency - does the mill operate
         efficiently as a rule
         so that production time
         and costs would have
         meaning; is equipment
         well maintained
      b. Utilization - does the mill have
         reasonably good utilization standards, thin
         slabs, good edging,
         good trimming, no more
         than average variation
         in sawing

B. Suitability of mill for study
   1. Accessibility - is the mill nearby so
      that trips are short
   2. Cooperation of mill management
   3. Ease of study - considering the follow-
      ing factors, is the mill
      suitable for conducting
      a study

   a. Log storage
      1) Type
         a) Pond
         b) Cold deck
         c) Hot deck
      2) Accessibility of logs for
         initial selection
      3) Place for log observation -
         is there a suitable
         place to study logs
         and take data
4) Place for study log storage, if logs studied prior to date of cutting
   a) Ease of moving logs to and from study and/or storage areas
   b) Capacity of storage area - will it hold logs needed

b. Mill layout and lumber flow

1) Log bucking location - is there available space for studying logs between pond saw and log slip

2) Log deck
   a) Accessibility of logs for taking data and marking or remarking logs
   b) Time allowable for above

3) Head saw - location of timer as to:
   a) View of operation
   b) Unobtrusiveness
   c) Safety
   d) Blackboard location

4) Off-bearer rolls - possibility of marking lumber at this point

5) Edger
   a) Possibility of marking lumber at this point
      (1) Does all lumber pass through edger
      (2) Can marker reach lumber not passing through edger

   b) Location of marker
      (1) Can marker see blackboard
      (2) Will marker interfere with employees
(3) Safety

6) Trimmer
   a) Possibility of marking lumber at this point
   b) Can marker see blackboard

7) Possibility of marking at intermediate point on roll case or transfer chains

8) Green chain
   a) Grading
   b) Tallying

II Preliminary planning

A. Plan of mill
   1. Location of men - where are study men to be placed
   2. Briefing the crew - do study men all know their duties

B. Data desired
   1. Log observation
   2. Timing
   3. Lumber recovery - lumber tallied by:
      a. Sizes
      b. Grades
      c. Reason for degrade
   4. General
      a. Cost data
         1) Operational cost
         2) Fixed cost
      b. Actual hours of cutting on an average day
      c. Product values at the green chain
      d. Log costs
C. Method of obtaining data
   1. Log observation
      a. Men required
         1) Selecting logs
         2) Marking logs
         3) Moving logs
         4) Storing logs
         5) Studying logs
         6) Recording logs
      b. Points to consider
         1) Log segregation and storage
         2) Log marking
            a) Permanency required
            b) Legibility
            c) Marked at point of first recorded observation
            d) Remarking
   2. In the mill - men required
      a. Log observation
      b. Timing - blackboard
      c. Lumber marking
      d. Grading
      e. Tallying
      f. Supervision
III Study procedure

A. Make log observation

B. Mark log number and note of sawing number if different than study number

C. Time head saw cutting time

D. Mark log sawing number on blackboard

E. Mark lumber

F. Grade and tally lumber
FINAL STUDY FORM

Log No. ______

Log Grade ______ Sawing No. ______

Log length ______

Top dib ______

Butt dib ______

Deductions:

Gross scale ______

Net scale ______

Cu. vol. ______

Diam. w/less than 6 rings ______

Diam. w/less than 4 rings ______

Log characteristics:

Max. knot size: Live knots ______ (fill in 1 or more)

Knot indicators ______

Dead knots ______

Burls ______

Approximate number of knots of max. size: ______

Approx. no. of total knots ______

No. of clear quarters ______

Remarks: ________________________________

% over or underrun ______

Top ______ Butt ______

(sketch unusual end features)

<table>
<thead>
<tr>
<th>Size:</th>
<th>Length:</th>
<th>Grade:</th>
<th>B. F.:</th>
<th>Reason for degrade</th>
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(continue on back)
### SUMMARY OF LUMBER RECOVERY

**LOG NO. _____**

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<tr>
<th>Grade</th>
<th>Knots:</th>
<th>Holes:</th>
<th>Grain:</th>
<th>Grain:</th>
<th>Stain:</th>
<th>Decay:</th>
<th>Wane:</th>
<th>None:</th>
<th>Total:</th>
<th>Percent:</th>
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<tr>
<td>Knot</td>
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<td>Size</td>
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<tr>
<td>&amp;</td>
<td>Knots</td>
<td>Split:</td>
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<td>Spike:</td>
<td>Med.:</td>
<td>Coarse:</td>
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**Total:**

**Percent:**

---

40
## SUMMARY OF LUMBER VALUE

<table>
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<tr>
<th>LOG NO.</th>
<th>Price</th>
<th>Size</th>
<th>Grade</th>
<th>Bd. Ft.</th>
<th>per M</th>
<th>Value</th>
<th>Sawing Time</th>
<th>minutes</th>
<th>@ $</th>
<th>Total lumber value $</th>
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|      |       |      |       |         |       |       |             |         |    |                  |

|      |       |      |       |         |       |       |             |         |    |                  |


### Cost & Value

- **Total lumber value**: 
- **Total milling cost**: 
- **Pond Value per M**: 
- **Pond Value per M (net log scale)**: 
- **Cost of log in pond (per M, net log scale)**: 
- **Margin on this log (per M, net log scale)**: 
- **Per M, lumber tally**: 
- **Total for log**: 

### Board Feet

<table>
<thead>
<tr>
<th>Lumber Tally</th>
<th>Gross Log Scale</th>
<th>Net Log Scale</th>
<th>Underrun or Overrun</th>
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<tbody>
<tr>
<td>Clear grades</td>
<td>B.F. Percent of</td>
<td>Percent of</td>
<td>Percent of</td>
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