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Characteristics of Declining Forest Stands on the Allegheny National Forest

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Abstract

Forest stands with advanced symptoms of forest decline located on the Allegheny National Forest in northwestern Pennsylvania were studied to describe contemporary stand structure and composition, and the status of regeneration. Across all 340 stands, 12 percent of the total basal area per acre was in dead trees and 16 percent was in trees at high risk of mortality. For sugar maple, 59 percent of the basal area was dead or at risk. Prior to recent mortality, sugar maple was the dominant species; now it ranks third behind black cherry and red maple. Beech and red maple were the other important decline species, with 28 and 20 percent of their basal area dead or at risk, respectively. Regeneration was adequate in only 8 percent of the sampled stands. Vegetation that interferes with regeneration was prevalent throughout the stands sampled. Sparse regeneration and the abundance of interfering vegetation raise serious concerns about regeneration and maintenance of forest cover.

The past decade has seen a rise in tree mortality for Allegheny hardwood forests of northern Pennsylvania. This phenomenon was first recognized when inordinate numbers of sugar maple trees began dying in the region (Fig. 1). Decline of sugar maple also has been reported elsewhere within the range of northern hardwood forests. A good overview and discussion of sugar maple decline are provided by Allen and others (1992). As with other decline complexes, the precise etiology of sugar maple decline is not fully understood (Bauce and Allen 1991; Kolb and McCormick 1993). Conditions on the Allegheny National Forest worsened following droughts of 1988 and 1991. This was followed by severe outbreaks of insects including elm spanworm, forest tent caterpillar, fall cankerworm, and cherry scallop-shell moth. As a result, forest decline became widespread among several tree species. Heavy mortality on the Allegheny National Forest began in 1992. To illustrate the magnitude of the decline, an aerial reconnaissance of the Allegheny National Forest revealed that approximately 89,600 acres had symptoms of decline (USDA Forest Service 1995). An inventory of some of the hardest hit stands and adjacent areas on the Forest was conducted in the summer of 1994. In this Note, we summarize the results of the inventory and more specifically, discuss general stand impacts, changes in overstory structure and vegetative composition, regeneration status, and possible future changes in composition in the decline area.

Figure 1.—Sugar maple stand with signs of decline on the Allegheny National Forest.

Methods

In the summer of 1994, an inventory was conducted in 340 stands of the Allegheny National Forest that were identified as being among the hardest hit by tree decline and mortality (Fig. 2). This approach to selecting sample stands was intended to provide a profile of what can be expected in stands with significant mortality and to establish a baseline for future monitoring. The area sampled totaled 8,343 acres; stands ranged in size from 2 to 149 acres. In each stand, standard SILVAH exams were conducted following the guidelines described by Marquis and others (1992). The exams consisted of measurements taken on overstory and understory plots. There was a minimum of 10 overstory plots in each stand; overstory trees were tallied with a 10-BAF prism. Crown condition was expressed as percentage of the normal live crown that was present, keeping in mind conditions of crown position, stand density, and species.

Trees were grouped into three classes that described their status at the time the sample was conducted:

- Healthy: Trees with 50 percent or more of their normal live crown.
- At risk: Trees with less than 50 percent of their normal live crown.
- Dead: Trees that had succumbed to damaging agents.

The 50-percent live-crown division between healthy trees and trees at risk though somewhat arbitrary, is used as a preliminary guideline for identifying trees to remove in silvicultural prescriptions, and follows the work of Miller and others (1994) as a coarse predictor of eventual mortality. Since stands were not inventoried prior to decline, the effects of decline were expressed using tree status. Dead trees were further divided into condition classes to assess the impact of mortality on opportunities for timber salvage:

- Salvable: Trees that recently died (within the past 6 months) and that have tight bark on the entire bole.
- Marginally Salvable: Trees on which 50 percent of the bark is tight and that likely will remain salvable for sawtimber and pulpwood.
- Nonsalvable: Trees on which most of the bark has sloughed off and that contain fungal fruiting bodies, and trees that are not salvable for sawtimber but may be salvable for pulpwood for another year.

Understory plots were installed at roughly double the intensity of overstory plots. The design consisted of two nested circular plots: a 6-foot-radius plot and a 1/20-acre plot. The 6-foot plot was used to tally tree regeneration and woody interference; the larger plot was used to estimate percentage of fern and grass cover.

For analysis, data were summarized by stand and averaged across all stands to describe overall conditions. These average conditions were used graphically to evaluate patterns in stand structure and composition, and the character of existing regeneration.

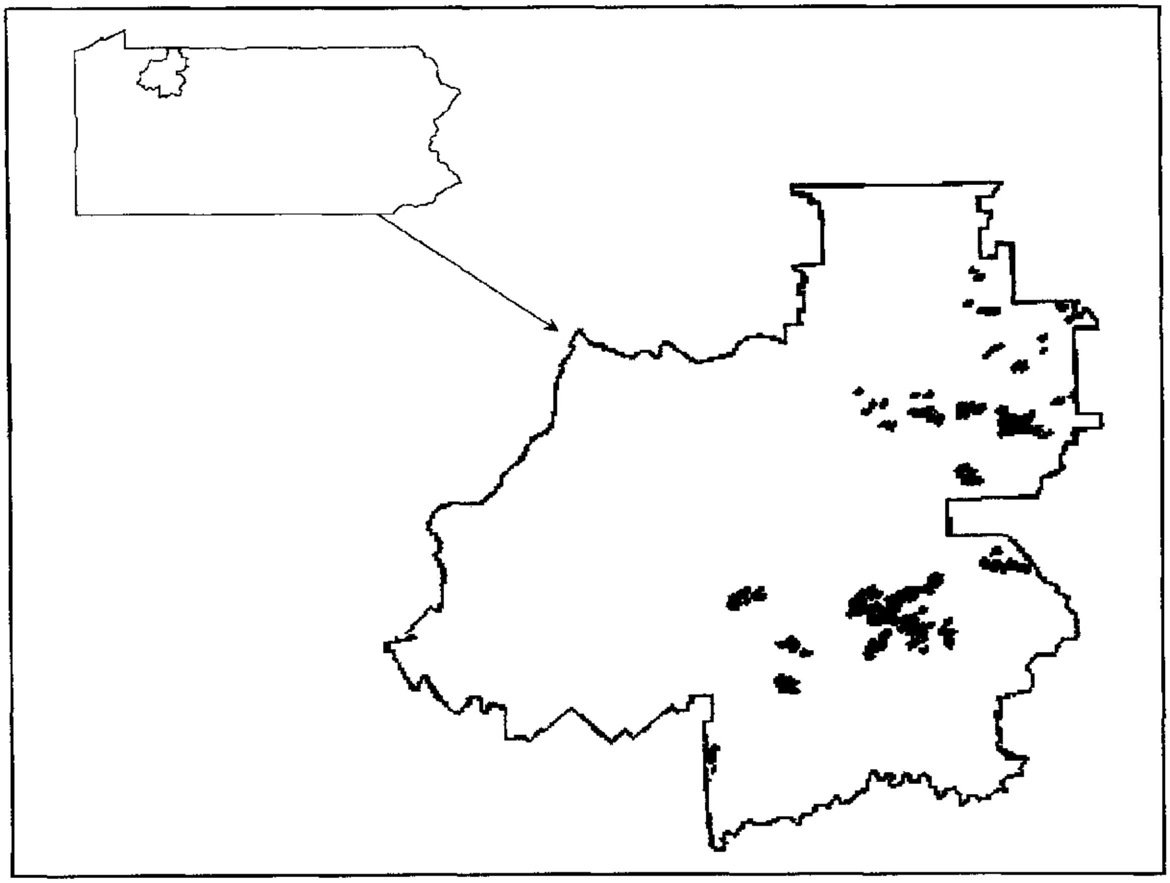

Figure 2.—Areas with high tree mortality on the Allegheny National Forest. Sample plots were located within the areas of high mortality. (To maintain map clarity, privately owned land within the Allegheny National Forest boundary is not shown. Implication of management activity on those lands is not intended by this omission.)

Results

Overstory Trees

The average basal area per acre of live, at risk, and dead trees in the sampled stands was 94 ft^2/acre. Sampled stands included a mixture of harvested, thinned, and uncut stands. Individual stands ranged from 33 to 136 ft^2/acre. Twenty-eight percent of the existing basal area was classified as dead (12 percent) or at risk (16 percent). Average basal area per acre is reduced to 83 ft^2/acre after deducting dead and at risk trees, a reduction of 12 percent. Spatially within the sample area, tree status varied considerably. In some stands, dead and at risk trees were a minor stand component scattered among healthy trees; in others, those trees made up the majority of the stand.

To gain insight into the effect of forest decline on individual species or species groups, it is useful to consider their relative importance prior to forest decline (Table 1). Sugar maple, black cherry, and red maple were the dominant overstory species in the sampled stands, accounting for about three-fourths of the total basal area. Beech was the fourth most important species (11 percent of total basal area), followed by conifers, birch, white ash, yellow-poplar, and other deciduous species. The importance of black cherry and red maple increased with increasing diameter. Sugar maple and beech decreased in importance in the larger diameter classes.

The dieback and death of sugar maple, beech, and red maple was the most consequential impact on forest stands in the sample (Fig. 3). Sugar maple had the highest levels of mortality and at risk trees with 59 percent of the basal area in these categories. Levels of dead and at risk trees were 28 and 20 percent for beech and red maple, respectively. Mortality and risk for sugar maple and beech seemed to be relatively independent of tree size (Fig. 4) except for sugar maple trees less than 5 inches in diameter. Decline was slightly lower in these trees. For red maple, decline was most severe in trees less than 15 inches in diameter. White ash suffered heavy decline on a percentage basis (47 percent dead or at risk) but was a relatively minor component in the sampled stands. The impact of decline was less significant for other species and species groups.

Table 1.—Percent basal area per acre by species/species group and diameter class prior to decline, and total area basal per acre by diameter class prior to decline for stands with significant symptoms of forest decline, the Allegheny National Forest

Species or species group	Diameter class (inches) 1.0-4.9	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0 29.9	30.0+	All classes
Sugar maple	39.8	47.4	36.8	12.8	4.4	1.3	1.2	26.6
Black cherry	2.3	3.1	13.8	35.1	54.3	63.7	61.4	24.8
Red maple	5.5	15.1	26.9	32.6	21.5	8.7	7.3	24.3
Beech	38.2	18.8	9.3	7.5	7.3	6.1	3.8	10.9
Conifer	6.6	8.1	3.6	2.4	3.6	10.1	16.5	4.3
Birch	2.1	5.3	5.3	1.5	0.1	0.1	—	3.3
White ash	0.1	0.9	2.6	4.5	2.7	1.4	—	2.7
Yellow-poplar	—	0.1	0.3	1.9	4.8	7.8	9.1	1.6
Other deciduous	5.4	1.2	1.4	1.7	1.3	0.8	0.7	1.5
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All species/species groups (ft^2/acre)	3.4	13.7	36.5	21.3	15.2	2.2	0.5	92.3

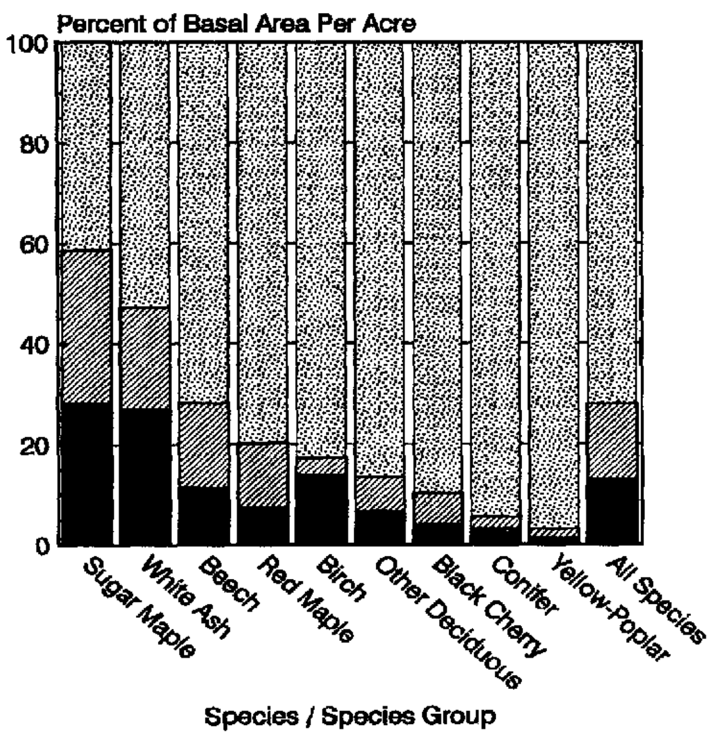

Figure 3.—Percentage of basal area per acre by tree status and species/species group for stands with with significant symptoms of forest decline on the Allegheny National Forest.

Mortality and risk were most noticeable in trees from 5.0 to 14.9 inches in diameter (Fig. 5). Although decreases in this range were significant, the distribution of basal area by diameter class after decline differed little from the distribution before decline. Changes in species composition were more noticeable. Before decline, the sampled stands were dominated by sugar maple, black cherry, and red maple. Sugar maple was the dominant species, but following decline it became the third most dominant species. Black cherry and red maple became the two most important species while beech remained of intermediate importance (9 percent of the basal area per acre). The other species and species groups retained rankings similar to those before decline.

There are opportunities to salvage dead timber in the sampled stands. Timeliness of the salvage is essential. Trees in the "marginally salvable" category are merchantable for sawtimber and pulpwood if salvaged within 6 months to 1 year. The distribution of dead timber (based on basal area) was 23 percent in salvable trees, 33 percent in marginally salvable trees, and 44 percent

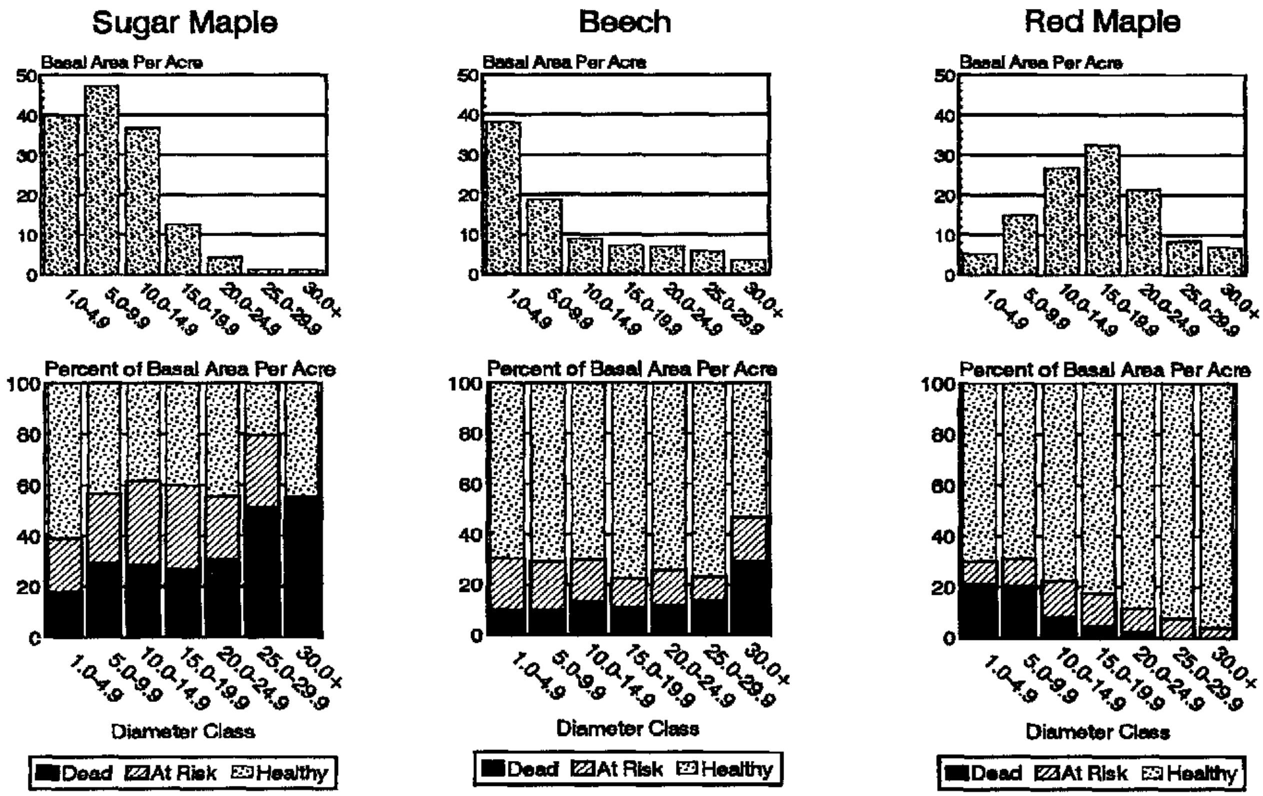

Figure 4.—Basal area per acre and percentage of basal area per acre by tree status for sugar maple, beech, and red maple by diameter class for stands with significant symptoms of forest decline on the Allegheny National Forest.

in nonsalvable trees (Fig. 6). The percentage of salvable trees was relatively constant across diameter classes.

Tree Regeneration

The understory sample plots were used to estimate regeneration adequacy for various components of regeneration (Fig. 7). For any single component, a stand was considered to be adequately stocked if at least 70 percent of the regeneration plots met regeneration criteria developed by Marquis and others (1992). It is apparent that regeneration is inadequate in the stands sampled for this study. Stands with any type of tree regeneration accounted for only 8 percent of those in the sample. Black cherry seedlings and residuals from the previous stand constituted what little regeneration was found, and regeneration of northern hardwood and oak species was essentially nonexistent. These findings are consistent with regional studies of regeneration adequacy for Pennsylvania (McWilliams and others 1995).

Interfering Vegetation

Estimates of the stocking of interfering vegetation are shown in Figure 8. Fern was the most abundant form of interfering vegetation. Interfering grass and woody plants (composed mostly of striped maple and beech suckers) were not as important as fern. When all forms of interfering vegetation are considered together, the effect is amplified. Interpreting these estimates requires a recognition that they were intended for individual stand prescriptions and not for drawing conclusions from a conglomeration of stands. However, the analysis can draw from the general flow of decisions built into the silvicultural guidelines. Under even-age management, the guidelines suggest a shelterwood seed cut if sufficient regeneration is lacking, as in this "average" stand. Herbicide treatment is considered if 30 percent of the understory plots have interfering vegetation. For such a scenario, herbicide treatment would be an option in 9 of 10 stands sampled in the study.

Discussion

The extent, duration, and complexity of poor forest health conditions in some areas of northern Pennsylvania fit the definitions and constructs of forest decline described by Houston (1992) and Manion and Lachance (1992). As such, forest decline is now a serious threat on the Allegheny National Forest as composition and structure can be affected significantly. This study documents conditions that can be expected in stands similar to those studied. It should be noted that decline is a dynamic process so additional effects may emerge as the decline complex progresses. A number of implications are apparent from this study. If sugar maple mortality continues, its role in stand composition will shift from codominance with black cherry and red maple to become a lesser species. Regeneration of sugar maple was virtually absent in our sample, providing additional evidence that the role of this species will continue to diminish. The regeneration data further suggest significant challenges for reestablishing northern hardwood forests at their current level of stocking and diversity.

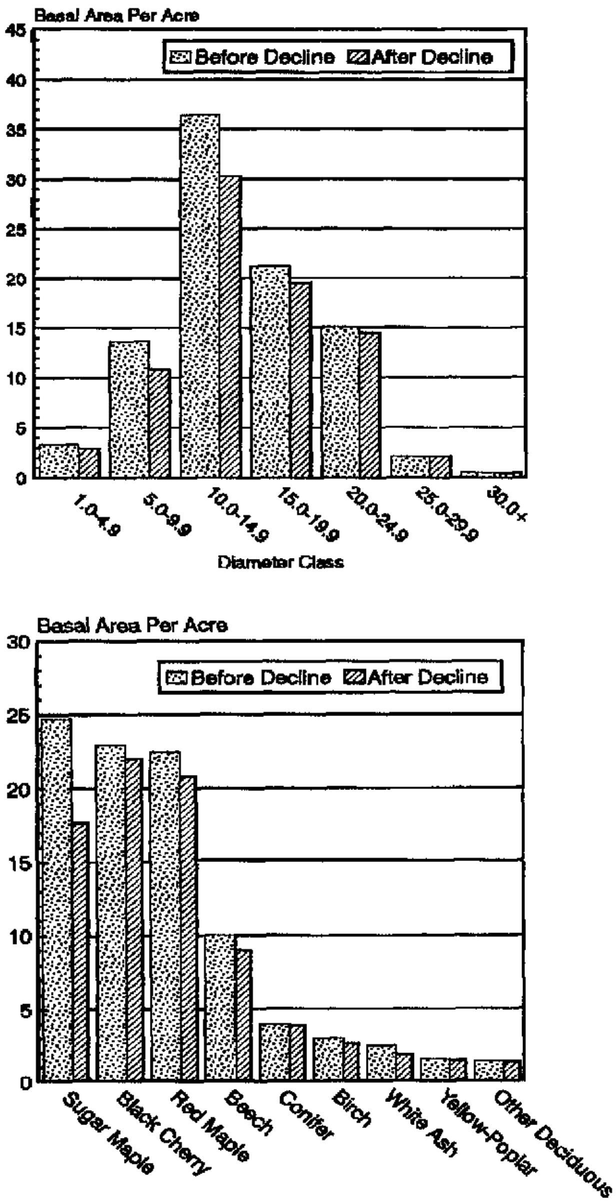

Figure 5.—Basal area per acre by diameter class and species/species group before and after decline for stands with significant symptoms of forest decline on the Allegheny National Forest.

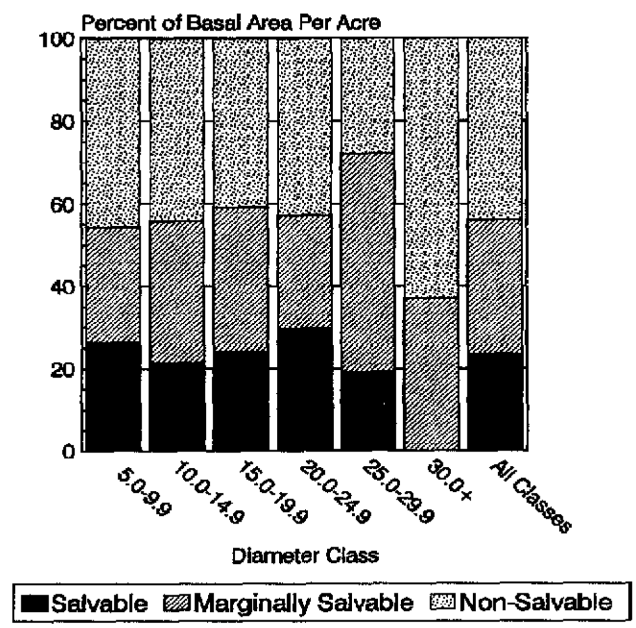

Figure 6.—Percentage of basal area per acre by tree condition and diameter class for dead trees in stands with significant symptoms of forest decline on the Allegheny National Forest.

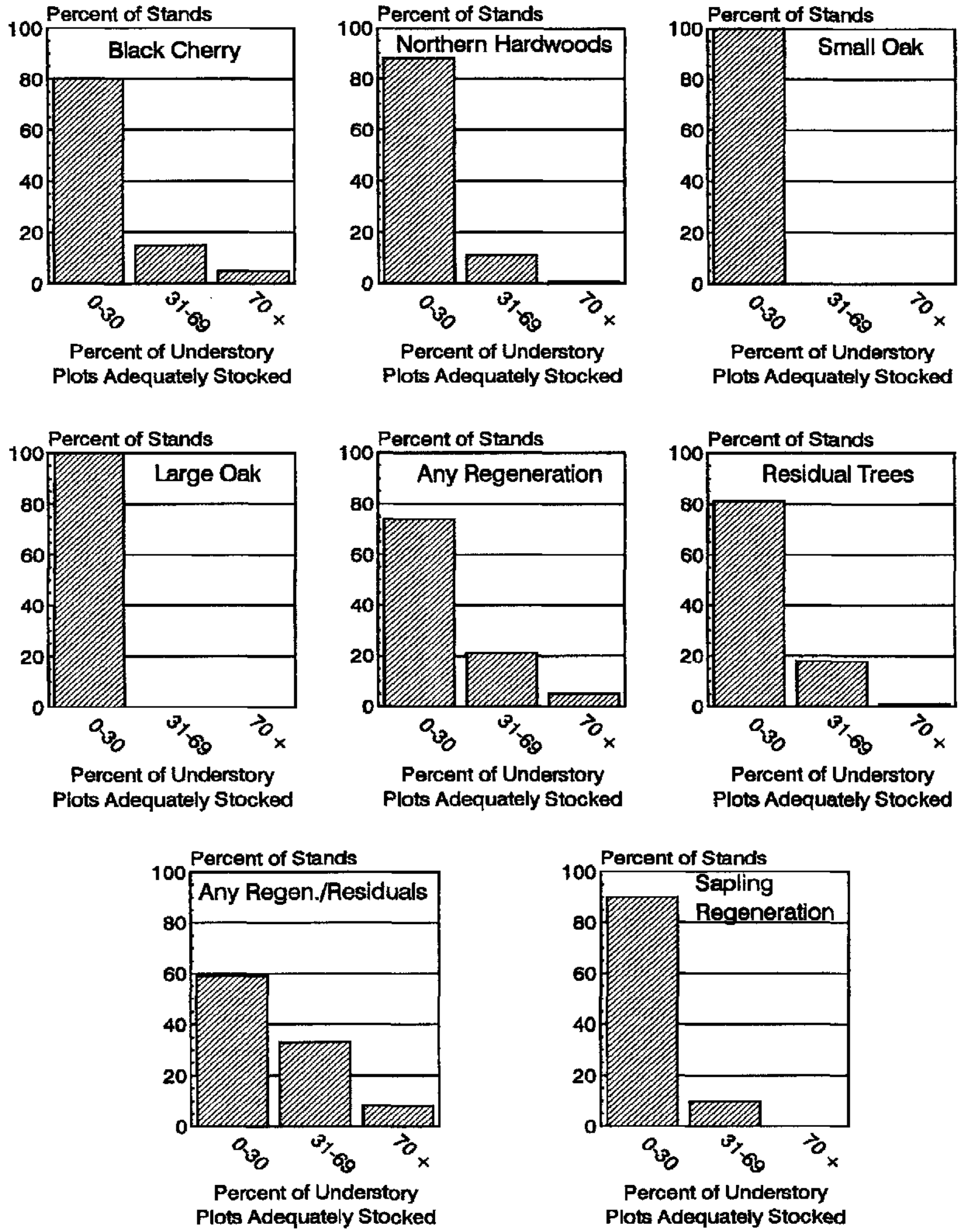

Figure 7.—Distribution of sampled stands by percentage of understory plots adequately stocked with advance regeneration or residual trees by regeneration component for stands with significant symptoms of forest decline on the Allegheny National Forest.

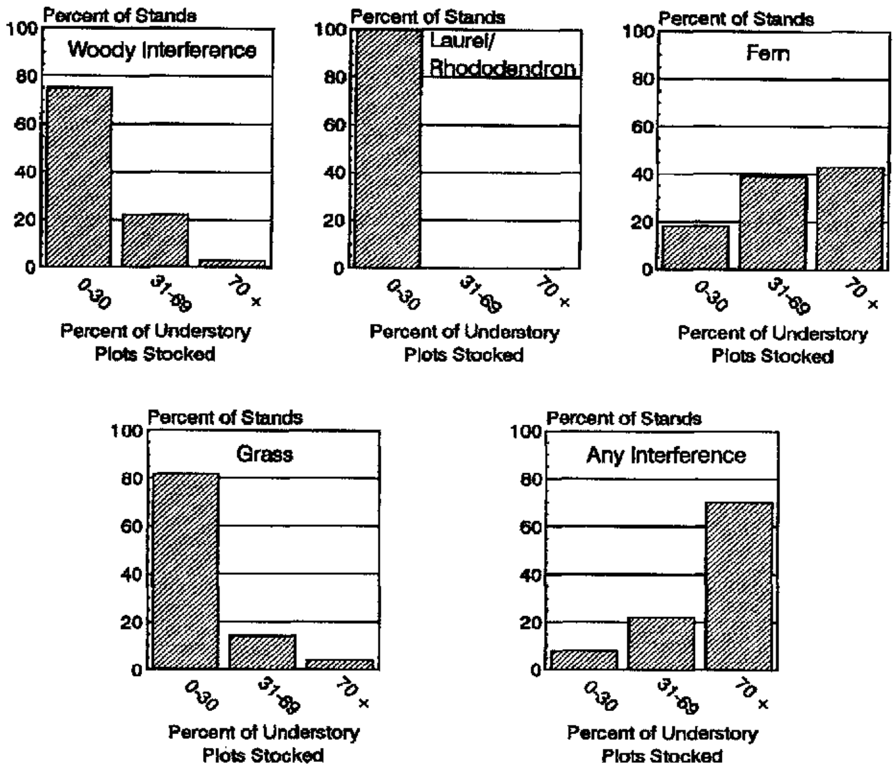

Figure 8.—Distribution of sampled stands by percentage of understory plots stocked with interfering vegetation for stands with significant symptoms of forest decline on the Allegheny National Forest.

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