AN INDEX FOR RATING TREES WITH DUTCH ELM DISEASE

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ABSTRACT

A quantitative disease index was developed for rating elms (*Ulmus americana* L.) exhibiting external symptoms of Dutch elm disease. The disease index is the product of a numerical value assigned to a specific tree condition times the average proportion of the crown affected times 100. The area of crown affected was determined by an objective grid measurement. The practicability of this disease index was assessed using shade or street-grown elms exhibiting various stages of DED in Ottawa and Sault Ste. Marie, Ontario. It is suggested that the general use of a standard rating system such as that proposed would be of mutual benefit to everyone working in DED.

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INTRODUCTION

Elms (*Ulmus americana* L.) with Dutch elm disease (DED) usually exhibit a progression of external symptoms from leaf droop to dieback of entire branches. However, the expression of the actual symptom development can vary greatly from elm to elm depending upon such factors as (a) the time of year when the elm becomes infected, (b) how the elm becomes infected, (c) the condition and age of the elm, (d) the environmental and predispositional factors and (e) the inherent resistance or susceptibility of the elm.

Frequently, it is necessary for researchers to measure visually the rapidity and extent of disease development in elms. The method most commonly used to evaluate the condition of an infected elm is to estimate visually and subjectively the percentage of the tree crown showing foliar symptoms and dieback (Dimond *et al.* 1949; Zentmeyer *et al.* 1946; Edgington and Dimond 1964; Stipes and Schreiber 1966; Smalley and Kais 1966; Hock and Schreiber 1971). However, comparison of data from such disease ratings is often difficult because of the use of differing parameters and the subjective nature of the estimates.

The methods that we have used for determining disease index permit the assessor to classify tree condition and to measure objectively the extent of this condition. He can then follow and measure the progress of the disease symptoms in the individual elm over a period of time, as well as make comparisons between experiments.

MATERIALS AND METHODS

This disease index is the product of the tree class times the average proportion of the crown affected times 100 (disease index = tree class x average proportion of crown affected x 100). Table 1 shows the tree classes from 0 to 4 and the corresponding tree condition. These classes are composites of observed symptom development in a large number of elms with DED over a period of years. Thus, a given diseased elm may not show all of the symptoms described for a particular tree class but should always fit into one of these tree classes at any given time, regardless of other factors that normally affect disease symptoms.

For the purpose of this index the proportion of the crown affected was defined as the area diseased divided by the area of the entire elm crown as measured in a vertical plane. The areas were measured with a transparent 1/2-inch square (1.27 cm square) plexiglass grid at a distance of approximately 50-100 feet (15.24-30.48 m) from the elm depending upon accessibility, as shown in Figure 1. The grid was held at a convenient distance from the eye. The outline of the entire elm crown was traced onto the grid along with the outline of the diseased portion. The proportion of the crown affected was

Table 1 Tree class descriptions

Tree Class	Tree Condition
(0)	Healthy
(1)	Normal-sized or small leaves wilting or drooping (doubtful as to disease)
(2)	Some leaves chlorotic (yellow) and other leaves wilted irreversibly, some leaves shrivelled, but not brown and dead
(3)	Many leaves dead and brown and/or shrivelled and fallen or persistent on tree; more than one twig or branch tip dead and crooked
	OR
	Small leaves, sparse foliage, many dead twigs and dead smaller branches, some leaves shrivelled or dead and brown
(4)	Major branch dead or almost so, with few or no green leaves or new shoots, other major branches exhibiting some symptoms described in (1), (2), or (3)

N.B. Borderline classes should be upgraded to the next higher class.

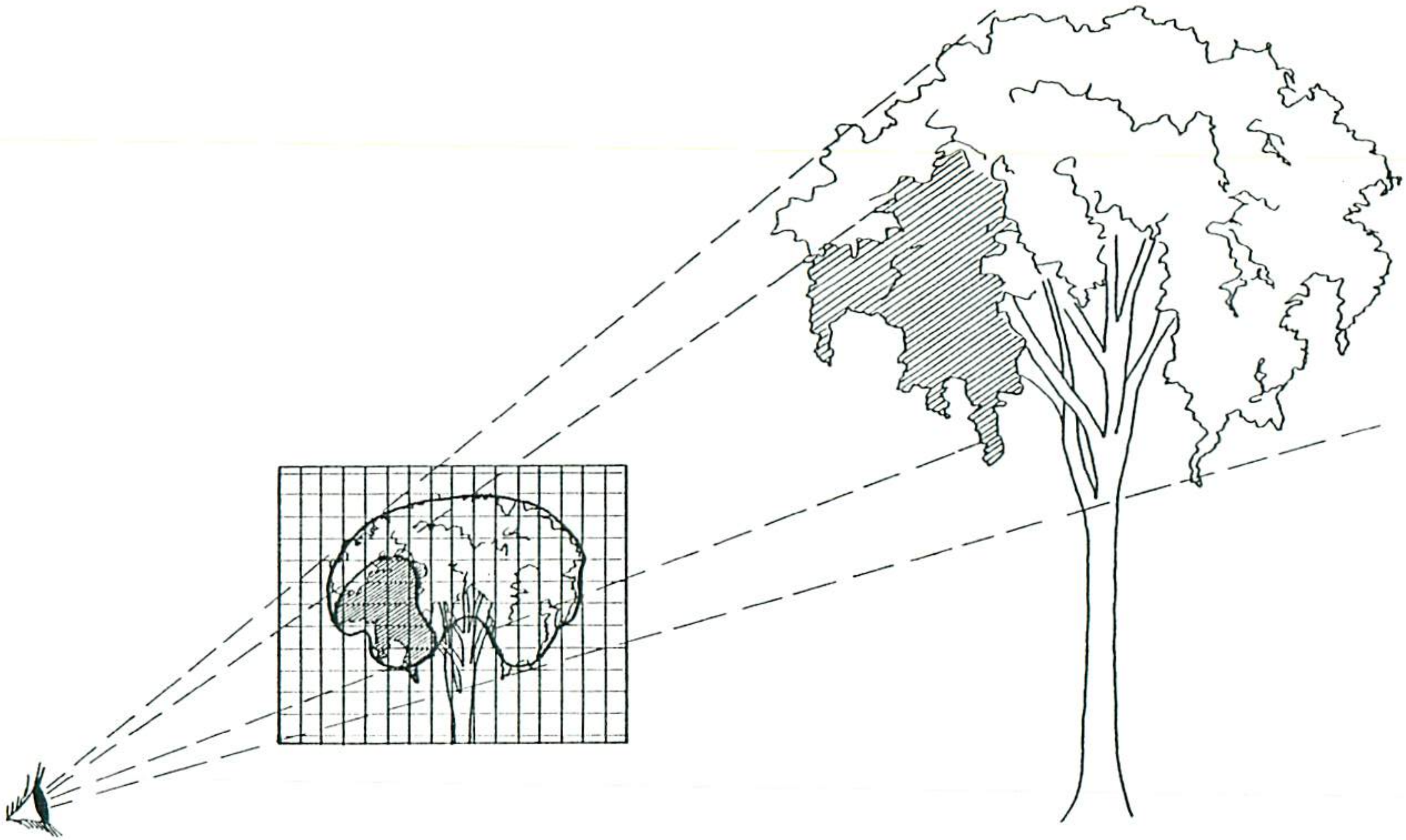

Figure 1. Measurement of disease and crown area using grid

then calculated as follows:

$$\text{Proportion of crown affected} = \frac{\text{total no. of squares within diseased area}}{\text{total no. of squares within entire outline of crown}}$$

This initial measurement should always be taken from the side of the diseased elm showing the greatest amount of symptom development. The procedure is then repeated on the opposite side of the elm and the average proportion of the crown affected is then calculated.

This disease index was tested on 167 diseased elms during the spring and summer of 1973 in Ottawa and Sault Ste. Marie, Ontario. All elms for this test were street or shade trees ranging in dbh from approximately 30 to 50 cm (11.7 to 19.5 in.) and in height from 14 to 21 m (45.92 to 68.88 ft). Nine different persons were employed in testing the index to determine possible variation due to subjectivity.

RESULTS AND CONCLUSIONS

Table 2 presents examples of disease index calculations for five different elms with DED. The disease index in these examples ranges from 0 for a healthy elm to 400 for a severely diseased elm with major dead branches and other disease symptoms throughout the crown. As shown in Table 3, the progress of the disease can be readily followed over a period of time. Also, the indexes allow the researcher to compare one diseased elm with another. The presentation of the average proportion of the crown affected and the tree class greatly increases the usefulness of the data for other researchers.

A visual estimate (without a grid) of the area of the crown affected resulted in a difference of 5-25% among individual assessors depending upon experience. However, our method of measuring the area of the crown affected resulted in only a 1-2% difference among individuals, regardless of experience. This suggests that a grid method of determining the area of the crown affected is less susceptible to subjective variation than a subjective ocular assessment.

It was found that the tree classes as presented in Table 1 were distinct enough that little or no indecision arose in classifying any elm with DED. However, it was decided that should borderline situations arise, the next higher tree class would be chosen. In addition, once a person was familiar with the external symptoms of DED he had no difficulty in determining the appropriate tree class for a particular diseased elm.

In conclusion, it is suggested that the general use in DED of a standard rating system such as that proposed in this paper would be of mutual benefit to all researchers. Data from different experiments could then be more confidently compared than at present.

Table 2 Examples of disease index calculations (from 1973 field trials)

		Total Number of Squares		Proportion of Crown Affected			
Tree Number	Side	Crown Area	Diseased Area	Side	Average	Tree Class	Disease Index
73-26	1	145	0	0	0	0	0
	2	135	0	0			
73-11	1	110	17	0.15	0.11	3	33
	2	95	7	0.07			
73-44	1	112	54	0.48	0.47	4	188
	2	93	44	0.47			
73-5	1	124	109	0.88	0.72	3	216
	2	137	77	0.56			
73-10	1	140	140	1.0	1.0	4	400
	2	120	120	1.0			

Table 3 Progression of the proportion of crown affected, tree class and disease index with time (from 1973 field trials)

Tree Number	Date	Proportion of Crown Affected	Tree Class	Disease Index
073-2	14 June 73	0.38	3	114
	20 June 73	0.56	4	224
	12 July 73	0.76	4	304
073-9	22 June 73	0.50	2	100
	5 July 73	0.80	3	240
	9 July 73	0.95	4	380
073-47	16 July 73	0.04	2	8
	25 July 73	0.04	3	12

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