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Photographic Guide to Crown Condition of Oaks: Use for Gypsy Moth Silvicultural Treatments

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Abstract

Crown condition of oaks (*Quercus* spp.) as a measure of tree vigor, has been shown to be the single most important factor in predicting mortality due to gypsy moth (*Lymantria dispar* L.) defoliation-induced stress. Although tree vigor is a continuous variable, common practice has been to assign trees to one of three crown condition classes to reduce subjective error. The assessment of crown condition is based on ocular estimates of percent of dieback in the crown, foliage density, size, and color, and presence of epicormic branches. Crown condition classes for oaks are defined. Color photographs are provided as guides to assessing crown condition, and the various factors involved in assigning crown conditions are discussed. Applications in vulnerability rating and silvicultural treatments to minimize gypsy moth impacts are presented.

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Cover Photograph: The good crown on this northern red oak is an indicator of the excellent health of this tree.

Introduction

Tree vigor has been defined as the overall physiological condition or "health" of a tree in a given environment (Wargo 1978a). Physiological condition of the tree will determine the tree's response to defoliation, but it is difficult to measure (Kozlowski 1969). A tree's health traditionally has been measured by general indicators such as crown class and condition. However, these indicators show long-term vigor status and may not represent adequately a tree's immediate physiological condition due to stresses that have occurred recently (Wargo 1978b). Adverse conditions such as drought, late spring frosts, ice storms, excessive moisture, fire, previous defoliations, competition, cutting, slash disposal, and other disturbances can cause stress on trees that influences and changes overall tree vigor. Trees can recover from stresses over time. Recovery from some stresses such as thinning or drought may occur in only 1 to 3 years, while other stresses, like defoliation, may require longer periods (up to 10 years) (Campbell and Valentine 1972).

Although it is not an ideal indicator of tree vigor, crown condition before defoliation is one of the most important single variables that influences tree death (Gansner and Herrick 1984, Herrick 1982, Herrick and Gansner 1987a,b). For this reason, crown condition has been used to develop risk and hazard rating systems for mortality and to identify high-risk trees for removal in silvicultural treatments to minimize gypsy moth (*Lymantria dispar* L.) impacts.

Photographic Guides

The purpose of this photographic guide is to provide forest managers with instructions and examples for determining crown condition of oaks. The guide focuses on northern red oak (*Quercus rubra* L.) and white oak (*Quercus alba* L.) with comparison to the other major upland oaks. We have limited our discussion to the upland oaks due to their importance as gypsy moth hosts and as major components of the eastern hardwood forest.

Figure 1. — Two northern red oaks of good crown condition.

Crown Condition

Crown condition represents a continuum from very healthy, vigorous trees to trees that are almost dead. Common practice has been to place trees into several crown-condition classes due to the difficulty of quantifying a continuous variable with any degree of objectivity. Using classes reduces the subjective judgment of the observer in rating crown condition. Past field experience has shown that a three-class rating system for crown condition is easy to apply in the field but still provides information useful for gypsy moth management. The three classes used are poor, fair, and good. The Forest Health Monitoring System has developed a slightly different system that uses two measures instead of one, foliage transparency and discoloration and branch dieback, and is less subjective in its application (Millers and others 1991, Millers and others 1992).

Trees have poor crowns when one or more of the following occurs: 50 percent or more of the branches are dead; foliage density, size, and coloration are subnormal; or epicormic sprouting is heavy. Trees have fair crowns when one or more of the following occurs: 25 to 49 percent of the branches are dead; foliage density, size, and coloration are subnormal; or some epicormic sprouting is evident. Good-crown trees have healthy foliage, less than 25 percent dead branches, and little or no epicormic sprouting. While these definitions seem distinct, crown condition is really a continuum and the appearance of a fair-crowned tree, for example, varies with species, crown class, and site.

Northern red oaks of good crown condition are shown in Figure 1. The photograph on the left is representative of the high end of the good class; little or no dieback of branches is evident and the crown appears full with good color. The relatively large dead branch with no small twigs and sloughed bark seen at the base of the crown is termed a "snag branch." Snag branches are assumed to have died much earlier as a result of shading and are not considered part of the crown; snag branches should not influence the

Figure 2. — Two northern red oaks of fair crown condition.

rating of the crown (Millers and others 1991). The photograph on the right represents the lower end of a good classification. Dieback is approaching 25 percent of the live crown and the foliage density is obviously less when compared to the tree on the left.

Figure 2 shows northern red oaks of fair crown condition. The tree depicted on the left represents the upper end of the fair class. Dieback is slightly more than 25 percent of the crown and a decrease in foliage density is apparent. Foliage density (or its reciprocal, foliage transparency) is important because a decreasing foliage density over time indicates reduced tree vigor and may lead to branch dieback (Millers and others 1991). The photograph on the right displays a tree representative of the low end of the fair class. Dieback in the crown is approaching 50 percent and heavy epicormic sprouting is evident.

Poor crown condition in northern red oaks is shown in Figure 3. The tree in the photograph on the left represents the upper end of the poor class. The majority of this crown is dead and epicormic branching is becoming heavier. The tree on the right has lost its entire crown (note the dead foliage in crown) and is now subsisting solely on epicormic branches. This tree is in very poor health.

Northern red oak (left) is compared with black oak (*Quercus velutina* Lam., right, Figure 4). Species differ in their foliage and growth characteristics; when assessing crown condition differences within and among species must be taken into account. The foliage characteristics of black oak, on the right, give the appearance of less density in the crown as compared to the red oak on the left. However, both are representative of good crown condition for their species.

In the comparison of northern red oak (left) with scarlet oak (*Quercus coccinea* Muenchh., right, Figure 5), or northern pin oak (*Quercus ellipsoidalis* E.J. Hill) another characteristic that differs between species is the retention of snag branches. Scarlet oaks and northern pin oaks are known to

Figure 3. — Two northern red oaks of poor crown condition.

be poor natural pruners, retaining their snag branches as the tree on the right shows. A cursory comparison of this scarlet oak tree with the red oak on the left might result in classing the scarlet oak as less vigorous because of the snag branches. As stated earlier, snag branches should not influence the rating of the crown. Both trees are representative of a typical fair crown condition. Also of note is the chlorotic, or off color, appearance of the foliage on both trees, providing further evidence of the fair health of these trees.

Figure 6 presents white oak (left) and chestnut oak (Quercus prinus L., right) of good crown condition. Both crowns are full with few or no dead branches. White oaks of fair crown condition (left) and poor crown condition (right) are shown in Figure 7. The fair-crowned tree on the left is typical of this species; more than 25 percent of the crown is dead. Note that the pattern of death appears to be from the tips progressing downward. This is a classic example of branch dieback and a sign of an unhealthy condition caused by stress (Millers and others 1991). The beginning of epicormic branches also are evident on the bole, further supporting the classification of this crown as fair. Compare this crown to that of the white oak on the right. The majority of this crown is dead, the foliage density is low and foliage is off color. This tree is typical of a poor-crowned white oak. Poor-crowned white oaks often bear foliage in tufts rather than in even distribution throughout the crown.

Crown Size

In addition to crown condition, crown size can be an indicator of tree vigor. Crown size usually is defined by two measures: crown width (or spread) and crown length. Sometimes a calculated crown volume is used (crown width times crown length). Crown size usually is determined by a combination of genetic traits and growing conditions of the

Figure 4. — A comparison of good crown conditions of northern red oak (left) with black oak (right).

species. The important growing conditions are directly related to the density of trees (or competitors) and their growth rates. Overstocked (crowded) stands have many trees with short, narrow crowns. Understocked, thinned stands, and stands where variable growth rates have produced good crown class differentiation have trees with longer, wider crowns. Crown size varies with crown class; dominant trees have wider, longer crowns than suppressed trees. The short, narrow crowns of trees in overstocked stands represent another kind of poor-to-fair vigor. When stands are thinned, the residual trees expand their crowns, both in terms of foliage density (usually within 1 to 2 years) and crown width and length. The increase in crown size takes longer, from 3 to 10 years depending upon the thinning intensity. During crown expansion, trees may be under more stress than their crown condition suggests since they are still adjusting to the new conditions in the thinned stand environment. The response is called thinning stress or shock. Crown size, not included in the photographs, is a variable to be considered when evaluating tree vigor.

Applications

Risk and Hazard Rating

A number of studies have examined the relationship between the crown condition of oaks (and other species) and the percent probability of dying following first-time gypsy moth defoliation (Gansner and Herrick 1984, Herrick 1982, Herrick and Gansner 1987a,b, Campbell and Sloan 1977, Campbell and Valentine 1972). These studies spanned the New England seaboard and upland, the glaciated Allegheny Plateau and Ridge and Valley areas of the Pocono Mountains in eastern Pennsylvania, and the Ridge and Valley area of central Pennsylvania. Across this wide area, the same trend of crown condition versus mortality probabilities held: poor-crown trees >fair-crowned trees >good-crown trees:

Figure 5. — Comparison of fair crowns of northern red oak (left) with scarlet oak (right).

Study area and date	Mortality rate (percent) Good crown	Fair crown	Poor crown
New England 1911-31	15	35	45
Pocono Mts., PA 1975-1980	5	24	79
Ridge & Valley, PA 1979-1985	10	21	49

These individual tree rates have been incorporated into vulnerability rating guides for individual trees that require crown condition as one of their inputs. Two stand-vulnerability rating guides were developed for the Poconos; the guides also use information on number or percentage of live trees per acre with poor crowns (Gansner 1981, Gansner and Herrick 1984, Gansner and others 1978).

Silvicultural Treatments

Silvicultural treatments to minimize gypsy moth impacts also utilize crown condition of individual trees to determine marking priorities for trees to be removed (Gottschalk 1993). For example, presalvage thinning is designed to reduce damage by removing highly vulnerable trees before they are defoliated and die. Priorities for marking trees to be removed are (highest to lowest). 1) oaks with poor crowns, 2) non-oak species with poor crowns; 3) oaks with fair crowns, and 4) non-oak species with fair crowns. These priorities are integrated with the normal marking priorities of maintaining the desired residual stand density, removing unacceptable growing stock trees before better quality trees (also could include species priorities), and achieving the desired stand structure. Heavily overstocked stands may have few good crowns; in this situation, light thinnings to develop and build crowns are called for rather than a heavy thinning.

When gypsy moth has already defoliated an area, salvage thinning is used to obtain the economic value from all of the dead trees and the remaining live trees are thinned to reduce susceptibility and vulnerability. Priorities for marking trees to be removed are (highest to lowest): 1) dead trees, 2) oaks with

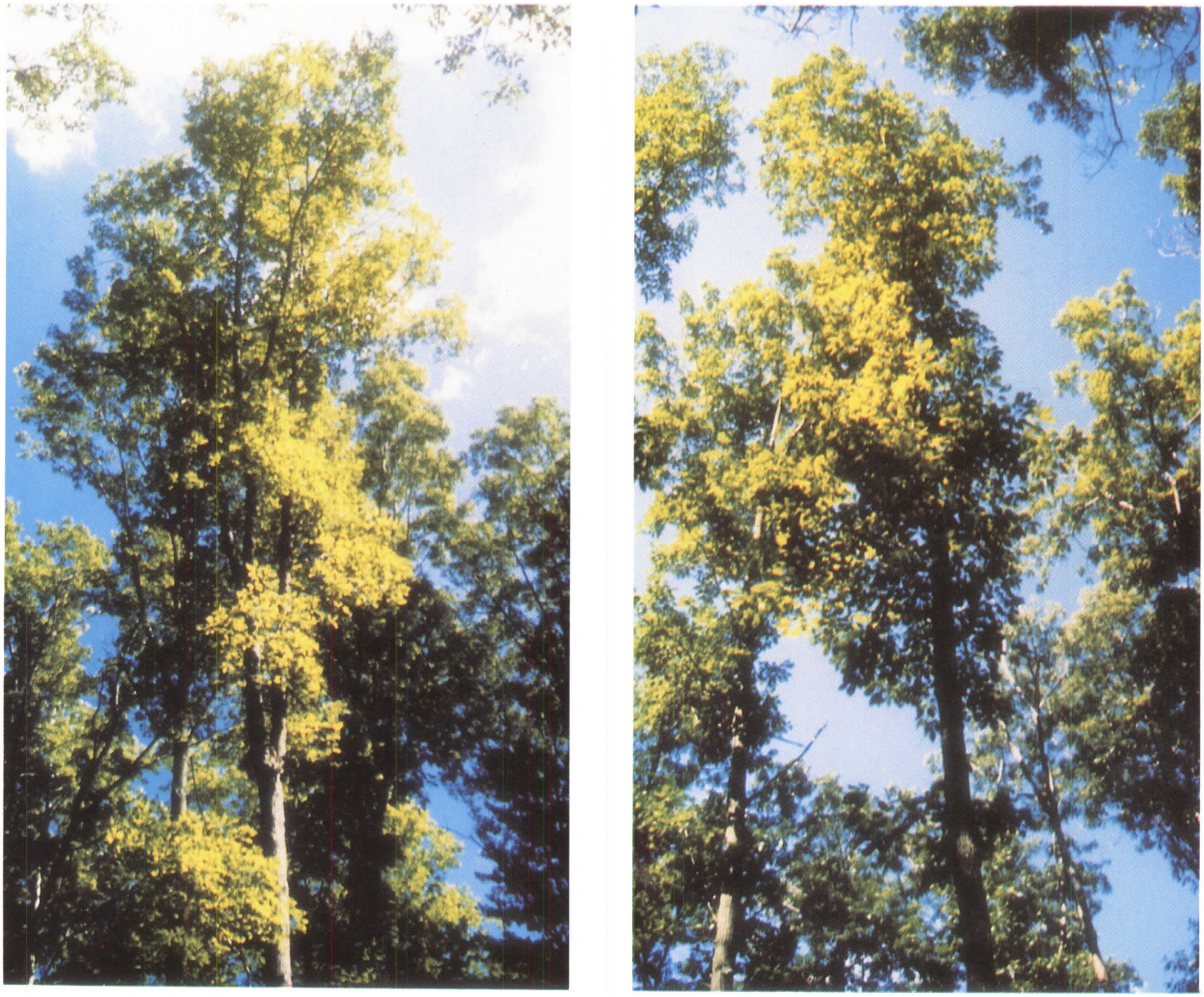

Figure 6. — A white oak (left) and a chestnut oak (right) of good crown condition.

Figure 7. — Two white oaks; one of fair crown condition (left) and one of poor crown condition (right).

poor crowns that are likely to die, 3) other species with poor crowns that are likely to die, and 4) trees with fair crowns. These priorities are to be integrated with the normal ones of maintaining the desired residual stand density, removing unacceptable growing stock trees before better quality trees, and achieving the desired stand structure. In stands that receive a salvage cutting treatment, dead and dying trees are economically salvaged. Marking priorities are simple—only dead and dying trees should be cut and removed because all of the live trees are needed to carry the stand to maturity (or to the next thinning). Trees with very poor crowns that will not recover are considered the same as dead.

Conclusions

Forest managers dealing with the gypsy moth can use crown condition ratings to improve their management of oak stands through tree and stand vulnerability rating systems that utilize crown condition and through marking guides for silvicultural treatments to minimize gypsy moth impacts. This photographic guide provides these managers with the tools to develop their own ability to do crown condition ratings.

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Color photographs as guides to assessing crown condition of oaks are provided. Use of crown condition for gypsy moth vulnerability rating and silvicultural treatments to minimize gypsy moth impacts are presented.

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