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THE ECONOMIC SIZE OF LOG FOR MILL EQUIPMENT

by

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Statement of problem

The subject of the economic size of log has been long discussed. Theoretically all mills should cut only such logs as are best and easiest handled by the equipment at hand. At present all agencies agree that there is both an upper and a lower limit to the diameter of log which can be handled with facility and profit. However most literature published in relation to mills and their output either side-steps the question or touches on it only vaguely.

This problem has to be solved for each individual mill as the equipment, the orders handled and the type of timber all play a part in determining an economic size of log. It is important to know the size of log, as some logs can not be economically handled due to the time that it takes to produce a thousand board feet of lumber.

As the matter now stands most mills say, "yes, it would be nice to know, but let someone else find the figures and we'll use them."

Elton J. Lodewick say in the Timberman, (1) "Lumbermen are realizing more and more the influence exerted by log size and quality on logging and sawmill costs and profits. This is evident in the growing practice of selecting logs in the woods, the establishing of mills especially equipped to handle small logs economically, and the greater tendency to sort and hold logs for the items and grades they will yield to the best advantage. The necessity for more "cutting to order" and the need for keeping inventories of slow moving items at a minimum has brought home forcibly the need for better knowledge of the possibilities of each log. Such knowledge is obtained through carefully planned and conducted mill studies or as they are more appropriately called, mill production studies.

A mill production study determines the milling time for logs of different species, sizes and qualities, and the lumber recovery therefrom by grades and by sizes under current conditions in the mill where the study is made.

Outstanding limitation is that they are indicative only under specific manufacturing conditions, costs and selling prices in effect at the time of analysis."

Related studies

The Shevlin Hixon Company at Bend with the Pacific Northwest Experiment Station and the United States Forest Service made a study of log sizes in relation to value, taking the log from the tree to the shipping dock. (2)

The study was conducted with logs from a Shevlin tract near Bend. The tract contained 2617 acres and had a stand of over mature Western Yellow Pine with a total log scale of 464 M.

Logs were scaled, Forest Service practice, with Scribner Decimal "C" rule and were graded and marked in the woods. The boards cut from each study log were marked behind the head saw, and time was taken in seconds for each log at the headrig with stops prorated over all logs for the day. The smaller logs were sent through the gang saw, one study log or cant to each five cants going through the gang saw. The lumber was graded "as is" except for pencil trims to raise the grade of a piece.

Unfortunately for the present study the reports in the Timberman (2) do not show a statement as to the amount of lumber per minute or per man hour for the different log sizes.

However the mill has an arrangement in the mill pond to separate the logs into size classes to be used with different types of equipment. This segregation shows that they have recognized the necessity of using equipment to fit the logs.

E. F. Raperager, Assosiate Forester, in a bulletin published by the University of Idaho (3) reports on a study made in western white pine of Idaho. The study, made in 1938, was conducted by the University of Idaho, the United States Forest Service, and the Northern Rocky Mountain Forest and Experiment Station working with several private mills of the area. This report also took some trees through to the shipping dock. Times for milling and production will be found in Table I page 8.

The Raperager report (3) took the tree through the mill for a small area at one mill, while they studied only logs through the mill at several other mills cutting the same type of timber. Comparison of average cutting with that of other mills will be found on the graph page 12.

The Forest Products Laboratory at Madison, Wisconsin conducted a study in white pine in New England, (4) where it was found that the larger trees and logs graded out poorer than the intermediate sizes. This report (4) carried the log from the tree through the mill also. The results as this study was interested in them will be found in Table II page 9 and a comparison with other mill times will found on the graph page 12. There has been as yet only a preliminary report on the results.

The Forest Products Laboratory also made an extended study of the manufacture of birch, beech, and maple lumber in the northeast in 1939. (5) It carried the log from the tree through the sawmill. Results of the time study for the mill will be found in Table III and a comparison with the times of other mills will be found on the graph page 12.

R. L. Ulrich in a thesis presented at Oregon State College showed the origional data which was collected on Douglas Fir second growth. This data was collected during the fall and winter of 1935 and 1936. (6)

Personal investigation

In the fall of 1935 R. L. Ulrich and the writer decided to investigate the economic size of log for mill equipment. It was quickly discovered that there was very little material to be obtained on the subject, for this reason it was decided to do some origional research on the subject. Due to the limitations of time it was decided that a study of a small mill would have to do.

It was also known that to make a complete study of the subject a study of log grades and of the lumber grades produced should be made. Having decided to study a small mill it was known that there would be only a few pieces of the structural grades of timbers cut and thus lumber grades could be disregarded for this particular study.

Considerable difficulty was encountered in finding a finding a mill suitable for study. After several tries one was found just west of Corvallis. The owners, the Winney brothers, allowed us to gather information there.

The mill was of a 25,000 to 30,000 board foot capacity. It was cutting second growth Douglas Fir and small old growth. Logs from fourteen to twenty-four feet in length were stored on a rollway or dry pond as it was called. The headsaws were a fifty-six inch lower and a forty-eight inch upper saw. The carriage had three knees, an Armstrong setworks, and handled twenty-four foot logs easily. The dogger had to handle all three dogs and the setworks besides.

The carriage had a cable drive reverse feed motor and was handled by the sawyer. All logs were hand turned by the sawyer, the dogger, and the rollway man. If the logs were too large to be handled by the three men the rest of the mill crew was called in to help stopping all other departments while it was being done. The headrig was also used as a ripsaw when cutting anything heavier than three inches in thickness. If there was more than one piece to be ripped it was cut off the cant and laid on the rolls until the cant was finished and then it was put back on the carriage and cut into the desired widths.

The edger was a three saw table type and could handle only three inch thicknesses with two saws cutting and with all three cutting could not take anything heavier than two inches. The edger was powered from the same drive that the carriage and headsaw were driven by, making a very inefficient setup.

Dead, wooden rolls necessitated all lumber being pushed by hand when moving it. The trimsaws were overhead frame-built and had to be pulled through the lumber or timbers by hand. From the trimsaws the lumber was pushed by means of more dead rolls to the loading dock.

The logging equipment did not permit a very large choice of log lengths for cutting desired timber lengths and at one time it was found necessary to cut from two to eight feet off the ends of sound timbers to get them to length for orders. This practice of cutting up large timbers caused considerable loss of tally.

The winter was an unusually cold one for this vicinity and considerable difficulty was encountered in trying to saw frozen logs. These frozen logs caused some loss of sawing time.

For this study it was decided to take only the time which it took to get the lumber from the log through the mill. This system for all sizes of logs gave exact times for each size of log. Time was taken from the instant the carriage was in position to recieve the log until the last piece cut from the log was given to the loading dock to handle.

After a day or so it was noticed that the length of the log had very little effect upon the sawing time, so it was decided to use only diameter classes in taking the time for the logs. However length was taken into consideration when computing the scale for the individual logs. The board tally was what actually reached the loading dock from a particular log.

Results

The results of these studies will be found in the following tables, and a comparison of cutting times for all mills will be found on the composite graph page 12.

The results of the study in Douglas Fir will be found in Table IV and also on the graph page 12.

Table I

Milling Time For Idaho White Pine Logs

Log Diam inches	Sawing Method: Commercial Lbr. min / M	Sawing Method: Match Plank Lbr. min / M
5		34.4
6	25.8	25.1
7	22.7	22.0
8	20.4	18.8
9	16.5	16.1
10	15.5	13.5
11	13.6	11.6
12	13.1	10.3
13	12.2	9.5
14	13.3	9.0
15	13.3	10.6
16	12.9	10.1
17	12.5	10.3
18	12.1	10.6
19	12.2	10.8
20	12.5	11.1
21	13.3	11.7
22	12.5	12.9
23	13.2	11.9
24	14.3	13.3
25		13.7
26	19.7	14.7

The figures in the above table were taken from the average figures for three mills in the Idaho white pine. The mills were made for fairly large logs. See (3) Biblio.

Table II

Milling Time For Northeastern White Pine Logs

Log Diam. inches	Minutes per M. bm Lumber tally	Net scale	Output per hour bm. Lumber tally	Net scale
4	91.9	168.2	652.9	365.7
5	71.0	117.6	845.1	510.2
6	54.6	83.2	1098.9	721.2
7	44.9	63.6	1336.3	943.3
8	38.6	51.4	1554.4	1167.3
9	33.9	42.8	1769.9	1401.9
10	31.4	38.0	1910.8	1579.0
11	30.7	35.8	1954.4	1676.0
12	30.2	33.9	1986.8	1769.9
13	30.4	33.1	1973.7	1812.7
14	30.8	32.8	1948.0	1829.3
15	31.0	32.4	1935.5	1851.8
16	31.6	32.5	1898.7	1846.2
17	31.9	32.5	1880.9	1846.2
18	32.4	32.6	1851.8	1840.5
19	32.7	32.7	1834.9	1834.9
20	33.0	32.8	1818.2	1829.3
21	33.6	33.2	1785.7	1807.2

The logs used in the above table were part of a study taking the log thru the mill from the tree. It was made in a stand of from fifty to eighty years. Some from a selected plot and others from the vicinity were cut graded and tallied. See (4) bibliography.

Table III

Milling Time For Yellow Birch Logs

Log Diam. inches	Minutes per M. bm. Lumber tally	Minutes per M. bm. Net scale	Output per hour bm. Lumber tally	Output per hour bm. Net scale
7	101.9	87.2	592	688
8	94.5	80.0	635	750
9	88.4	73.7	679	814
10	82.5	67.7	727	876
11	77.3	64.1	776	936
12	72.4	60.4	828	993
13	68.2	57.3	880	1047
14	64.6	54.3	928	1104
15	61.6	51.9	974	1156
16	61.6	49.7	1020	1208
17	56.4	48.0	1064	1250
18	54.5	46.5	1101	1289
19	52.9	45.6	1133	1316
20	51.7	44.8	1160	1340
21	50.9	44.3	1179	1353
22	50.4	44.3	1190	1355

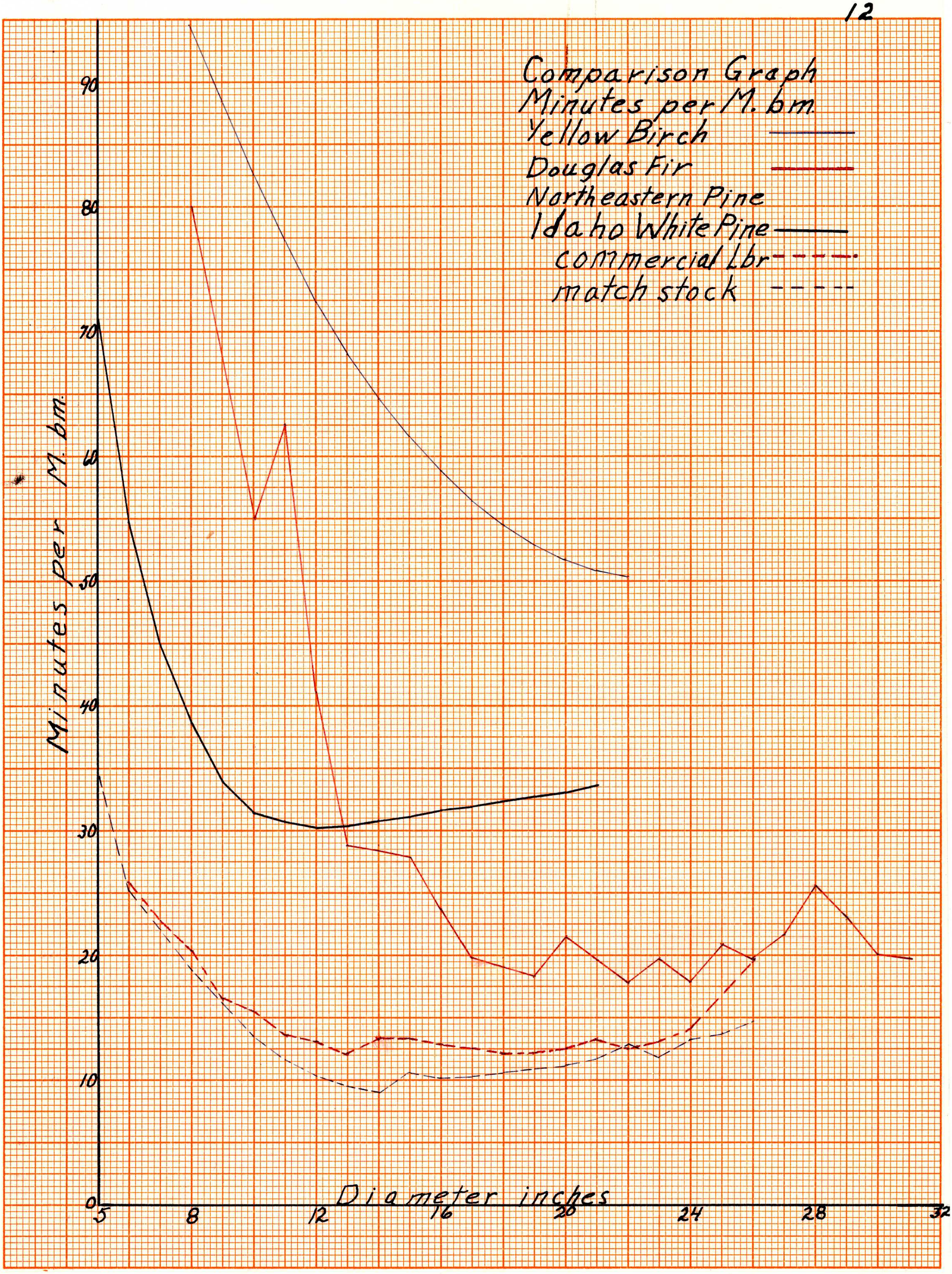
The above figures were taken from a report on a small mill in New England. The mill had a crew of ten men a head-saw, edger, trimsaw, and slasher. It was a ten thousand board foot capacity mill. The larger logs were the poorest due to the large amount of decay that they generally had. See (5) bibliography.

Table IV

Milling Time For Douglas Fir Logs

Log Diam. inches	No Sample	Ave. Time Min.	Ave. Scale	Ave. Tally	Ave. over run %	Min. per M. bm Scale	Min. per M. bm Tally
8	1	4.0	46	50	5.7		
9							
10	1	4.0	63	73			
11	2	5.0	78	80			
12	4	4.0	75	98	30.1	53.0	41.0
13	3	4.8	144	169	17.3	33.5	28.7
14	10	4.6	136	164	20.6	34.2	28.4
15	14	5.1	162	183	13.0	31.4	27.7
16	12	4.8	178	205	15.1	27.4	23.7
17	17	4.8	209	244	16.8	23.0	19.8
18	18	5.4	261	285	13.3	20.5	19.0
19	23	6.2	302	336	15.1	20.5	18.4
20	13	6.8	291	317	8.9	23.2	21.4
21	13	7.3	355	371	4.5	20.5	19.6
22	7	7.3	375	412	9.9	19.4	17.7
23	14	8.7	440	442	0.5	19.7	19.6
24	8	9.2	475	515	8.8	19.4	17.8
25	5	10.1	492	492	0.0	20.7	20.7
26	5	11.5	548	582	6.2	21.0	19.8
27	1	11.0	528	508	-3.8	20.8	21.6
28	1	16.0	569	625	9.9	28.0	25.5
29	1	14.0	612	612	0.0	23.0	23.0
30	1	14.0	656	701	6.8	21.0	20.0
31	1	15.0	701	729	9.7	21.4	19.8

The above figures were those that were taken personally in my own investigation of the subject. There are not enough samples of the largest logs to make for good sampling but they will show the trend.


Comparison Graph
Minutes per M. bm.
Yellow Birch
Douglas Fir
Northeastern Pine
Idaho White Pine
commercial Lbr
match stock
Minutes per M. bm.
90
80
70
60
50
40
30
20
10
0
Diameter inches
5
8
12
16
20
24
28
32

Conclusions

The results of these investigations were shown in the tables and on the comparison chart.

The different mills were all graphed on the same sheet so as to show a comparison of the various sections and sawing practices on logs of the same size.

In the northeastern white pine, with its small mill, the optimum log was reached in a twelve inch small end diameter although from nine to twenty-one inches the time per thousand board feet was fairly constant but showing less production as the logs became larger. The equipment in this mill was evidently designed to take care of small logs.

In the yellow birch of the northeastern hardwood section time per thousand board feet was getting less to the largest log in the data shown. The mill was evidently designed to handle slightly larger logs than those which circumstances were forcing it to work with.

The Idaho white pine mills were evidently equipped for medium sized logs, eighteen inches being the optimum log for the amount of production for time expended, when cutting for commercial lumber. The rate was fairly constant with logs from thirteen to twenty-two inches where it took a sharp swing up in the amount of time for lumber produced. When sawing for match stock the optimum log in point of quantity for time expended was fourteen inches showing constant to twenty-three inches before swinging upward again. The flatness of the two curves shows that the equipment was designed to suit the size of log and the type of timber in which it was being used.

The study conducted in Douglas Fir showed that the time per thousand board feet dropped sharply from eighty minutes for eight inch diameters to twenty minutes for seventeen inch diameters. Time was comparatively constant from seventeen inches to twenty-six inches where it started to swing upward again. The optimum log for this study was found at twenty-two inches. Samples for sizes over twenty-six inches were too few to show more than a possible trend upward.

The figures obtained in the Douglas Fir study were far from complete, but they were all that were obtainable with the time and resources at its disposal. The study covers close to three weeks of actual mill time although the time was scattered over two school terms.

Small logs are found at most mills and, unless special equipment is available, must be handled at a loss. A gang saw will handle small logs as efficiently and as economically as any type of equipment.

Recommendations

My recommendation to the mill with which I worked would be, to handle as few as possible of logs under seventeen inches and none over twenty-six or twenty-eight inches, as the time consumed per thousand board feet would make them less profitable than the others.

My recommendation to all mills is that the equipment should be based on the size and type of timber to be cut, unless one can buy the size of log best suited to equipment already on hand. It is also recommended that a thorough investigation be made of both timber and machinery to see how they will work together.

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