

# VALIDATION OF A TREE FAILURE EVALUATION SYSTEM

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**Abstract.** In 1987, 695 oak trees, *Quercus lobata* and *Q. wislizenii* were evaluated using a nine-component rating system. In 1994, the trees were reevaluated to validate the original system in predicting tree failure. Analysis of the results showed that 3 components [decline (vigor), trunk condition and lean] correctly predicted subsequent tree failure or survival. Decline, a relative measure of leaf cover and color, was the most important factor in predicting total tree failure.

Several quantitative tree hazard evaluation methods have been developed in recent years (1,3,4). These methods allow for ranking the hazard potential of trees by assigning numerical values to tree characteristics and target values. However, studies of the systems to prove their predictive ability have not been published. The purpose of this paper is to present results from a validation study of the Oak Tree Evaluation System (3), seven years after the initial ratings.

Oaks are among the most common hardwood trees within recreational areas in California. As a group they have been responsible for more accidents than any other type of tree (5), and are the most abundant tree genus reported in the California Tree Failure Report Program data set (2). In 1987, 695 native oak trees, *Quercus lobata* and *Q. wislizenii* in an established park (Micke Grove, Lodi, California) were evaluated with a new oak hazard rating system (3). This system includes nine tree related components: irrigation frequency, soil, wind, root, butt, trunk, limb, lean and decline. Each component was assigned a numerical rating from one to five, with one indicating a minimal problem and/or a low failure potential. A rating of five indicates a severe problem and/or imminent failure. These component ratings are added together, yielding a summary rating (SR). The hypothesis was that by evaluating these components, the SR would accurately predict tree failure. A simple, accurate evaluation method would be

useful for developing a schedule for corrective tree maintenance.

The site for this study is typical of western landscaped parks, with irrigated turf the dominant ground cover under the trees. Using detailed maps and individual tree tags, all native oaks were reevaluated in 1994, seven years after the 1987 survey, to determine the predictive ability of the Oak Tree Evaluation System. Although individual branch failures were not recorded in the test area, whole tree failure could be observed. (Park policy does not allow the removal of native oaks unless the trees have died or fallen). A major failure pattern of valley oak is root failure from decay, especially in heavily irrigated sites (4). Using the data collected in 1987, statistical analyses were conducted to determine the whole tree failure predictive value of the system. The data were subjected to stepwise linear discriminate analysis. The nine components of the system were added to the model and tested for their ability to improve the correct prediction of tree failure.

## Results

Of the 695 trees surveyed in 1987, sixty (8.6%) had failed by 1994. Stepwise linear discriminate analysis showed that three components, decline, trunk and lean, contributed significantly to correct prediction of tree failure or survival. Use of the equation  $Y = -8.876 + 1.696 \times \text{decline} + 1.203 \times \text{trunk} + 0.463 \times \text{lean}$ , where positive values of Y lead to a prediction of tree failure and negative values lead to a prediction of survival, resulted in correct classification of 83% of the living trees and 78% of the failed trees. Based on the magnitude of the coefficient, the subjective measure, decline, was the most significant parameter for correct classification of tree failure. This is consistent with an observation by Wagener that all cases of oak

basal failures, where trees had an advanced root fungal infection that resulted in accidents, the trees were in a "plainly decadent condition" (5).

Irrigation frequency was the same for all trees in the park and thus not useful for comparison. The other five components of the evaluation system did not contribute to accurate prediction of tree failure. However, since individual limb failures were not evaluated in this study, some of these factors may be important in predicting those failures.

Decline, the most important factor in predicting total tree failure, is a measure of relative leaf cover and color and can be considered to be a negative evaluation of tree vigor. A rating value of one indicates excellent vigor and a value of five indicates a dead or dying tree.

In the original evaluation, the mean decline rating for all trees was 3.10. The 1987 mean decline rating for trees still surviving in 1994 was 3.06. However, the 1987 mean decline rating for trees that had failed by 1994 was 3.78. By substituting this value into the equation from discriminate analysis, it can be seen that decline alone is nearly sufficient for predicting tree failure. Decline is a subjective measure that may be evaluated differently depending on the experience and training of the evaluator. It nevertheless provides a rapid and accurate prediction when used properly in conjunction with the more objective measures, trunk and lean.

## Conclusions

Quantitative tree hazard evaluation systems can be useful in predicting potential failures. Although a thorough evaluation is important in determining as many potential hazards as possible, the use of a decline rating can be predictive of whole tree failures of California oaks. Three components of the oak hazard evaluation system reported in this study, decline, trunk, and lean, contributed to accurate prediction of subsequent actual tree failures.

## Literature Cited

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**Résumé.** Six cents quatre-vingt quinze chênes, *Quercus lobata* et *Q. wizlizenii*, ont été évalués au cours de l'année 1987 en utilisant un système d'évaluation comportant neuf critères. En 1994, les arbres ont été réévalués afin de valider le système original de prédiction des risques potentiels de chute. L'analyse des résultats a montré que trois composantes – dépérissement (vigueur), condition du tronc et inclinaison – servent à prédire la chute subséquente de l'arbre ou son potentiel de conservation. Dans cette étude, le degré de dépérissement, c'est-à-dire une mesure relative de la couleur et de la densité du feuillage, était le facteur le plus important entrant dans l'évaluation (prédiction) du risque potentiel de chute de l'ensemble de l'arbre.

**Zusammenfassung.** 1987 wurden 695 Eichen, *Quercus lobata* und *Q. wizlizenii*, anhand eines aus neun Erfassungsmerkmalen bestehenden Systems bewertet. 1994 wurden die Bäume erneut erfasst, um festzustellen, inwieweit dieses System zur Vorhersage von Baumversagen geeignet ist. Die Analyse der Ergebnisse zeigte, daß drei Komponenten (Verfall, Zustand des Stamms und Schräge) zuverlässig ein darauf folgendes Absterben oder Überleben des Baumes vorhersagen konnten. Der Verfallsgrad, der sich in der relativen Laubdichte und Blattfärbung ausdrückt, war der wichtigste Faktor in dieser Studie bei der Früherkennung von Baumsterben.