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RAISE cutting DIAMETERS FOR increased RETURNS

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Abstract

Diameter-limit cutting is widely used to harvest logs in eastern hardwoods. Studies show that cutting limits are often set so low that they sacrifice financial returns.

The value of lumber cut from logs is largely dependent on the diameter, grade, and tree species. As tree size increases so does the proportion of higher grade lumber, and this is reflected in improved log grades. Small trees, even though they are of sawlog size, saw out little high-grade lumber. The maximum grade log that can be obtained from a 12-inch dbh tree is a 3, which produces little quality lumber. On the other hand, a 16-inch dbh tree has the potential for producing a butt log with a grade of 1. Leaving the tree to grow from 12 to 16 inches may increase the financial value of the tree by several times. This increase in tree value with increasing tree size and grade can be expressed in annual percent value increase.

INTRODUCTION

DIAMETER-LIMIT CUTTING is probably the most widely used method of harvesting sawtimber in eastern hardwood stands. Its appeal lies in its short-range economic advantages and in that little, if any, supervision is needed if the limit is set to include all merchantable trees. Yet many foresters do not favor diameter-limit cutting as currently practiced because it results in high-grading of forest stands and lost income to the stumpage seller. We are concerned here with the latter. Diameter-limit cutting *is* often misused. Our aims are to show how and why it is improperly used, and to provide guidelines for improving its application.

The biological advantages and disadvantages of diameter-limit cutting have been thoroughly discussed in other publications (Hutnik 1958, Trimble 1971, Smith and Lamson 1977) and will not be repeated here. Rather, we will point out some of the economic implications of choosing an appropriate diameter limit by demonstrating the financial gain from leaving to grow trees that have the potential to improve their butt-log grades.

On many sawlog operations, the minimum stump diameter is set so that it approximately separates the trees that are large enough to return a profit from those so small that it does not pay to log them. To illustrate, a 14-inch stump diameter limit is one of the most commonly used guides. The reason for using this diameter limit is that a tree 14 inches on the stump (which roughly translates to 11 or 12 inches at dbh) is about the minimum size tree that will make a sawlog. Any tree smaller than this must be sold for other products of lower value, which usually are of little interest to the sawlog operator. But those who use the 14-inch stump diameter limit ignore the interrelationships among tree diameter, butt-log grade, and tree value.

Log grades are related to lumber grades and, in combination with tree volume, they provide a basis for deriving tree values. Other things being equal, the percentage of higher lumber grade improves as tree size increases. So does butt-log grade. And so does tree value. Timberland owners and foresters should be aware of these important interrelationships so that they can make intelligent choices in designating what trees to cut and what to leave in their woodlands.

METHODS

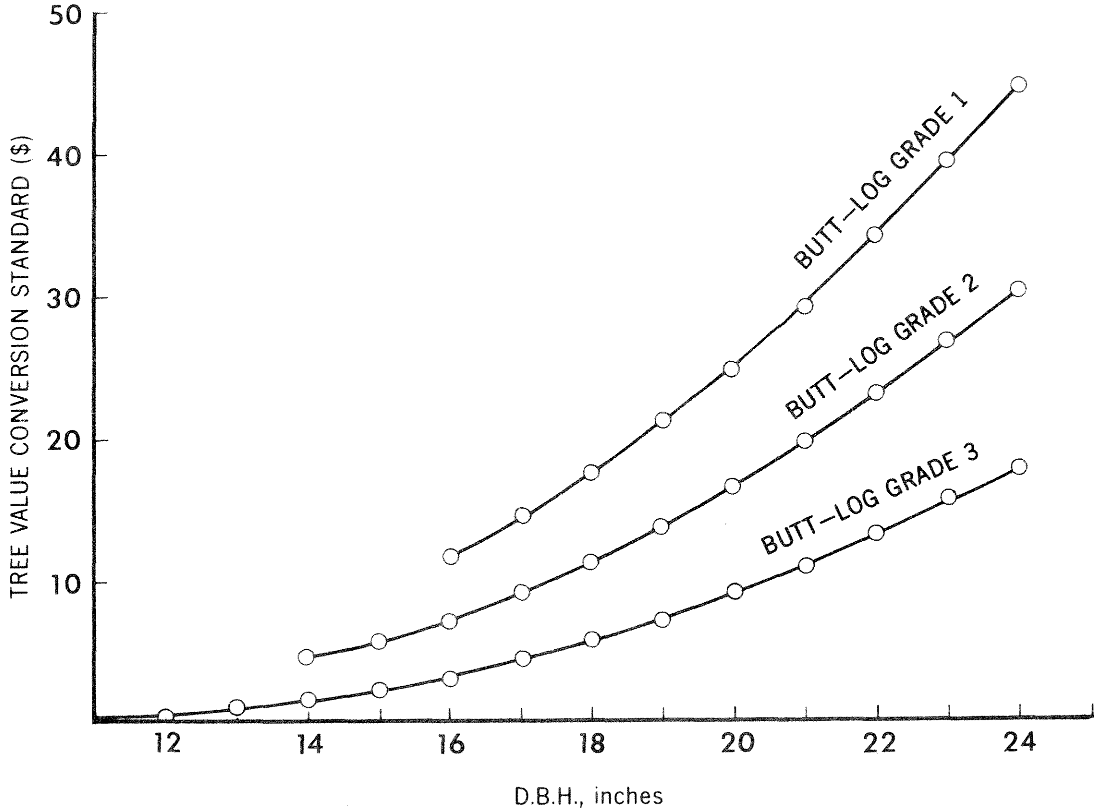
Table 1, which we condensed from *A Guide to Hardwood Log Grading* (Rast et al. 1973), summarizes the general relationships between tree diameters and butt-log grade. The diameters shown are averages; actually, diameters vary because of differences in species, site, stand density, and tree size. However, as indicated in this table, there is a generalized relationship between (1) stump diameter outside bark, measured at the height of 1 foot (2) dbh outside bark; and (3) the diameter,

Table 1.—General diameter to butt-log grade relationships.

Stump diameter (o.b.)[a]	Dbh (o.b.)	Diameter at top of butt log (i.b.)[b]	Maximum butt log grade
Inches			*Grade*
14	11	8	3
15	12	9	3
16	13	10	3
17	14	11	2
18	15	12	2
19	16	13	1
20	17	14	1
21	18	15	1

[a]o.b. = outside bark
[b]i.b. = inside bark

Figure 1.—Tree value of 2-log red oaks by butt-log grade and dbh.



inside bark, measured at the top of the butt log—at 17 feet 3 inches above ground. These diameters are all related to butt-log grade and they determine the maximum potential grade of logs that can be sawed from the tree.

One way to emphasize the importance of the diameter-grade relationships is to point out the differences in dollar value among trees with various diameters and grades (Fig. 1). This demonstrates the financial gain from letting grow trees that have the potential to improve their butt-log grade.

In this first example we use a single species to illustrate the general trend—northern red oak (*Quercus rubra* L.). For tree values, we used the tree value conversion standards developed by Mendel, DeBald, and Dale (1976). These tree value conversion standards are similar to stumpage values, except that a percentage for profit and risk has not been deducted from them. They do, however, serve well for comparing the relative worth of trees of different sizes and log grades.

Figure 1 shows graphically for 2-log northern red oaks that the larger the tree within each butt-log grade, the higher its value. Figure 1 shows, too, the big variation in tree value within each dbh class that depends on butt-log grade. Although the relationships apply specifically to 2-log northern red oaks, the principles they demonstrate apply, generally, to all sawlog species.

Using dbh growth rate and tree value for 1-, 1½, and 2-log yellow-poplar (*Liriodendron tulipifera* L.) northern red oak, and sugar maple (*Acer saccharum* Marsh.) trees for a 10-year period, we computed increases in tree value and compared the interest rates that result, based on 10 years of additional growth and assuming that each tree would attain the maximum butt-log grade possible for its size (Table 2). Growth data were taken from

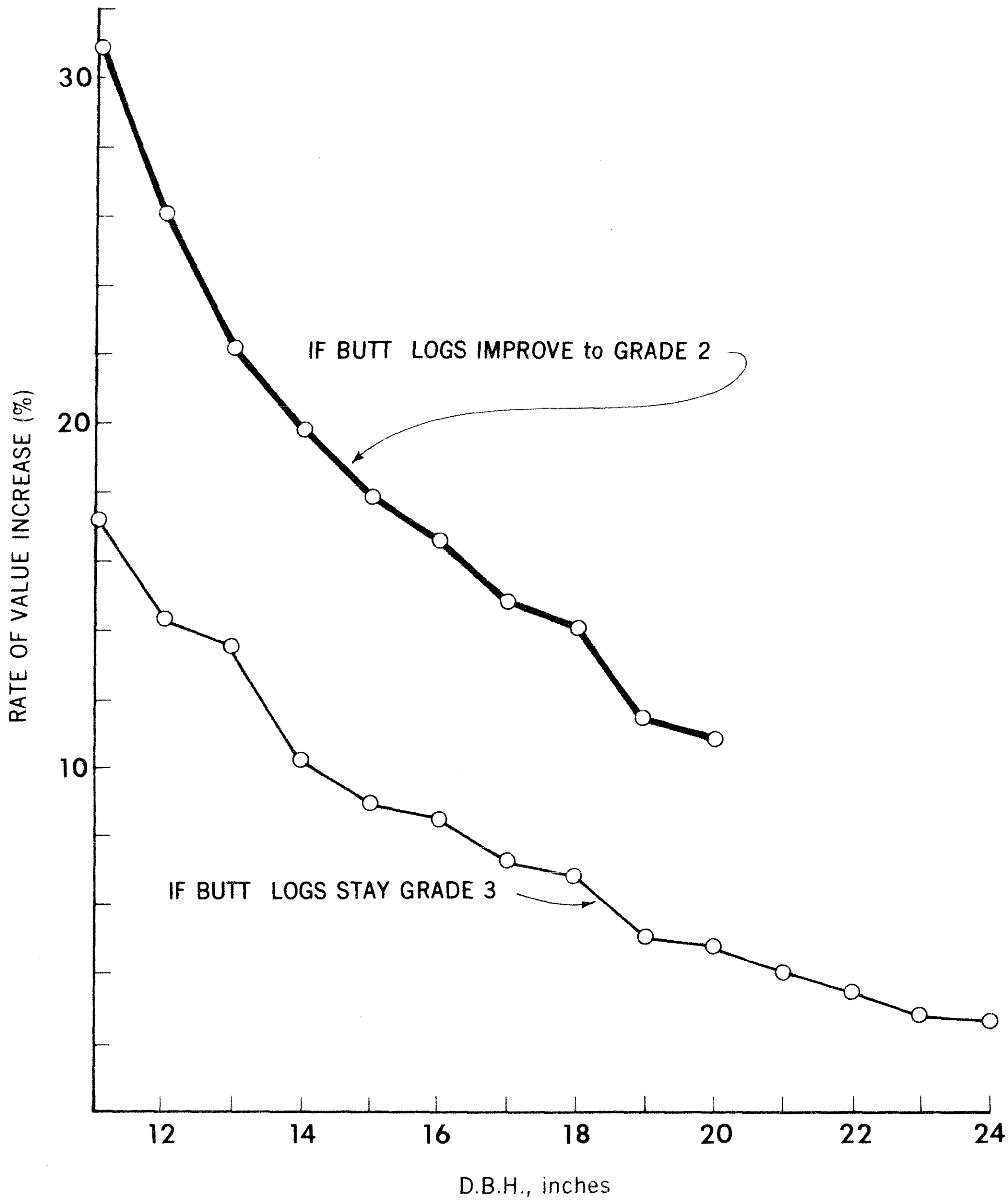
Table 2.—Tree value increases based on growth rates of codominant trees growing on good sites and having the potential to develop the best log grades consistent with their diameters

Original dbh	Maximum butt log grade	Tree value: 1-log tree	Tree value: 1½-log tree	Tree value: 2-log tree	10-year dbh growth	New dbh	Maximum butt log grade	New tree values[a]: 1-log tree	New tree values[a]: 1½-log tree	New tree values[a]: 2-log tree	10-year value increase[b]: 1-log tree	10-year value increase[b]: 1½-log tree	10-year value increase[b]: 2-log tree
Inches	*Grade*	*Dollars*			*Inches*	*Inches*	*Grade*	*Dollars*			*Percent*		
						YELLOW-POPLAR							
11.0	3	0.21	—	—	2.1	13.1	3	0.81	—	—	286	—	—
12.0	3	.47	.54	—	2.1	14.1	2	3.57	4.45	5.01	660	724	—
13.0	3	.81	1.01	1.06	2.1	15.1	2	4.49	5.65	6.32	454	459	496
14.0	2	3.57	4.45	5.01	2.0	16.0	1	5.97	8.19	9.83	67	84	96
15.0	2	4.49	5.65	6.32	2.0	17.0	1	7.27	10.05	12.36	62	78	96
16.0	1	5.97	8.19	9.83	1.9	17.9	1	8.97	12.28	15.09	50	50	54
17.0	1	7.27	10.05	12.36	1.9	18.9	1	10.83	14.87	18.29	49	48	48
18.0	1	8.97	12.28	15.09	1.8	19.8	1	12.93	17.68	21.78	44	44	44
						RED OAK							
11.0	3	0.32	—	—	2.2	13.2	3	0.87	—	—	172	—	—
12.0	3	.56	.60	—	2.2	14.2	2	2.96	3.79	—	429	532	—
13.0	3	.87	1.01	—	2.2	15.2	2	3.81	4.92	—	338	387	—
14.0	2	2.96	3.79	4.40	2.1	16.1	1	7.74	10.08	11.41	161	166	159
15.0	2	3.81	4.92	5.66	2.1	17.1	1	9.30	12.23	14.24	144	149	152
16.0	1	7.74	10.08	11.41	2.0	18.0	1	11.32	14.80	17.28	46	47	51
17.0	1	9.30	12.23	14.24	1.9	18.9	1	13.52	17.76	20.83	45	45	46
18.0	1	11.32	14.80	17.28	1.8	19.8	1	15.98	20.87	24.68	41	41	43
						SUGAR MAPLE							
11.0	3	0.04	—	—	1.8	12.8	3	0.59	—	—	1375	—	—
12.0	3	.27	—	—	1.8	13.8	2	2.88	3.76	4.47	967	—	—
13.0	3	.59	—	—	1.8	14.8	2	3.79	4.98	5.86	542	—	—
14.0	2	2.88	3.76	4.47	1.7	15.7	1	9.01	11.28	12.17	213	200	172
15.0	2	3.79	4.98	5.86	1.7	16.7	1	10.86	13.76	15.35	187	176	162
16.0	1	9.01	11.28	12.17	1.6	17.6	1	13.25	16.75	18.79	47	48	54
17.0	1	10.86	13.76	15.35	1.6	18.6	1	15.86	20.19	22.83	46	47	49
18.0	1	13.25	16.75	18.79	1.5	19.5	1	18.79	23.94	27.24	42	43	45

[a]Using the values of the nearest 1.0-inch dbh class.

[b]Value increase must be at least 160 percent to earn 10 percent rate of interest, and 80 percent to earn 6 percent rate of interest.

Figure 2.—Rate of value increase for 2-log red oaks with grade 3 butt logs.



three recent publications describing rates of value increase for individual trees (Mendel and Trimble 1969; Trimble and Mendel 1969; and Mendel, Griesez, and Trimble 1973). Present and 10-year tree values were determined (Mendel, DeBald, and Dale 1976).

To further demonstrate the effect of log grade and tree size on the expected rates of value increase, 2-log red oaks were evaluated for trees of butt log grades 3, 2, and 1 and graphed over a range of dbh classes (Figures 2, 3, and 4). These rates do not include the effects of inflation. To convert these real rates to money rates, simply add on an inflation rate.

Note that for all figures, even without a premium for inflation, the trees in our example that improve in butt-log grade will in-

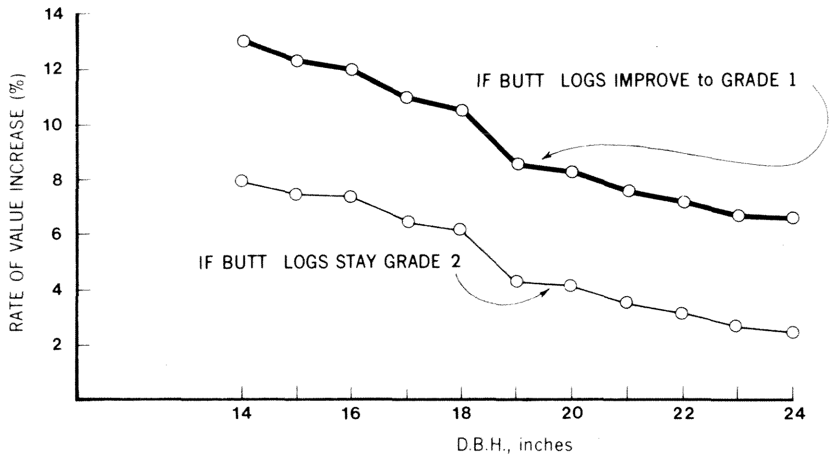


Figure 3.—Rate of value increase for 2-log red oaks with grade 2 butt logs.

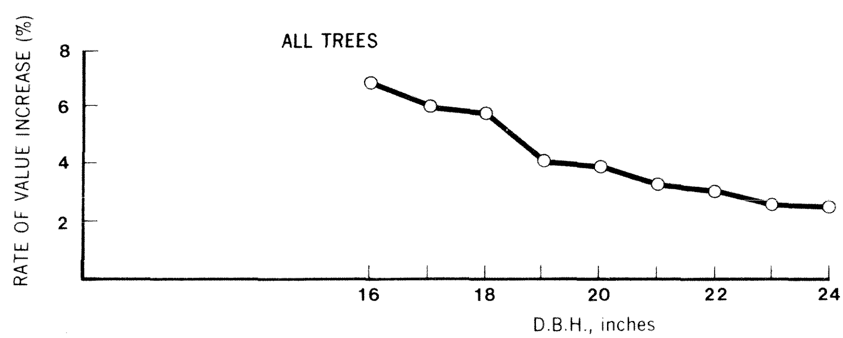


Figure 4.—Rate of value increase for 2-log red oaks with grade 1 butt logs.

crease in value at least 6 percent annually. Adding a conservative 4 percent rate for inflation translates the return to a minimum rate of 10 percent.

Note, too, that even those trees that do not improve in butt-log grade exhibit fairly respectable rates through at least part of the diameter range beyond a 14-inch dbh. The degree of fairness and the diameter at which it is no longer a fair return depends, of course, on individual attitudes. Each of us has an alternative interest rate, cost of capital, hurdle rate, or whatever we choose to call it. No one, single rate applies to us all. Thus, we cannot recommend a particular diameter limit to substitute for the 14 inch diameter limit.

The data (in Table 2) indicate without question that tree value is greatly increased by leaving trees that have the potential to develop better butt-log grades through an increase in diameter. Some additional examples of this are:

1) A 1-log, 12-inch dbh red oak, which has about a 15-inch stump diameter (Table 2), can have a butt-log grade of 3. It can have at best a grade 3 butt log worth $0.56 after deducting extraction and milling costs. This tree may not pay its way out of the woods right now. However, if left standing for 10 years and with a butt-log grade increase to 2, the tree value will increase by $2.96 or 429 percent over its present value, an 18-percent annual rate of interest. Can you envision liquidating an investment that would increase this much in 10 years? The answer would be "yes" only if a higher alternative rate of return was available for investment capital.

2) Take the case of a 2-log sugar maple that is now 15.0 inches dbh with a stump diameter of about 18 inches and a butt-log grade of 2—the best possible grade for a tree of this size (Table 2). The value of the tree is $5.86. If we let it grow 10 years, it can have a dbh of about 16.7 inches, a stump diameter of nearly 20 inches, and probably a grade 1 butt log. It will be worth $15.35, an increase in value of 162 percent, or a 10-percent annual rate of interest. This tree returns a big dollar increase as well as a high interest rate.

3) But what about the tree that already has a butt-log grade of 1? The value of this tree may increase in the future for several reasons: (1) Improved butt-log lumber quality within the grade 1 class because of the addition of clear wood (volume) on the bole, (2) increased tree volume, and (3) improvement in grade of upper logs. We can see, however, that the big jump in value comes from an improvement in butt-log grade (Table 2). Take, for example, a 17-inch 2-log yellow-poplar that has a grade 1 butt log now and a tree value of $12.36. In 10 years it will still have a grade 1 butt log, but its tree value will have risen to $18.29, a 48-percent increase or a 4-percent annual rate of return. The rate of increase is much below that of a tree with a butt-log grade increase.

Other dbh, grade and log height combinations are summarized in Table 2. Over a 10-year period we must have about a 160-percent tree value increase to earn a 10-percent rate of return. An 80-percent increase is needed to get a 6-percent interest rate of return.

DISCUSSION

We emphasize that higher diameter limits are often warranted economically. And we point out some rules of thumb for setting higher diameter limits: the financial-maturity diameters listed in *A Procedure for Selection Marking in Hardwoods Combining Silvicultural Considerations with Economic Guidelines* (Trimble et al. 1974). Diameter limits appropriate to individual owners' financial expectations can be selected. The financial maturity diameters (Table 3) can be adapted from real rates of return to monetary rates of return by simply adding an expected inflation-rate percentage to the real rates shown.

In the use of these established relationships between tree value, log grade and size, the individual has wide latitude in setting cutting

Table 3.—Diameters at financial maturity, by 2-inches classes[a]

Species	Real rate of value increase														
	2%			3%			4%			5%			6%		
	S.I.[b]			S.I.			S.I.			S.I.			S.I.		
	80	70	60	80	70	60	80	70	60	80	70	60	80	70	60
Yellow-poplar	26	26	24	24	22	22	20	18	18	20	18	18	18	18	18
Beech	24	22	22	22	20	20	20	18	18	20	18	18	18	18	18
Black cherry	32	30	30	28	26	24	22	20	18	20	20	18	18	18	18
Red maple	32	30	30	28	26	24	22	22	18	20	20	18	18	18	18
White ash	30	28	28	26	24	24	22	20	18	20	20	18	18	18	18
Sugar maple	32	32	30	28	28	24	22	22	18	20	20	18	18	18	18
Red oak	26	26	24	24	24	22	22	22	20	22	20	20	20	18	18
White oak	24	22	20	22	20	20	20	18	18	20	18	18	18	18	18
Chestnut oak	24	24	22	22	22	20	20	18	18	20	18	18	18	18	18
Other long-lived species	26	26	24	24	24	22	20	20	18	20	20	18	18	18	18

[a]Mark trees of these 2 inch dbh classes and larger, unless potential grade improvement can be foreseen in the next 10 years.
[b]Site index.

diameters. He can set them by individual species, but that would include so many different limits that he would have to mark the stand to obtain compliance with them. Or he could make two or three species groups, which would retain much of the simplicity credited to diameter-limit cutting. In any case, harvest cutting aimed at maximizing stumpage returns would require setting diameters for good vigorous trees that are much higher than the 14-inch stump diameter so widely used.

Also, it is important to mention here that at each harvest cut, regardless of the level at which the diameter limit is set, all culls and poor growing stock should be eliminated if stand high-grading is to be prevented.

SUMMARY

Based on tree value change, it is good business to leave the vigorous high-quality trees that have the potential to increase in butt-log grade or even veneer material. For sawlog-size trees this means cutting to at least a minimum dbh of about 16 inches or a minimum stump diameter of about 19 inches. The increase in tree value with size results from changes in butt-log grade and diameter growth as well as increased volume. The relationship is similar for all hardwood species that are sawed for lumber, although there is considerable variations among species in actual tree-value increases. Using diameter-limit cuts with flexible diameters following financial maturity guidelines has potential to improve current diameter-limit cutting practices.

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