EFFECTS OF SEASON OF CUT AND RESIDUAL OVERSTORY DENSITY ON STUMP SPROUT GROWTH AND DEVELOPMENT

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Stump sprouts contribute to the regeneration potential of upland hardwood forests in the southern Appalachian Mountains (Cook and others 1988); however, most of the information regarding stump sprout potential and subsequent sprout growth and development is from studies following regeneration cuts. The effects of less-than-stand-replacing disturbances (e.g. thinnings) on stump sprout potential is lacking. In addition, the season during which trees are harvested has been shown, in some instances, to affect the ability of certain upland hardwood tree species to produce stump sprouts (Buell 1940, Harrington 1984). Lack of data related to the growth and development of stump sprouts following a range of canopy-reducing disturbances and timing of harvests limits our ability to predict the regeneration response of a stand subjected to alternative management scenarios. The objective of this study was to examine differences in stump sprout potential in upland hardwood forests in the southern Appalachian Mountains across a range of canopy-reducing disturbances. Preliminary (2-year) results related to: (1) the effects of season of cut on the probability of sprouting of upland hardwood tree species, and (2) the effects of residual overstory density and season of cut on subsequent stump sprout growth and development are presented.

In 2009, 24 plots 0.1-ha in size were established in upland, mixed-hardwood forest types on Bent Creek Experimental Forest in Asheville, NC. On 12 plots, basal area was mechanically reduced from below by 10, 20, 30, or 40 percent between January and February 2009 (dormant season). Basal area was reduced from below on another 12 plots by 10, 20, 30, or 40 percent between July and August 2010 (growing season). Each season of cut and level of basal area reduction combination were replicated three times (n = 3). On each cut stump, with the number of cut stumps varying with the level of basal area reduction, the following data were recorded: (1) sprouting (yes/no); (2) height of the dominant sprout in each clump (m); and (3) maximum length (m) and width (m) of each individual sprout clump.

Logistic regression (PROC GLIMMIX) was utilized to examine the probability of sprouting for each species as a function of: (a) parent tree diameter at breast height (d.b.h.; cm); (b) season of cut (dormant vs. growing); and (c) the interaction between parent tree d.b.h. and season of cut. The hierarchical nature of the data (i.e., cut stumps nested within plots) was accounted for by including plot as a random effect in the probability of sprouting model. A two-factor analysis of variance (ANOVA) was used to examine how season of cut and basal area reduction as well as the interaction between basal area reduction and season of cut affected sprout growth after two growing seasons post-treatment, with dependent variables being: (a) height (m) of dominant sprout; and (b) area (m^2) of sprout clump calculated from maximum length and width data, with area modeled as an ellipse.

In total, 1,369 individuals were felled and the associated cut stumps were analyzed. The sample size of nine species, including red maple (*Acer rubrum* L.), sweet birch (*Betula lenta* L.), hickory (*Carya* spp.), flowering dogwood (*Cornus florida* L.), yellow-poplar, (*Liriodendron tulipifera* L.), blackgum (*Nyssa sylvatica* Marsh.), sourwood (*Oxydendrum arboretum* DC), white oak (*Quercus alba* L.), and chestnut oak (*Quercus prinus* L.), was sufficient to analyze the effects of season of cut and parent tree d.b.h. on the probability of stump sprouting by species. Only for sweet birch was the probability of stump sprouting affected by the season of cut, with trees cut during the growing season less likely to sprout (54 percent sprout rate) than trees cut in the dormant season (93 percent sprout rate). The relationship between the probability of stump sprouting and parent

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Table 1—Mean height (m) of the dominant sprout in each clump (averaged across species) and mean area (m^2) of individual sprout clumps (averaged across species) in each basal area reduction treatment

Basal area reduction	Growing season height (*m*)		Growing season area (m^2)		Dormant season height (*m*)		Dormant season area (m^2)	
Percent	Mean	SE[a]	Mean	SE	Mean	SE	Mean	SE
10	1.2	0.1	1.3	0.2	1.2	0.2	1.7	0.5
20	1.6	0.3	1.7	0.5	1.6	0.2	2.4	0.1
30	1.9	0.1	2.4	0.4	2.0	0.1	2.9	0.1
40	2.1	0.1	3.0	0.1	2.0	0.1	3.4	0.5

[a]SE = standard error

tree d.b.h. was not statistically significant (P > 0.05) for sweet birch (sprout rates presented above), red maple (95 percent sprout rate), dogwood, (88 percent sprout rate), sourwood (98 percent sprout rate), hickory species (77 percent sprout rate), chestnut oak (86 percent sprout rate), and yellow-poplar (91 percent sprout rate). For blackgum and white oak, a negative relationship between parent tree d.b.h. and the probability of stump sprouting (P < 0.05) was observed (fig. 1).

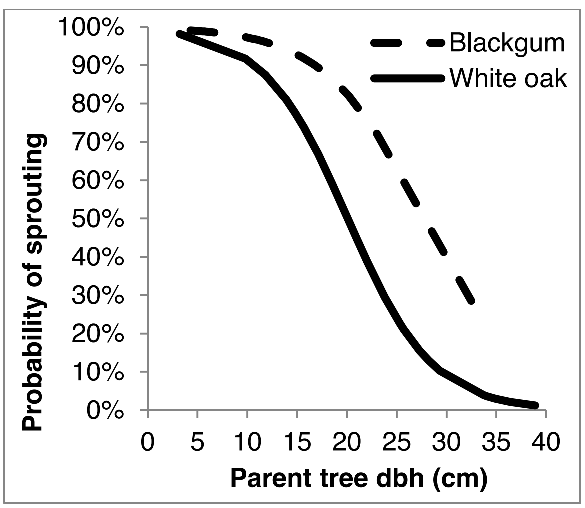

Figure 1--Probability of sprouting as a function of parent tree d.b.h. (cm) for white oak and blackgum.

Averaged across species, the height of the dominant sprout was positively affected by the percent of basal area removed (P < 0.05) (table 1) but was not influenced by the season of cut or the interaction between season of cut and basal area reduction (P > 0.05). Regardless of season of cut, height of the dominant sprout was similar between the 10 and 20 percent reductions in basal area and the 30 and 40 percent reductions in basal area. The area of individual sprout clumps was affected by the percent of basal area removed ($F_{3,16} = 10.2$, P = 0.0005) as well as the season of cut ($F_{1,16} = 4.9$, P = 0.0423) but not the interaction between season of cut and basal area removed (P > 0.05). Averaged across the levels of basal area reduction, sprout clumps from trees cut in the dormant season were slightly larger in area than those cut in the growing season averaging 2.6 m^2 (± 0.2) and 2.1 (± 0.2) m^2, respectively. The relationship between the area of individual sprout clumps and level of basal area reduction was similar to that of dominant sprout height (table 1). As a percent of the 0.1-ha plot occupied by sprouts, it is apparent that as overstory density is reduced, growing space is quickly occupied by sprouting species of which most were red maple and sourwood. Expressed as a percentage of total plot area, sprout clumps occupied between 0.6 and 35 percent of the 0.1-ha plots.

Although thinnings are not designed with regeneration in mind, they can affect the regeneration potential of a stand by altering the size distribution of the advance reproduction layer as well as initiate the production and growth of stump sprouts. The rapid growth of stump sprouts, if not controlled though further intermediate treatments, can alter the regeneration potential of a stand. The increase in growing space and light conditions that may facilitate the growth and development of a diverse advance reproduction layer, therefore, may be short-lived, which may limit the ability of the advance regeneration layer to contribute to species composition after a final regeneration harvest.

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