Effects of Small Patch Cutting on Sugar Maple Regeneration in New Hampshire Northern Hardwoods

William B. Leak, *USDA Forest Service, Northeastern Research Station, P.O. Box 640, Durham, NH 03824.*

ABSTRACT: *In many northern hardwood stands in New Hampshire and New England, partial cutting or single-tree selection results in understories with a high proportion of beech and other species with low timber values. Patch cutting, using small openings of about 1/4-ac in size or larger coupled with sufficient logging disturbance, has proved to be an effective way to replace understories of beech and other less valuable species with a new stand containing a high proportion of yellow and paper birch in mixture with other deciduous species. Unless present as well-developed advanced regeneration, sugar maple is seldom common in the new stands produced by small patch cutting. However, when these early successional stands reach 40–50 years of age, understories dominated by sugar maple and with lesser proportions of beech frequently develop, possibly due to the rich leaf-fall, lower proportions of beech litter, and/or changed light conditions. Although small patch cutting may not immediately regenerate abundant sugar maple, it appears as though this technique may help over time to maintain sugar maple as a significant component of northern hardwood forests. North. J. Appl. For. 22(1):68–70.*

Key Words: Northern hardwoods, patch cutting, sugar maple.

American beech (*Fagus grandifolia*) is one of the primary competitors of sugar maple (*Acer saccharum*) when regenerating northern hardwood stands (Bohn and Nyland 2003, Jones et al. 1989, Kelty and Nyland 1981). On the best sites (Leak 1978), sugar maple is competitive. But on average or mediocre sites in New England, single-tree selection or any form of partial cutting may result in understories completely dominated by beech together with other low-value species. Recent information shows that the shade cast by beech understories as well as the alleleopathic effects of beech foliage may be partly responsible for the inhibition of sugar maple regeneration (Hane 2003a, 2003b). Control of understory beech by chemical or mechanical means usually is effective but requires a substantial investment (Horsley 1994, Sage 1987).

Patch cutting, using small clearcut openings about 1/4 ac or larger coupled with ample logging disturbance, has been effective in New Hampshire northern hardwoods by replacing beech understories with an abundance of paper (*Betula papyrifera*) and yellow birch (*B. alleghaniensis*) as well as other species such as white ash (*Fraxinus americana*) and red maple (*A. rubrum*) (Leak 2003, McClure and Lee 1993). Sugar maple is not abundant in the new stand unless present as well-advanced regeneration. However, in small patch cuts about 40–50 years old on the Bartlett Experimental Forest in New Hampshire, observations indicated that understories were developing that frequently had abundant sugar maple regeneration—much more than occurred in the adjacent older stand. A survey was conducted in the summer of 2003 to assess this phenomenon.

Methods

A total of 14 small patches (one long, narrow patch was treated as two patches) were located according to the following restrictions. They were all about 50 years old, and averaged about 1/2 ac in size. We avoided the few best sites on the Bartlett Forest (fine till sites over compact till and enriched sites) where sugar maple regeneration was abundant, even in unmanaged stands. And we avoided the poorest northern hardwood sites (generally sandy, washed tills) where sugar maple was almost nonexistent. We sampled patches where there was a sharp border between the cut patch and an adjacent section of uncut stand with comparable topography. Four of these patches had almost no understory development due to the presence of a noticeable beech midstory that had not been destroyed or minimized during the original harvest. These were not sampled in this study. In the remaining 10 patches, a 50-ft transect, 3 ft

NOTE: William B. Leak can be reached at (603) 868-7655; Fax: (603) 868-7604; bleak@fs.fed.us.

Table 1. Average species composition (trees 4 in. dbh and larger) in 10 patches and adjacent uncut stands in basal area (ft^2/ac) and percent of basal area.

Stand type	Measure	Beech	Yellow birch	Sugar maple	Red maple	Paper birch	White ash	Hemlock	Other	Total
Uncut	Basal area	62	12	38	14		8	6		140
	Percent	44	9	27	10		6	4		100
Patch	Basal area	9	15	7	5	34	9	2	3	84
	Percent	11	18	8	6	41	11	2	3	100

Table 2. Average numbers of stems per acre 1–4 ft tall and 2–4 ft tall by species in 10 patches and adjacent uncut stands.

Stand	Stem size (ft)	Beech	Sugar maple	Red maple	White ash	Other
Uncut	1–4	7,645	581	116	—	87
	2–4	1,082	58	29	—	—
Patches	1–4	2,004	9,612	203	552	58
	2–4	900	2,004	58	29	29

wide, was randomly located, extending into the patch beginning at the crown edge defining the patch opening. A comparable transect was established in the adjacent uncut stand, beginning at edge of the border-tree crown away from the patch opening. On these transects, all seedlings were counted by 1-ft height classes between 1 and 4 ft tall. The 1–4 ft range included the majority of understory stems and avoided older stems that were advanced growth before the patch cut. Prism counts (20-factor) were taken of trees 4 in. dbh and larger along the transects in the patches (2 plots per transect) and adjacent uncut stands (1 plot) to characterize the species composition of the overstory.

Results

Overstory species composition was fairly typical for older, uncut stands and new stands following patch cutting (Table 1): in the uncut stands, there was an average of 44% beech, 27% sugar maple, and 9% yellow birch; in the patch cuts, the stands averaged 70% paper birch, yellow birch, and white ash combined with only 11% beech.

In the understory of the uncut stands (Table 2), beech stems outnumbered sugar maple by a factor of 13 to 18 times in the 1–4 ft and 2–4 ft classes, respectively. Using the system developed by Bohn and Nyland (2003), these numbers suggest a very high probability of beech dominance after a partial cut—a prediction in line with experience on the Bartlett Experimental Forest.

In the understory of the patches, sugar maple (plus a few white ash) stems outnumbered beech by about 2 to 5 times in the 2–4 ft and 1–4 ft classes, respectively. Numbers of sugar maple and ash stems were equal to or greater than beech stems in 9 out of 10 patches in the 1–4 ft height class and 7 out of 10 patches for the 2–4 ft class. Sugar maple is not considered fully established until it reaches 3–4 ft tall (Tubbs 1977) and free-to-grow status; however, smaller sugar maple stems will persist under a light canopy and respond to any natural disturbance or partial harvest.

Applications

Small patch cuttings in northern hardwoods in New England, coupled with sufficient logging disturbance to minimize the beech advance growth, are effective in replacing beech understories with a new stand containing abundant paper and yellow birch in mixture with other species. One added advantage of this system is that it appears to encourage the development of an understory containing a fairly abundant representation of sugar maple and some ash, provided that the group/patch harvest removes the advance growth of beech through logging disturbance. This tendency toward sugar maple appears when the group/patch is about 40–50 years old. Small clearcuts probably will produce the same effect, provided that a nearby seed source is available.

The reasons for this development are unknown. However, the possible reasons include the reduction in beech shade and toxic beech foliage and the light shade cast by the early successional species that dominate group/patch reproduction. In addition, because sugar maple and white ash are nutrient-demanding species, it seems quite possible that their development might be encouraged by the high foliar contents of nitrogen, calcium, and potassium found in certain early successional species (Smith et al. 2002, Young and Carpenter 1967) and the subsequent effects on litterfall and throughfall.

Literature Cited

Bohn, K.K., and R.D. Nyland. 2003. Forecasting development of understory American beech after partial cutting in uneven-aged northern hardwood stands. For. Ecol. Manage. 180:453–461.

Hane, E.N. 2003a. Indirect effects of beech bark disease on sugar maple seedling survival. Can J. For. Res. 33:807–813.

Hane, E.N. 2003b. Phytotoxicity of American beech leaf leachate to sugar maple seedlings in a greenhouse experiment. Can. J. For. Res. 33:814–821.

Horsley, S.B. 1994. Regeneration success and plant species diversity of Allegheny hardwood stands after Roundup application and shelterwood cutting. North. J. Appl. For. 11:109–116.

JONES, R.H., R.D. NYLAND, AND D.J. RAYNAL. 1989. Response of American beech regeneration to selection cutting of northern hardwoods in New York. North. J. Appl. For. 6:34–36.

KELTY, M.J., AND R.D. NYLAND. 1981. Regenerating Adirondack northern hardwoods by shelterwood cutting and control of deer density. J. For. 79:22–26.

LEAK, W.B. 1978. Relationship of species and site index to habitat in the White Mountains of New Hampshire. USDA For. Serv. Res. Pap. NE-397. 9 p.

LEAK, W.B. 2003. Regeneration of patch harvests in even-aged northern hardwoods in New England. North. J. Appl. For. 20:188–189.

MCCLURE, J.W., AND T.D. LEE. 1993. Small-scale disturbance in a northern hardwoods forest: Effects on tree species abundance and distribution. Can. J. For. Res. 23:1347–1360.

SAGE, R.W., JR. 1987. Unwanted vegetation and its effects upon regeneration success. P. 298–315 *in* Managing northern hardwoods: Proc. of a silvicultural symposium, Nyland, R.D. (ed.). SUNY Faculty of Forestry Misc. Pub. 13.

SMITH, M.L., S.V. OLLINGER, M.E. MARTIN, J.D. ABER, R.A. HALLETT, AND C.L. GOODALE. 2002. Direct estimation of aboveground forest productivity through hyperspectral remote sensing of canopy nitrogen. Ecol. Appl. 12:1286–1302.

TUBBS, C.H. 1977. Manager's handbook for northern hardwoods in the North Central States. USDA For. Serv. Gen. Tech. Rep. NC-39. 29 p.

YOUNG, H.E., AND P.M. CARPENTER. 1967. Weight, nutrient element and productivity studies of seedlings and saplings of eight tree species in natural ecosystems. Maine Agr. Exp. Sta. Tech. Bul. 28. 39 p.