age or stand density, or both. Oak decline is more common in mature overstory trees (usually larger) than in immature trees (usually smaller), and affected stands generally are older and have higher volume than unaffected stands. Basal area and volume differences could reflect an association between oak decline and stand density. Decline is stress-mediated and trees in stands with high basal area and volume may endure more intense competition for resources during times of stress. Effects of age, stand density, site quality, and physiography on decline incidence and severity will be more fully explored later in this paper.

Oak composition and total annual mortality volume were closely linked. Nearly all the difference in annual mortality between affected and unaffected areas was accounted for by higher oak mortality. Similar amounts of mortality among non-oak species occurred in affected and unaffected areas (7.6 and 8.5 cubic feet per acre per year, respectively), while oak mortality volume was three times as high in affected as in unaffected areas. Non-oak species were not dying at higher rates in affected areas like oak species were.

Large volume losses were associated with oak decline in the Mountains and Northern Piedmont of Virginia between 1977 and 1986. The total volume loss in affected areas was over 29 million cubic feet in the three Survey Units, with oaks accounting for 20.6 million cubic feet. However, not all of this total can be attributed to oak decline. The loss caused by oak decline can be estimated by deducting the oak mortality volume expected if decline had not occurred. The difficulty, of course, is that we do not know how much oak mortality would have occurred in the absence of oak decline. One estimate of this figure is the oak mortality volume in unaffected areas. If one assumes that oak mortality volume per acre in affected areas would have been the same as in unaffected areas, the annual loss caused by oak decline in the Mountain and Northern Piedmont Survey Units during the survey interval was 13.8 million cubic feet. This assumption, however, ignores the large difference in initial oak inventory between affected and unaffected areas. If one assumes that the percentage loss of oak volume in the absence of oak decline would have been the same in affected and unaffected areas, annual decline loss was 7.4 million cubic feet. This estimate does not account for differences between affected and unaffected areas in age and site quality that could influence mortality rates. The actual oak decline loss was probably somewhere between 7.4 and 13.8 million cubic feet per year.

There were clear differences in oak decline incidence among land ownership classes. Most of the 1.1 million acres of decline-affected oak forest was privately owned, but the incidence of decline was much higher on National Forests than on other ownerships (table 2). About one-fourth of the oak stands on National Forest land had decline damage. Incidence in other public and private oak stands was 16 and 14 percent, respectively.

The severity of oak decline was also greatest on National Forest land (table 3). Annual oak mortality on National Forests in affected areas was 26.9 cubic feet per acre. This was three-fourths of the total annual mortality volume on affected National Forest land. Other public and private ownerships had much lower total annual mortality than did National Forests, and only two-thirds of it was oak. Thus, a disproportionately large amount of the oak mortality in the study area occurred on National Forests. Forty-two percent of the annual oak mortality (8.7 million cubic feet) came from the 29 percent of decline-affected acres that occurred on National Forest land. The variation among ownerships in the percentage of annual gross growth (annual mortality volume + net annual volume growth) lost in decline-affected areas was large. National Forests lost 44 percent of gross growth, and other public ownerships lost 24 percent. In contrast, the percentage of gross growth lost in unaffected areas varied little among ownerships.

Predicting Oak Decline

Six factors that show promise for predicting oak decline are species composition, site quality, age, site index/age, physiography, and stand density. In prediction, two factors must be accounted for: vulnerability and risk of loss. Vulnerability is the probability of occurrence in a given stand. The incidence of oak decline by category provides a measure of relative vulnerability. Risk is the probability of volume loss if oak decline occurs. Mortality volume by category provides a measure of relative risk. We have not attempted to merge these two components into an oak decline rating system, but we believe that additional research could lead to such a system.

Species composition—Individual oak species vary in their susceptibility to decline. Therefore, it is reasonable to assume that species composition affects vulnerability and risk. For analysis, oak forest types were placed in three type groups: oak–pine, oak–hickory, and chestnut oak.

In terms of total acreage, most of the oak decline occurred in the oak–hickory forest type group because it was by far the most prevalent type group in the