Changes in Species, Grade, and Structure Over 48 Years in a Managed New England Northern Hardwood Stand

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ABSTRACT: *Three individual-tree selection harvests over a 48 yr period in a northern hardwood stand in New Hampshire resulted in an increase in the percentage of volume in trees with grade 1 and 2 butt logs from 21% (1952) to 30% (2000) in beech and 40% (1952) to 65% (2000) in sugar maple and other hardwoods. By 2000, 90% of the volume was in tolerant species. North. J. Appl. For. 19(1):25–27,*

Key Words: Tree grade, individual-tree selection, northern hardwoods.

One basic tenet in forestry is that good silviculture will improve the productivity and value of forest stands. However, there are few long-term records to document the rate or extent of this expected improvement.

A study in Upper Michigan showed that stands dominated by sugar maple increased in butt-log grades 1 and 2 (Hanks 1976) from 57% to 80% of the volume over a 20 yr period under a series of three light improvement cuts (Erickson et al. 1990). A 20 yr record from Wisconsin gave similar results: a series of five medium selection harvests resulted in an average improvement of 1.1 tree grades, ending up with 66% of the sawtimber volume in tree grades 1 and 2 (Strong et al. 1995). A young (40–45 yr old initially) Appalachian hardwood stand exhibited an increase in percent of grade 1 and 2 logs over a 34 yr period from about 20% to over 50% under single-tree selection (Smith and Miller 1987). However, a comparable increase in an unmanaged reference stand emphasized the importance of not confusing the effects of management with the effects of increasing tree size or, in other words, changes in stand structure.

However, northern hardwood stands in New England may behave differently, primarily because of the preponderance of lower value and more defective species such as beech and red maple. Over a period of about 40 yr following a selection cut, the average quality of six northern hardwood stands on the Bartlett Experimental Forest improved by about 0.1 to 0.9 grades, averaging 0.5 grades (Sendak et al. 2000). In two of the better stands, the final proportion of volume in tree grades 1 and 2 was about 55%. The primary change in species composition was a noticeable increase in hemlock.

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To provide additional long-term information under a more intensive management regime, a stand in the Bartlett Experimental Forest previously described by Filip (1978) was prism-sampled in the summer of 2000. In 1952, the 32 ac stand was harvested by individual-tree selection. Species, structure, and butt-log grade were inventoried before and after harvest. Reinventories were conducted in 1976 and 2000 after second and third harvests in the stand, providing a 48 yr record of change. Results through 1976 have been reported (Filip 1978). This note updates the record through the year 2000.

Methods and Background

Single-tree selection cuttings were made in 1952, 1975, and 1992 in this 32 ac northern hardwood stand, which initially was an old-growth stand with a well-developed structure. All harvests left a residual basal area of about 75 to 80 ft^2/ac in trees 5.0 in. and larger. There was an attempt to maintain a roughly J-shaped structure with a Q (2 in. diameter classes) of about 1.5. However, this goal was not attained because the marking was heavily weighted toward removing beech of poor health and quality, a result of heavy infestations of the beech-bark disease complex in the late 1940s and early 1950s. The volume marked in the first (1952) harvest was 45% beech and 24% overmature paper birch. About 80% of the sawtimber volume was tree grade 3 or worse. In the later markings (1975 and 1992), about three-quarters of the harvested sawtimber volume was beech with at least two-thirds in tree grade 3 or worse.

The inventories before and after the 1952 and 1975 harvests were 100% tallies, with a sampling of butt-log grade. The 2000 inventory (8 yr after the 1992 cut) was a 20-factor prism tally with 72 plots (over 2 per acre); the standard error from this tally was 3.6% of the mean basal area per acre. On

Table 1. Percent of cubic volume (5.0 in. and larger) by species and year.

Species	Year		
	1952	1976	2000
Beech	53	53	49
Sugar maple	18	27	25
Paper birch	11	0	0
Yellow birch	11	7	6
Hemlock	3	9	15
Red maple	2	2	3
Red spruce	1	1	1
White ash	1	1	1

these plots, all sawtimber trees were butt-log graded, hardwoods 11.0 in. and larger, softwoods 9.0 in. and larger; however, the grade results in this article are restricted to hardwoods. Although the butt-log grading rules are precise (Hanks 1976), grading is subjective due to the difficulty of recognizing and evaluating indicators of defect. In this study, some degree of consistency was maintained by measuring (rather than estimating) lengths of clear cuttings and by having one person (the senior author) involved in both the 1952 and the 2000 grading. The 1952 inventory used log grade rules (Rast et al 1973) rather than tree grades; however, the external indicators are the same, and where there were slight discrepancies, the 1952 procedures were followed.

Following the format set by Filip (1978), comparisons were made of species, grade, and structure for the 1952 (before cut), 1976 (after the 1975 cut), and 2000 (8 yr after the 1992 cut) inventories.

Results

In 1952, before the first cut, beech and sugar maple comprised 53% and 18% of the cubic-foot volume, respectively, with lesser amounts of the other species (Table 1). Despite the beech bark disease and heavy marking of defective beech, the proportion of beech declined very little over the years, from 53% in 1952 and 1976 to an estimated 49% in 2000; the propensity of beech to maintain its dominance in the stand apparently was due to aggressive regeneration from root suckers, and the presence of individuals resistant to the beech-bark disease. Sugar maple and hemlock increased, while paper and yellow birches declined due to heavy marking and lack of recruitment. As commonly observed with individual-tree selection, the species composition is moving toward a predominance of tolerant species (90%) with a high proportion of beech and a growing proportion of hemlock.

The percentage of volume in hardwood trees with grade 1 and 2 butt logs rose appreciably between 1952 and 1976, from 29% to 42%, but increased to only 45% after that (Table 2). This increase was due to the gradual removal of

Table 2. Quality of hardwood sawtimber, all species combined: percent of gross cubic-foot volume (trees 11.0 in. dbh and larger) by butt-log grade and year.

Grade	1952	1976	2000
1 and 2	29	42	45
3	50	31	40
5	14	26	11
Cull	7	1	3

poor trees coupled with a slight increase in sugar maple. Trends in grades 3 and 5 were somewhat inconsistent. Cull percentage was somewhat lower in the 1976 and 2000 inventories than in 1952. Beech quality was considerably lower than that of other hardwoods (predominantly sugar maple) (Table 3). However, by year 2000, the percentage of beech in grades 1 and 2 had risen from 21% to 30%. The percentage of volume in grades 1 and 2 in other hardwoods (65-67%) was comparable to the tree quality found in the sugar-maple dominated stands of the Lake States (Erickson et al. 1990, Strong et al. 1995).

Gross sawlog volumes per acre were estimated at about 7,300 bd ft (Int. 1/4-in.) in 1952 and 10,200 in year 2000. Using low, medium, and high stumpage prices reported for Carroll County, New Hampshire in 1998–1999, dollar values were assigned to the estimated volumes in grades 1, 2, and 3 with a flat rate for cubic volumes below grade 3 (University of New Hampshire 1999). For example, grade 1, 2, and 3 sugar maple was valued at $500, $300, and $100/mbf and $8/cord. Values per acre in constant dollars were nearly twice as much in 2000 as compared to 1952; most of the difference was due to the increase in grade 1 material (Table 4), but also can be attributed to an increase in volume per acre, particularly for the higher valued sugar maple. Value per mbf was $108 in 1952 versus $147 in 2000 (1998–1999 dollars).

Stand structure, in terms of numbers of trees by dbh class, varied between inventories from a slightly sigmoid form in 1952 (before cut), to a uniform J-shape in 1976 (after cut), to a pronounced sigmoid form in 2000 (8 yr after cut) with a bulge in all species in the 12 and 14 in. classes (Figure 1). The Q for the 1976 inventory was about 1.7, although the ratio varied considerably from one dbh class to another. Calculation of Q for the sigmoid diameter distributions is somewhat inappropriate. However, stand structure as measured by percent of basal area in sawtimber (trees >11.0 in. dbh) did not vary greatly over time: 56%, 53%, and 58% in 1952, 1976, and 2000, respectively, with total basal areas(>5.0 in. dbh) of 107, 82, and 106 ft^2/ac. The bulge in the 2000 inventory probably reflects the disinclination of tree markers to mark 12 and 14 in. trees, which are just beginning to improve rapidly in grade and value. In addition, there is a slight concentration of the mid-successional yellow birch and

Table 3. Quality of beech and other hardwood sawtimber: percent of gross cubic-foot volume (trees 11.0 in. dbh and larger) by butt-log grade and year.

Grade	Beech			Other hardwoods		
	1952	1976	2000	1952	1976	2000
1 and 2	21	21	30	40	67	65
3	52	36	47	47	25	31
5	16	41	18	10	8	3
Cull	11	2	5	3	0	1

Table 4. Estimated dollars per acre by tree grade in 1952 and 2000, based on 1998–1999 stumpage prices.

Tree grade	1952	2000
	($)	
1	134	721
2	386	525
3	260	251
<3	99	55
All	879	1,552

red maple in the mid-diameter classes. Without these two species, the bulge in the year 2000 diameter distribution becomes essentially a plateau, so it is possible that the bulge is a temporary aberration. Current guidelines on appropriate structural forms include both J-shaped and slightly sigmoid forms (Leak 1996)

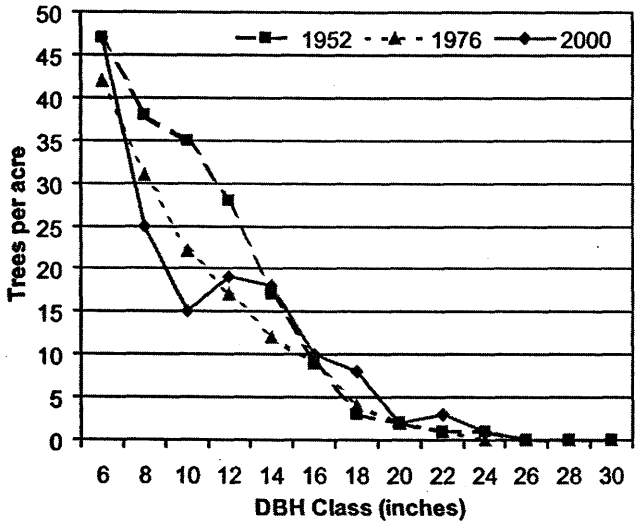

Figure 1. Stand structure: trees per acre by dbh class in 1952 (before first cut), 1976 (postcut), and 2000 (8 yr postcut).

Application

In northern hardwoods of New England, the careful application of individual-tree selection harvests can achieve up to about 30% of the sawtimber volume of beech and 65% of other hardwoods (mostly sugar maple) in trees with grade 1 and 2 butt logs. Up to 90% or more of the stand will consist of tolerant species. The structure will maintain a J-shaped or sigmoid form, with nearly 60% of the basal area in sawtimber-sized trees (>11.0 in.). Improvements to this approach might include more liberal usage of group/patch selection openings to regenerate a better mix of valuable intolerant and mid-tolerant species.

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