JOURNAL OF
ARBORICULTURE

August 1989
Vol. 15, No. 8

OAK TREE HAZARD EVALUATION

by Gary W. Hickman, Janet Caprile, and Ed Perry

Abstract. A practical system for evaluating hazardous landscape trees is an important element of any tree maintenance program. An evaluation system was developed in California for two species of native oaks, *Quercus lobata* and *Quercus wislizenii*. The system uses eleven separate components which can be grouped into the four larger categories of environment, structure, vigor and target. A Summary Rating (SR) is generated for each tree from component ratings using a database management computer program. The SR has been useful in prioritizing and scheduling corrective tree work. The evaluation system has now been implemented on 244 acres of oak parklands and has been adopted by other public agencies responsible for maintaining urban oaks.

Résumé. un système pratique pour évaluer les arbres dangereux est un élément important de tout programme d'entretien des arbres. Un syst``me d'evaluation fut développé en Californie pour deux esp``ces de chênes indigènes, Quercus lobata et Quercus wislizenii. Le système utilise 11 composantes indépendantes qui peuvent être groupées en quatre caatégories: environnement, structure, vigueur et cible. Une cote est donnée à chaque arbre à partir des composantes en utilisant un programme informatisé. Les cotes ont été utiles pour prioriser et céduler les travaux correctifs. Ce système d'évaluation est maintenant implanté sur un terrain boisé de 244 acres ªcomposé de chênes) et a été adoptépar d'autres organismes publics responsables de l'entretien de chênes en milieu urbain..

Practical methods for evaluating landscape trees have been studied for many years. The scope of these evaluations has ranged from the determination of monetary value for landscape trees (7), to general tree condition (19), to tree hazard potential (1, 14, 15, 18). Sharon (15) developed an evaluation system utilizing qualitative elements in determining tree hazard. Other systems have used quantitative rather than qualitative rating formats. Most of these systems have been developed by public agencies responsible for maintaining large numbers of trees.

One of the earliest and most extensive studies for evaluating landscape trees was conducted by the USDA Forest Service, Pacific Southwest Research Station in Berkeley, California (8, 9, 10, 11, 12, 13). Lee Paine collected information on thousands of trees in forested recreational sites. From these data he developed tables of tree damage potentials based on tree species, tree size and the part of the tree subject to failure. This damage potential figure was combined with numerical estimates for the probability of failure, the probability of impact and the target value, to arrive at an overall numerical rating for hazard. The utility of this system has been limited due to the subjective nature of the latter three estimates. Also, considerable expertise is required to make accurate estimates and the individual evaluations are very time consuming. The applicability of this system is further restricted to forested recreation sites and to the specific trees included in the database.

Other rating systems have been developed using the "Paine system" as a model. As such, they are subject to many of the same limitations as their prototype. The California Department of Parks and Recreation has been using a slightly modified "Paine system" since the late 60's (2). The USDA Forest Service has modified the original system for use in the central Rocky Mountain states. Their system uses three factors—tree species, potential target and tree defect—to arrive at a risk value for forest trees (14). This system requires less time to complete than the true "Paine system"; however, it has a lower sensitivity to local hazard conditions. The National Parks in Washington State use a similar rating system which is more subjective than the above systems and has a smaller supporting data base (14).

More recent systems have been developed

specifically with amenity tree hazards in mind. The Recreation and Parks Department of the City of San Francisco has developed perhaps the most detailed hazard rating system for urban landscape trees. Eighty-five tree factors are listed on their rating sheet and are grouped into larger categories such as tree location, root conditions, trunk conditions and branch factors. This system provides very complete information, with good numerical and objective ratings. However, each tree evaluation requires considerable time to complete. An initial inventory of trees in San Francisco parks is expected to take over five years. Additionally, a high level of horticultural knowledge and training is required to complete the evaluation forms (1).

A need still exists for a practical landscape tree hazard evaluation system which would meet the needs of public agencies responsible for the maintenance of urban park and street trees. Ideally, the evaluation system would: 1) be predictive of potential hazards, 2) prioritize trees according to potential hazards to assist with scheduling corrective tree work, 3) be amenable to computerization to increase the flexibility of information retrieval, 4) be appropriate for staff with limited arboriculture training, 5) rely primarily on non-invasive visual inspections and minimize the need for inspection equipment, 6) reduce liability concerns, 7) require a short time for completion (preferably, less than 10 minutes per tree), and 8) be relatively quantitative in nature to improve consistency. Such a system has been developed for two native oak species in California and is the subject of this report.

Developing the System

Development of the evaluation system began at Micke Grove Park near Stockton, California in the Spring of 1987. This 65 acre suburban park was developed within an existing stand of mature native oaks *(Quercus lobata* and *Quercus wislizenii)* in 1938. The site is typical of western landscaped parks, with irrigated turf being the predominate ground cover under the trees.

For purposes of our evaluation system, the park was divided into 16 zones based on use patterns (high to low use). The native oaks in each of the 16 zones were inventoried, mapped, and tagged with aluminum identification numbers. All oaks with diameters (dbh) of eight inches or greater were included in the inventory and totaled 706 trees. The inventory, as well as later evaluations, proceeded from the high use zones to the low use zones. This allowed for the early correction of hazards in high use areas.

After a review of the literature on various aspects of tree evaluation eleven components were identified as being important to a tree hazard evaluation system. These eleven components were grouped into the following four categories:

I. Tree Environment
1. Irrigation Frequency Component
2. Irrigation Pattern Component
3. Soil Component
4. Wind Component

II. Tree Structure
5. Root Component
6. Butt Component
7. Trunk Component
8. Limb Component
9. Lean Component

III. Tree Vigor
10. Decline Component

IV. Target Value
11. Target Component

During a tree inspection, each of these components is systematically considered and given a numerical rating from 1 to 5. Numerical ratings were developed based on the following general guidelines:

1 = a minimal problem exists and/or hazard is very unlikely

2 = a slight problem exists and/or hazard unlikely

3 = a significant problem exists and/or hazard is likely

4 = a serious problem exists and/or hazard is definite

5 = a severe problem exists and/or hazard is imminent

From these general guidelines, more specific guidelines were developed (see Table 1) which detail the condition or set of conditions which constitute a rating of 1 to 5 for each of the 11 components. The condition listed under a numerical rating represents the upper limit of that rating for the component. For example, the soil component

OAK HAZARD EVALUATION GUIDELINES

GENERAL GUIDELINES	1	2	3	4	5
(PROBLEM/ HAZARD)	LEAST/VERY UNLIKELY	SLIGHT/ UNLIKELY	SIGNIFICANT/ LIKELY	SERIOUS/ DEFINITE	GREATEST/ IMMINENT
SPECIFIC GUIDELINES					
IRRIGATION FREQUENCY	1/month	2/month	3/month	4/month	>4/month
IRRIGATION PATTERN	to edge of RZ	to 6' of Butt	to 3' of Butt	to 1' of Butt	to Butt
SOIL					
Pavement or Fill	edge RZ or path	to 1/4 RZ	to 1/3 RZ	to 2/3 RZ	entire RZ
ROOTS					
Exposed/Girdled/Cut	to edge of RZ	to 1/4 RZ	to 1/3 RZ	to 2/3 RZ	entire RZ
Root Movement				old movement	recent movement
BUTT					
Wounds/ Sloughing Bark	to 1/8 CRC	to 1/3 CRC	to 1/2 CRC	to 2/3 CRC	entire CRC
Rot		to 1/8 CRC	to 1/4 CRC	to 1/3 CRC	to 1/2 CRC
TRUNK					
Wounds/ Sloughing Bark	to 1/8 CRC	to 1/3 CRC	to 1/2 CRC	to 2/3 CRC	entire CRC
Rot		to 1/8 CRC	to 1/4 CRC	to 1/3 CRC	to 1/2 CRC
LIMBS					
Scaffold Attachment		equal boles	imbedded bark		split
Deadwood/Stubs	small limbs	few medium limbs	1 large stub or many medium limbs	1 large limb or >1 large stub	>1 large limb
Rot - Medium limbs		minor		major	
Large limbs		to 1/8 CRC	to 1/4 CRC	to 1/3 CRC	to 1/2 CRC
LEAN (Degree)	10	20	30	40	50
WIND (Tree Position)	below canopy	lower canopy	mid canopy	above canopy	single tree or windward canopy edge
DECLINE					
Leaf cover & color	excellent vigor	good vigor	fair vigor	poor vigor	dead/dying
TARGET	low use trail low use lawn shrub bed	medium use trail medium use lawn	high use trail high use lawn roadway, fence, sign, etc.		picnic area play area parked cars buildings
AESTHETIC VALUE	unattractive in stand	acceptable in stand	attractive in stand	speciman in stand	speciman single

NOTES: CRC = circumference of trunk or limb; RZ = Root Zone
Medium Limbs = 3-6" in diameter; Large Limbs = > 6" in diameter

Table 1

is given a rating of three when pavement covers more than 1/4 but not more than 1/3 of the root zone. The specific guidelines were created with the particulars of site and species in mind. They were meant to promote consistency and reduce the subjectivity of the evaluation. Both sets of guidelines are included on the back of each evaluation form for easy reference in the field.

A standard field evaluation form was prepared (Table 2). The eleven components were arranged on the form in an order which allowed the inspection to begin at the base of the tree and progress upward and outward. This arrangement saved considerable time in moving around a tree during an evaluation.

Making the Evaluation

Tree Environment. Of the four components grouped under the category of Tree Environment, two of them address irrigation. The rating for the *irrigation frequency component* is based on the number of times per month a tree is watered. The rating for the *irrigation pattern component* is based on the proximity of the irrigation to a tree's base or root crown. There is evidence to suggest that irrigating native oaks contributes to crown rots, root rots and the general decline of trees that have matured under natural conditions of summer drought (5). Therefore, the more frequently a tree is irrigated, and the closer the irrigation comes to the base of the tree, the higher the evaluation number. The rating system for the two irrigation components may not be appropriate for species other than the oaks species evaluated here. It would need to be adjusted before the system could be adopted for use on other tree species.

The *soil component* rating is based on the percentage of the root zone affected by pavement and/or fill. Pavement has been shown to be inversely correlated with tree condition (17). Similar decreases in water, air and nutrient uptake by the tree is assumed to occur when more than 6 inches of dense fill is added to the root zone (4). For the purposes of practical evaluation, the "root zone" is considered to be the area within the dripline of the tree, even though it is acknowledged that roots may extend far beyond this area (3). The condition(s) responsible for the rating are noted by circling the appropriate code (P for pavement, F for fill) on the evaluation form. A compaction measurement is not included in the soil component because of the time and equipment necessary to gather accurate quantitative data for each tree.

The *wind component* considers the position of the tree within the woodland canopy. This is an indication of how exposed or protected an individual tree is from wind, a primary cause of tree failure during storms. The highest rating is given for single trees standing outside a wooded canopy or for trees on the windward edge of the canopy which receive the full force of the wind.

Tree Structure. The evaluation of a tree's structural integrity begins with the *root component.* A root inspection includes an examination of the root zone for two separate conditions: 1) evidence of disfunctional roots (cut, girdled, and/or exposed roots) and 2) evidence of root movement. Common indicators of cut roots include the occurrence of irrigation lines, roadways, buildings, retaining walls or other excavations within the root zone. If disfunctional roots are found, the percentage of the root zone affected is estimated. If root movement is evident (ie. soil mounding and cracking) it is determined whether the movement is old or new. After both conditions have been considered, all problems present are noted by circling the appropriate codes. Then, an overall numerical rating is assigned for the root component based on the single most severe condition (ie. root movement or the percent of exposed/girdled/cut roots).

The *butt component* is considered next. This involves an examination of the butt area, also known as the trunk base or root crown. Both the degree of wounding and the volume of rot in this area contribute to the overall component rating. Each of these conditions is examined separately. The percentage of the butt circumference affected by wounds is estimated first. Wounds do not represent a hazard in themselves, but are included to provide information on general tree condition and the potential for future structural hazards. Reduced growth and decline may result when wounding involves over 50% of the trunk circumference (6). Additionally, pest and disease organisms may enter the tree through wounds (6). Next, the percentage of the butt circumference that is visibly rotten is estimated. If the actual extent of a

OAK HAZARD EVALUATION WORKSHEET

PARK:____________________ **INSPECTOR:**____________________

ZONE:____________________ **DATE:**____________________

TREE NUMBER								
TREE SPP. 0=Valley 1=Live								
DBH								
IRRIGATION FREQUENCY (1-5)								
IRRIGATION PATTERN (1-5)								
SOIL (1-5)								
Pavement or Fill	P F	P F	P F	P F	P F	P F	P F	P F
ROOTS (1-5)								
Root Movement or Exposed/Girdled/Cut Roots	M E G C	M E G C	M E G C	M E G C	M E G C	M E G C	M E G C	M E GC
BUTT (1-5)								
Wounds/Sloughing Bark or Rot	W R	W R	W R	W R	W R	W R	W R	W R
TRUNK (1-5)								
Wounds/Sloughing Bark or Rot	W R	W R	W R	W R	W R	W R	W R	W R
LIMBS (1-5)								
Poor Scaffold Attachment or Deadwood or Rot	A D R	A D R	A D R	A D R	A D R	A D R	A D R	A D R
LEAN (1-5)								
WIND (1-5)								
DECLINE (1-5)								
TARGET (1-5)								
Table-bench/Play/Cars/Bldg	T P C B	T P C B	T P C B	T P C B	T P C B	T P C B	T P C B	T P C B
AESTHETIC VALUE (1-5)								
IMMEDIATE ACTION (*)								
MAINTENANCE SUGGESTION								
Prune - Deadwood	PD	PD	PD	PD	PD	PD	PD	PD
Weak wood	PW	PW	PW	PW	PW	PW	PW	PW
to Lighten Load	PL	PL	PL	PL	PL	PL	PL	PL
for Clearance	PC	PC	PC	PC	PC	PC	PC	PC
Target - Move	TM	TM	TM	TM	TM	TM	TM	TM
Prohibit	TP	TP	TP	TP	TP	TP	TP	TP
Cable or Brace	CB	CB	CB	CB	CB	CB	CB	CB
Remove Tree	RT	RT	RT	RT	RT	RT	RT	RT
No Action Required	NA	NA	NA	NA	NA	NA	NA	NA
PESTS/DISEASES								
Conks	CK	CK	CK	CK	CK	CK	CK	CK
Large Cankers	CN	CN	CN	CN	CN	CN	CN	CN
Fluxing	FX	FX	FX	FX	FX	FX	FX	FX
Pit Scales	PS	PS	PS	PS	PS	PS	PS	PS
Rodent Damage	RD	RD	RD	RD	RD	RD	RD	RD
Woodpecker Holes	WP	WP	WP	WP	WP	WP	WP	WP
	NOTES	NOTES	NOTES	NOTES	NOTES	NOTES	NOTES	NOTES

Table 2

decayed area cannot be determined from a visual inspection (ie. the decay is covered by callus tissue or cement) it is assumed to affect all the wood present at the time of the original wounding. After the occurrence of both wounds and rot are noted by circling the correct code(s), an overall numerical rating is assigned which corresponds to the higher of the two numerical ratings for rot and wounds. For example, a tree with a wound that encompasses ¼ of the circumference and a decayed area that extends around an additional ¼ of the circumference will receive an overall butt rating of 3.

The *trunk component* is evaluated using the same criteria as are used for the butt component. Similarly, the presence of wounds and rot are indicated by circling the correct code(s), and an overall numerical rating is assigned based on the worst of these two conditions.

The *limb component* has three conditions contributing to its rating: 1) Attachment problems on primary scaffold limbs. These include equal sized boles, embedded bark and limb attachments that are beginning to split. 2) The amount of dead wood in the canopy. This evaluation is based on the size and number of dead limbs. 3)The extent of rot in the canopy branches. For small and medium sized limbs (to 6 inches in diameter), a general classification of minor or major rot is used. For large limbs (greater than 6 inches in diameter), the rot is evaluated by the percent of the branch circumference that is affected. After the limb inspection, the appropriate codes are circled indicating present conditions and a component rating is assigned which corresponds to the highest value for the individual conditions. This means that a tree with no limb attachment problems, no deadwood and little rot still receives the highest rating of 5 if it has only one 7" limb with rot affecting ½ the limb's circumference.

The *lean component* is the last to be evaluated in the Tree Structure category. Both canopy weight and trunk lean are included in this determination. The degree of lean can be easily estimated by standing well back from the tree, lining a pencil up, at arms length, with the trunk, and estimating the angle of the pencil from the vertical. If the canopy is unevenly distributed, then the additional weight is considered when assigning an overall rating.

Tree Vigor. Only one component is included in the Tree Vigor category. This is the *decline component* which can be considered to be a negative evaluation of tree vigor. This "negative vigor" rating was employed at the suggestion of the inspectors who felt it was more consistent with the problematic approach of the other components. The vigor rating is the most subjective and relative of all the components; it is based on leaf cover and leaf color. However, despite the subjectivity, assigning trees to one of the numerical categories is easily accomplished, and it seems to be one of the best indicators of general tree health. By using several trees in a practice evaluation, the comparative values of leaf color and cover for the site become the basis for these ratings. Performing more quantitative analyses (ie. twig growth, trunk expansion) is not feasible on mature trees which often exceed 70 feet in height and average over 25 inches in diameter.

Target Value. This category is similarly composed of only one component—the *target component.* This is an extremely important aspect of the tree safety evaluation. No matter how poor the trees' environment, structure or vigor, it is not considered hazardous unless it is likely to hit something (the target) upon failure. The component rating is based on the identification and value of a potential target, should a limb or the entire tree fail. If a high value object (person, building, car, etc.) is likely to be damaged, the tree is given a high target value. Thus, trees in areas frequented by people (ie. parking lots, picnic areas, play areas, sports fields, benches, buildings) receive the highest target value of 5. Trees in areas less frequented by people and in areas where people pass through but do not stop, (ie. roadways, bridges, foot paths or lawn areas) receive a lower target value of 3. Trees near structures that are not typically occupied by people, (ie. pump houses, monuments, fences) are also assigned a value of 3. Trees in infrequently occupied areas receive the lowest target value rating of 1. An additional note is made of the type of high value target by circling the appropriate code. This information is later useful in hazard reduction activities.

Evaluating the Data

After all the trees within a zone are evaluated, the data are entered into the computer using a data management program. A Summary Rating (SR) for each tree is then generated. The purpose of this overall Summary Rating is to assist with prioritizing corrective tree work. At present, high priority trees are those that have a high SR value or a rating of 5 for any of the Tree Structure components. The SR value is calculated from the 11 components using the following formula:

SR = (the sum of the 4 component ratings for Tree Environment)

X

(the sum of the 5 component ratings for Tree Structure)

X

(the component rating for Tree Vigor)

X

(the component rating for Target Value)

Note that this formula uses the four categories: Tree Environment, Tree Structure, Tree Vigor and Target Value, as multiplicative factors rather than the individual components. This first attempt at factor weighting is based on a small database. More data will be collected as evaluated trees fail and we will be better able to determine the ability of this formula to predict tree failures.

The Target Value and Tree Vigor categories both depend on a single component rating. Thus, the target component and the decline component are very influential in the calculation of the Summary Rating and appropriate care must always be taken when rating these two components. Similarly, managers can greatly reduce the SR of a tree by taking steps to lower the target component or the decline component ratings. Target components may be lowered by moving the target away from the impact area (i.e. relocating tables and benches, redirecting pathways). The decline component rating may be lowered by correcting the apparent cause of decline (ie. pest control, soil and water management, etc.)

Once SRs are calculated, two complete data printouts are generated for park managers. One is organized by the SRs in descending order, so that corrective work can begin on the trees with the highest rating. The second is organized by tree number and zone for general reference. Additional field lists are generated to meet specific needs and situations. For example, proper corrective pruning is one of the easiest hazard reduction measures to accomplish; thus, a list of trees needing limb work (ie. trees with limb ratings of 3, 4 and 5) is printed out for the park manager. Another field list is generated for trees with high target values and high SRs so that movable targets such as benches and picnic tables can be relocated.

All tree maintenance and hazard reduction activities are recorded for each tree on "Maintenance Request/Report Cards". These are preprinted 3"x5" cards which park staff can easily carry in their pockets. The cards include spaces to record tree number, the maintenance activity requested or completed, the request date, the completion date, and any additional notes. The same card may be used both as a work order (maintenance request) and as a record of work completed (maintenance report). From these cards, the completed work is entered into the computer. All maintenance activities have been categorized and coded to facilitate computer entry. No changes are made in any component ratings that may have been affected by the maintenance activity until the tree is scheduled for reinspection. Currently, reinspection takes place on a two or three year cycle, depending on the tree's use zone rating and the availability of qualified inspectors.

In addition to the 11 components, each tree is also given a numerical rating for its aesthetic value. This rating is not added into the SR calculation but is used only as a tool to aid in management decisions. Other items included on the evaluation sheet but not in the calculations include:

- an immediate action check box. This is meant to red flag trees with an obvious immediate hazard (ie. root movement, cracked or hanging branch, cracked trunk).
- a check list of maintenance recommendations. This is included to reduce the number of trips to a tree. If a tree has a high damage potential, the maintenance recommendations

are already outlined for the manager.

- a check list of pest and disease problems. These are not included in the damage potential since a serious pest problem would most likely be picked up in the decline rating.
- an area for miscellaneous field notes.

After a year of development and testing, park staff and volunteers were given 6 hours of tree evaluation training and began the evaluation of oaks in another 180 acre park. The training consisted of 4 hours of classroom work on the basics of arboriculture (as related to safety evaluations) and the particulars of the evaluation system. The remaining 2 hours consisted of field demonstration and practice. Both park staff and volunteers selected had had some sort of previous training in general horticulture. Spot checks of the trainees' evaluations showed them to be accurate and relatively consistent.

Conclusions

This system provides a practical and quantitative method for evaluating the hazards of landscape trees. It has now been implemented on 244 acres of oak parklands (1400 trees) and adopted by other public agencies who are responsible for maintaining urban oaks. The relatively objective nature of the evaluation process provides a reliable analysis of tree conditions that may affect tree hazard potential. The Summary Rating has been effective in assisting with the prioritization and scheduling of corrective maintenance. As more data are collected, the true utility of the SR in predicting the likelihood of tree failure will be evaluated.

Literature Cited

1. Anonymous. 1986. The tree assessment program. The City and County of San Francisco, Recreation and Park Department.
2. Bakken, Stephen R. 1986. Tree hazard control program: guidelines and standards for the Calif. Dept. Parks and Rec., Natural Heritage Section, Resource Protection Div., Ca. Dept. Parks and Rec.
3. Gilman, Edward F. 1988. *Predicting root spread from trunk diameter and branch spread.* J. Arboric. 14(4)85:89.
4. Harris, Richard W. 1983. Arboriculture: Care of Trees, Shrubs and Vines in the Landscape. Prentice-Hall, New Jersey. 688pp.
5. Hecht-Poinar, Eva I., Costello, L.R., and Parmeter, J.R. 1987. Protection of California oak stands from diseases and insects. **In:** Proc. of Symp. on Multiple Use Mngmt. of Ca. Hardwood Resources, Gen. Tech. Rep. PSW-100. Berkeley California. Pacific Southwest forest and Range Exp. Sta., Forest Service, USDA.
6. Neely, Dan. 1988. *Tree wound closure.* J. Arboric. 14(6):148-152.
7. Neely, Dan, ed. 1988. Valuation of landscape trees, shrubs and other plants. 7th ed. International Society of Arboriculture. Urbana, Ill.
8. Paine, Lee A. 1966. Accidents caused by hazardous trees on California forest recreation sites. Pacific Southwest Forest Range and Exp. Sta., U.S. Forest Service Research Note PSW-133.
9. Paine, Lee A. 1967. Effective tree hazard control on forested recreation sites—losses and protection costs evaluated. Pacific Southwest Forest Range and Exp. Sta., U.S. Forest Service Note PSW-157.
10. Paine, Lee A. 1967. Tree hazard control on recreation sites—estimating local budgets. Pacific Southwest Forest Range and Exp. Sta., U.S. Forest Service Research Note PSW-160.
11. Paine, Lee. 1971. Accident hazard and control decisions on forested recreation sites, U.S.D.A. Forestry Research Paper PSW-68/1971.
12. Paine, Lee A. 1973. Administrative goals and safety standards for hazard control on forested recreation sites. Pacific Southwest Forest and Range Exp. Sta., USDA Forest Serv. Res. Paper PSW-88.
13. Paine, Lee A. 1978. Coding hazardous tree failures for a data management system. Gen. Tech. Rep. PSW-29, Pacific Southwest Forest and Range Exp. Sta., Forest Serv., USDA, Berkeley, CA.
14. Pronos, J. 1986. Comparison of rating systems. US Forest Service Pest Management Division, San Francisco.
15. Sharon, Michael E. 1987. *Tree health management: evaluating trees for hazard.* J. Arboric. 13(12):285-293.
16. Sudol, Frank J. and Alvin L. Zach. 1987. *City establishes urban tree management program.* Arbor Age 8(6):12-16.
17. Talarchek, G.M. 1987. *The indicators of urban forest condition in New Orleans.* J. Arboric. 13(9):217-224.
18. Wagener, Willis W. 1963. Judging hazard from native trees in California Recreation Areas—a guide for professional foresters. U.S. Forest Service Research Paper PSW-P1.
19. Webster, B.L. 1978. *Guide to judging the condition of a shade tree.* J. Arboric. 4(11):247-249.

University of California
Cooperative Extension
420 S. Wilson Way
Stockton, California 95205