Rates of value increase for YELLOW BIRCH in New England

by

William B. Leak

Stanley M. Filip

Dale S. Solomon

U. S. FOREST SERVICE RESEARCH PAPER NE-120
1968
NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE
RICHARD D. LANE, DIRECTOR

The Authors

WILLIAM B. LEAK, Principal Silviculturist, received Bachelor of Science and Master of Forestry degrees at the State University of New York College of Forestry in 1953 and 1956. He has worked with the Northeastern Forest Experiment Station ever since in silvicultural, management, and mensurational research in Vermont, New Hampshire, and at Station headquarters in Upper Darby, Pennsylvania. He is now principal silviculturist at the Station's research unit at Durham, N. H.

STANLEY M. FILIP, Silviculturist, received his forestry training at The Pennsylvania State University. After working several years in consulting, industrial, and farm forestry, he joined the Northeastern Forest Experiment Station of the U. S. Forest Service as a research forester in 1946. Most of his research work has been in timber management, mainly with beech-birch-maple stands in Pennsylvania and New Hampshire. He is now on the staff of the Experiment Station's research unit at Durham, N. H.

DALE S. SOLOMON, Associate Mensurationist, joined the Northeastern Forest Experiment Station in June 1962 after earning his Master's Degree in forestry from Yale University. He had earned a Bachelor's degree in forestry from The Pennsylvania State University in 1961, and completed some special studies at Temple University the same year. Since 1962 he has worked on the Station's beech-birch-maple silviculture project. Formerly located at Laconia, N. H., this research unit was relocated at Durham, N. H., in 1965.

A GUIDE TO FINANCIAL MATURITY

LIKE ANY OTHER businessman, the timber grower needs to know at what rate his investment is earning money for him. He needs to know at what rate his trees are increasing in value, and at what point in their growth they cease to bring him the rate of return he expects. This is the point of financial maturity—the time to harvest the tree.

Foresters have long used biological criteria such as growth rate and vigor to estimate the maturity of a forest tree or stand. In recent years a relatively simple business concept has been made applicable to forest management. Known as the financial maturity concept, this enables foresters to use economic criteria for determining the prospective rate of value increase of a tree.

Using this concept, the Northeastern Forest Experiment Station has begun a series of studies to determine the financial maturity of the important hardwoods of the New England and Middle Atlantic States. The studies include yellow birch, sugar maple, several of the oaks, yellow-poplar, beech, black cherry, red maple, and white ash.

This is a report on the study of yellow birch *(Betula alleghaniensis)*, one of the northern hardwoods.

Despite trends toward even-aged management of northern hardwoods in New England, selection of individual trees for cutting is still a common forest-management practice. Selection cutting under uneven-aged management remains in use on areas of aesthetic and recreational importance, or where tolerant species are desired. Commercial thinnings in more-or-less even-aged stands of northern hardwoods are based upon individual tree selection of which trees to remove—and which to retain. And even the final harvest cut in even-aged stands usually is based upon the judgment that a majority of the individual trees in the stand have reached maturity.

Marking practices for northern hardwoods usually are based upon general biological and technological considerations such as life expectancy of the tree, merchantability, current and expected losses from decay and discoloration, and the like. The overall objective is to retain those trees that will produce quality wood and thus produce adequate financial gain. However, to date no guidelines have been available for determining the financial status or financial maturity of individual northern hardwood trees in New England.

This study does provide such a guideline. It gives the timber manager a means of estimating the rate of value increase to be expected of yellow birch trees in the next 10 years.

METHODS

The basic approach was this: we assembled the necessary data to estimate initial stumpage value and future stumpage value—10 years hence—for a range of d.b.h. and height classes, vigor classes, and tree qualities. Then we determined the compound interest rate of value increase over the 10-year period.

Sawlog Quality

The quality data were developed from a sample of 200 yellow birch trees 11.0 inches d.b.h. and larger, located in both mature and immature stands throughout the White Mountain National Forest. These stands had sustained no more than light partial cutting in the last few years. Tree diameter and number of saw-logs to the nearest half log were recorded. The grade of each 16-foot log (and upper half log) was determined, using U. S. Forest Service standard specifications for hardwood factory-lumber logs.[1]

We decided to express tree value or quality in terms of quality index, defined as the ratio of the dollar value of the lumber in a log or tree to the value of an equal volume of No. 1C lumber. The following price ratios were obtained by summarizing 5 years of quotations (1959, 1961, 1962, 1965, 1966) from the *Boston Commercial Bulletin* and—for products not covered in the *Bulletin* — from a previous analysis of local price structures by Gilbert:[2]

Lumber grade	*Price ratio*
FAS	1.7
Select	1.5
No. 1C	1.0
No. 2C	.5
No. 3C	.4
Construction	.5
Local use	.3

Next, a table of log quality index was developed by multiplying the percent yield of each lumber grade[1] times the appropriate price ratio for various combinations of d.i.b. and log grades (table 1).

Using International ¼-inch log volumes, we determined the volume of each log in each of the 200 sample trees. The quality index of each log was taken from table 1. The products of quality index times log volume were summed for each tree and divided by tree volume to produce a weighted quality index for the tree.

The sample trees were segregated into three groups based on butt-log grades 1, 2, and 3. A separate multiple regression was

[1] U. S. Forest Products Laboratory. HARDWOOD LOG GRADES FOR STANDARD LUMBER. U. S. Forest Prod. Lab. Rpt. D1737, 66 pp., illus., 1953. Hardwood log grades are more recently described in: Ostrander, M.D., A GUIDE TO HARDWOOD LOG GRADING, U. S. Forest Serv. NE. Forest Exp. Sta., 50 pp., illus., 1965.

[2] Gilbert, Adrian M. SAMPLING THE QUALITY OF HARDWOOD TREES. U. S. Forest Serv. NE. Forest Expt. Sta., Sta. Paper 114. 18 pp., illus., 1959.

Table 1.—*Quality index of yellow birch for 16-foot logs, by d.i.b. and log grade*

D.i.b. (inches)	Log grade 1	2	3	4	5
8	—	—	0.58	0.5	0.3
9	—	—	.51	.5	.3
10	—	0.65	.53	.5	.3
11	—	.70	.48	.5	.3
12	—	.75	.47	.5	.3
13	0.94	.71	.49	.5	.3
14	1.02	.78	.51	.5	.3
15	1.03	.74	.50	.5	.3
16	1.03	.79	.55	.5	.3
17	1.11	.68	.46	.5	.3
18	1.18	.81	.44	.5	.3
19	1.26	.94	—	—	—
20	1.18	.75	—	—	—
21	1.24	1.03	—	—	—
22	1.38	.98	—	—	—
23	1.28	.89	—	—	—
24	1.40	—	—	—	—

computed for each butt-log grade, relating weighted quality index to tree d.b.h. and log height:

Butt grade 1:

QI = .641099 + .016125 (d.b.h.) − .060146 (# logs)

Butt grade 2:

QI = .585487 + .00839 (d.b.h.) — .04112 (# logs)

Butt grade 3:

QI = .443344 − .004868 (d.b.h.) — .009835 (# logs)

Veneer Quality

In both value and volume, veneer is an important usage of yellow birch. To reflect veneer quality, we took six log grades used by a large veneer industry in New Hampshire:

Grade	*Min. d.i.b. (inches)*	*Allowable defects*
AA	16	None.
Aircraft	14	No surface defect; 3-inch end defect well centered.
Select	12	1 defect.
No. 1	12	2 defects.
No. 2	12	4 defects.
No. 3	10	None; no sweep allowed.

These veneer specifications apply to logs approximately 8½ feet long. Additional specifications, which we need not mention here, are given on sweep, seams, and ring shake. As described later, these veneer specifications were used to describe a range of hypothetical veneer-log trees for purposes of computing value increases and compound interest rates.

Vigor Class

Growth data for yellow birch are not sufficiently accurate to define the relationships between descriptive vigor classes (based on crown class, etc.) and d.b.h. growth. For purposes of this study, it was necessary to establish four arbitrary vigor classes based on 10-year diameter growth:

Vigor class	*10-year d.b.h. growth (inches)*
1	2.0
2	1.5
3	1.0
4	.5

These vigor groups cover fairly well the possible range in 10-year diameter growth. Vigor 1, for example, represents an unusually fast-growing yellow birch under New England conditions.

Value Increase

Value increase computations were run for hypothetical sawlog trees defined by all likely combinations of vigor class (four classes), U. S. Forest Service butt grade (three classes), initial d.b.h. (ten 2-inch classes), log height 10 years hence (three classes—same, increase of .5 log, increase of 1 log), and butt grade 10 years hence (same, increase of 1 grade).

Similar computations were run for a series of hypothetical veneer-log trees defined by combinations of vigor class (four classes), veneer butt grade (six classes), three log heights (1.0, 1.5, and 2.0), six veneer upper-log grades, and eight 2-inch d.b.h. classes.

For sawlog trees, initial stumpage value was computed by starting with a value of $200.00/M for No. 1C lumber on the

Boston market. This value was reduced by 5 percent for brokerage and 12 percent for profit and risk. We then multiplied by tree quality index, as estimated by the regression equations previously given. Then the following conversion costs, based on locally used appraisal figures, were subtracted:

	Cost per thousand
Woods costs	$22.00
Transportation	13.25
Logging overhead	2.50
Erosion control	.25
Temporary roads	2.79
Miscellaneous development costs	2.79
Manufacturing costs	38.00
Total	$81.58

The result was multiplied by tree volume in M board feet to give initial stumpage value.

Initial stumpage value per M board feet for veneer trees was computed by beginning with appropriate log prices at the mill, reduced by a 12 percent profit-and-risk margin:

Veneer log grade	*Advertised*	*Reduced 12%*
AA	$300	$264.00
Aircraft	260	228.80
Select	210	184.80
No. 1	160	140.60
No. 2	120	105.60
No. 3	120	105.60

For each category of veneer-log tree, mill price of each log in the tree was multiplied by log volume, and the results were summed for the tree. Harvesting and transportation costs (without erosion-control charges) equal to $43.33 were multiplied by tree volume and subtracted to provide an estimate of initial stumpage.

Future stumpage value—10 years hence—for both sawlog and veneer trees was computed in the same way as initial stumpage value, but using assumed vigor class to provide an estimate of future d.b.h. and incorporating any options on change in merchantable height or butt-log grade.

Finally we determined the compound interest rate that represented the change from initial to future stumpage value for each class of tree.

RESULTS

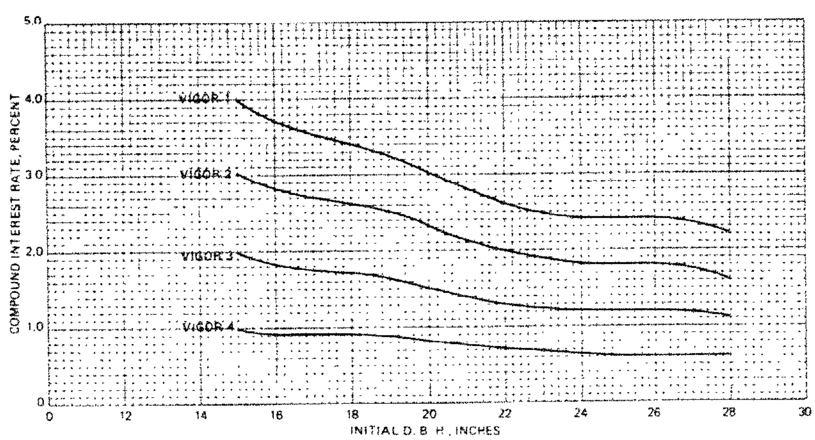
Value Growth Rate

First we will examine the rate of value increase due to diameter growth alone. In the next sections we will examine the effects of changes in grade and merchantable height.

Compound interest growth rates were plotted over d.b.h. for 2-log sawlog trees with grade-1 butts (fig. 1). The curves were fitted by eye through actual plotted points. Curves for grade-2 butts and 1-log trees were similar in shape and amplitude; thus similar general conclusions apply to all.

A compound interest rate of 3 percent or better was exhibited by vigor-1 trees smaller than 20 inches d.b.h. and by vigor-2 trees smaller than about 17 inches d.b.h. Vigor-3 trees never exhibited compound interest much better than 2 percent. Rates for vigor-4 trees seldom exceeded 1 percent.

Figure 1.—Compound interest rates over d.b.h. for sawlog trees in vigor classes 1 to 4 with 2 logs and grade-1 butts.



Trees with grade-3 butt logs exhibited negative stumpage valaues. Thus compound interest rates were meaningless for trees in this class.

Compound interest rates for veneer-log trees generally were lower than for sawlog trees, probably because of the high value of the former. The range in interest rates by vigor classes for trees with log grades ranging from select to AA were:

Vigor class	*Percent*
1	1.6-2.8
2	1.3-2.1
3	.8-1.5
4	.4- .8

There was a tendency for smaller trees with lower grade to exhibit the higher interest rates.

Merchantable Height Change

Yellow birch trees in the 12-, 14-, and 16-inch classes, especially vigor-1 and -2 trees, may increase in merchantable height by 0.5 log over a period of 10 years. Yellow birch trees larger than 16 inches usually have reached their peak of merchantable height development.

An increase in merchantable height over a 10-year period had a consistent effect upon compound interest rates of value increase. For example, a 16-inch, 2-log, vigor-3 sawlog tree with butt grade 1 produced a 1.8-percent compound interest value increase over a 10-year period when merchantable height remained the same, but a 2.6-percent rate when merchantable height increased to 2.5 logs. A comparable vigor-2 tree produced a 2.8-percent increase with no change in merchantable height, and 3.5 percent when merchantable height increased to 2.5 logs. Increases in compound interest rates attributable to changes in merchantable height tended to be a little larger than those mentioned above for 12- and 14-inch trees (which commonly increase from 1.5 to 2 logs).

Grade Changes

Changes in log grade over a 10-year period have an important influence upon compound interest rates of yellow birch. For vigor-3, 2-log sawlog trees, an increase in butt grade from grade 2 to 1 produced an interest rate of over 8 percent (table 2). The comparable rate for similar trees that did not increase in butt grade was between 1 and 2 percent.

Vigor-3, 2-log veneer trees exhibited interest rates between 2.1 and 3.7 percent when the butt grade increased by one grade (table 2). The comparable rate for trees with no grade increase was 1 to 1½ percent. Slightly higher interest rates than those in table 1 were shown by vigor 1 and 2 trees.

Table 2.—*Compound interest rates for sawlog and veneer-log trees increasing by one butt-log grade over a 10-year period —for 2-log, vigor-3 trees*

D.b.h. (inches)	Veneer-log trees[1]			Sawlog trees		
	Initial butt grade	Final butt grade	Interest rate (percent)	Initial butt grade	Final butt grade	Interest rate (percent)
16	Select	Aircraft	3.7	2	1	8.8
	Aircraft	AA	3.1			
18	Select	Aircraft	3.1	2	1	8.7
	Aircraft	AA	2.4			
20	Select	Aircraft	3.1	2	1	8.5
	Aircraft	AA	2.5			
22	Select	Aircraft	2.8	2	1	8.3
	Aircraft	AA	2.1			
24	Select	Aircraft	3.0	2	1	8.1
	Aircraft	AA	2.4			

[1] All veneer-log trees assumed to have a select top log.

The effects of grade change can be generalized by saying that an improvement in butt grade of sawlog trees from grade 2 to grade 1 produces at least a 2- to 4-fold increase in interest rates over the unaugmented rate; while a butt-grade change in veneer-log trees results in roughly double the normal rate.

The effects of a change from a sawlog grade to a veneer grade are difficult to evaluate precisely because (1) veneer logs and sawlogs are not graded on the same basis, and (2) we used a different appraisal system for the two types of logs. However, on the basis of size alone, it is possible and likely that a small grade-1 log could move over a 10-year period into the aircraft or AA classes. If a 16-inch, 1-log, grade-1, vigor-1 tree moved into the aircraft grade, our data indicate that the compound interest rate would be about 16 percent. A change to AA grade would produce a rate of about 18 percent.

DISCUSSION & RECOMMENDATIONS

Results of this study indicate that compound interest rates earned by yellow birch trees are greatest — up to 8 percent — where the butt log increases in grade. Large trees that do not increase in grade usually have low interest rates, although small fast-growing trees may earn rates of 3 or 4 percent—even without an increase in grade. Interest rates may also be augmented a little by increases in merchantable height.

Trees left as growing stock or crop trees after a harvesting or thinning operation should be those that show the best promise for future grade improvement. Trees that have reached their peak of grade improvement generally will not produce high or even reasonable rates of return.

In trees with a minimum amount of grade defect, size is a major determinant of log grade. Thus tree and log size set an upper limit on grade potential. A butt-log must be 13 inches d.i.b. at the small end to qualify as a grade-1 sawlog and about 16 inches d.i.b. for a top-grade veneer log. Thus a 20-inch, 1-log tree probably has reached, or passed, the peak of grade improvement. Upper logs must be 16 inches d.i.b. to qualify as top-grade veneer logs or sawlogs. Thus a 22-inch, 2-log tree would have reached, or passed, the peak of grade improvement. Of course in marking individual trees, the characteristics of each given tree—particularly the nature and extent of external and internal defect—should be considered in arriving at a judgment on the possibilities of future grade improvement.

Results of this study provide the basis for some recommendations on long-range tree harvest size objectives. Individual trees in a selection forest or the main body of an even-aged stand of yellow birch cannot be grown beyond 22 inches d.b.h. without sacrificing individual-tree rate of value increase. Where surface defect rules out the possibility for top-grade sawlogs or veneer logs, a size objective of about 18 inches d.b.h. (12 inches d.i.b. at the top of the second log) seems like a reasonable goal.