THE FACTOR STRUCTURE OF STREET TREE ATTRIBUTES

by Robert Sommer and Barbara A. Sommer

Abstract. A factor analysis of 816 householder evaluations of street trees showed a general benefits factor and discrete annoyance factors in such areas as ground disturbance, disease, reduced visibility, and debris from fallen tree parts. Benefits were more highly related than annoyances to overall satisfaction with the street tree. The findings have implications for management of street trees and for future surveys of attitudes.

Résumé. Une analyse de facteur sur l'évaluation des arbres de rues par 816 propriétaires de maisons a montré un facteur général de satisfaction et des facteurs négatifs discrets en regard des perturbations du sol, des maladies, de la visibilité réduite et des débris de branches mortes. Les bénéfices étaient plus associés à la satisfaction globale des arbres de rues que les nuisances. Ces résultats ont des implications pour la plantation d'arbres de rues et pour les études futures sur les attitudes.

Most published research on street tree attitudes and preferences has involved slide simulations or questions about the benefits of street trees in general. Researchers have described the value of trees in moderating temperature extremes, improved air quality, wildlife habitat, and erosion control (3), their association with increased property values and house sale prices (4, 5, 7), their role in improving privacy, accentuating neighborhood identity, and enhanced aesthetic value of urban life (2, 9). On the debit side, street trees have occasionally been linked to sidewalk and root problems, insect and disease infestations, blocked solar access, obstruction of power lines, and reduced visibility in high-crime neighborhoods. An earlier paper (10) described a mail survey technique for assessing householders' attitudes toward the specific trees associated with their residences. Unlike slide images perceived briefly and only visually from a pre-defined viewpoint, actual street trees associated with a residence are perceived throughout the seasons from diverse viewpoints and in various sensory modalities.

Brush and Moore (1) suggest that the chief research task for behavioral scientists in regard to street trees is to identify those attributes perceived as desirable and undesirable by city residents. Concerns about the greenhouse effect have prompted appeals for more tree plantings in cities. If there is to be a major increase in street trees, it is important that the varieties selected maximize householder satisfaction and minimize public maintenance costs. Evaluations of street trees collected during the development of a survey instrument for city tree agencies formed the data base for the present study which analyzes householder ratings of 28 potential benefits and annoyances. The objective is to isolate clusters of positive and negative attributes which will have both theoretical and practical value to arborists. A subordinate objective is to increase the researcher's understanding of residents' perceptions of street trees. This approach allows for economies in future research through the elimination of redundancy in item coverage. The possibility of methodological economies seems particularly relevant in view of Schroeder's (8) findings that simple methods of data collection and analysis using small samples produced results almost identical to more complex scaling procedures with larger samples. The inclusion of a rating of overall tree quality should permit determination of the relationship between item clusters and overall satisfaction with the tree.

Methods

The database consisted of 816 householder evaluations collected in 14 surveys of eight California cities (Albany, Berkeley, Davis, Fairfield, Napa, Sacramento, Stockton, and Vacaville). A description of the instrument and the early findings on two trees is presented elsewhere (10). Each respondent was asked to rate the specific tree in front of the residence. The four-page questionnaire included a list of 10 benefits and 18 annoyances that earlier research and interviews with arborists had established to be relevant to householder attitudes. In addition, the respondent is asked for an overall opinion of the tree, its growth characteristics, the quality of city maintenance, animals attracted to the tree, and

various demographic items used in the interpretation of the responses.

Developmental research for the questionnaire indicated that benefits and annoyances should be rated separately. Scales in which respondents could rate an attribute as either a benefit or annoyance proved confusing, particularly in the case of annoyances where the absence of a problem (e.g., roots clog sewers), was considered a benefit. Benefits were rated from *major benefit* [4] to *no benefit/does not apply* [1] and annoyances from *major annoyances* [4] to *no annoyance/does not apply* [1]. In this format, missing values were scored as *does not apply* [1]. Especially on the annoyance list, some respondents did not bother to check non-problematic items, and it seemed appropriate to consider these as not applying to their tree.

Pilot research revealed that the attraction of animals to street trees could be either a plus or minus. This required a more complex format than was possible in unipolar scales. Separate items were developed for the attraction of birds, squirrels, and bees, which precluded their use in a factor analysis. Also excluded were the answers to the open-ended questions following the benefits and annoyance lists requesting the respondent to list additional items considered good or bad about the tree. The open-ended questions turned up little in the way of new information, which supported the comprehensiveness of the prepared list for use in this region.

Principal components analysis was performed using SYSTAT software. The analysis was set at seven factors. The present study involved a replicated design, while still preserving a sufficient number of cases in each group (6). The data from the 14 surveys were arbitrarily divided into two portions consisting of questionnaires from Surveys 1-7 (N = 324) and questionnaires from Surveys 8-14 (N = 492). Each portion was subjected to an independent factor analysis to determine if the original factors would replicate. Once the stability of factors was demonstrated, a third principal components analysis with VARIMAX rotation was undertaken on the combined data both to reduce the minor differences between the two analyses and to relate the factors to independent ratings of overall satisfaction with the tree.

Results

The first principal components analysis intended to show which benefits and annoyances clustered together, involved the following street trees: *Carpinus betulus, Gleditsia triacanthos, Platanus acerifolia, Sophora japonica, Tristania laurina,* and *Zelcova serrata.* A second analysis was performed on the questionnaires from Surveys 8-14 involving the following trees: *Fraxinus velutina, Liquidambar styraciflua, Platanus acerifolia, Ulmus parvifolia,* and three mixed tree neighborhoods. The results from the two analyses were very similar; the five most significant clusters (i.e., factors) were virtually identical.

Since the major factors proved stable in the replicated design, the data from the two sets of surveys were combined to prove higher reliability from the expanded sample size. Table 1 summarizes the principal components analysis of all 816 questionnaires using a VARIMAX rotation. Factor 1, which explains almost twice as much of the variance as the others, concerns general benefits. Nine of the ten benefits are loaded .50 or higher on this factor. This means that the nine items shown at the top of the table form a single cluster of correlated benefits. The single casualty on the benefits list is "flowers on the tree" which was so often considered as a liability due to subsequent tree droppings that it lost its association with the other benefits.

Unlike the benefits, the annoyances were grouped into separate clusters (factors). Factor 2 was concerned largely with ground disturbance, Factor 3 disease and exudation, Factor 4 reduced visibility, Factors 5 and 6 debris (fallen tree parts), and Factor 7 tree base problems.

The respondents' scores on the seven factors in Table 1 were correlated with their overall ratings of each street tree along a 5 point scale from excellent to very poor. Table 2 shows that the general benefits factor correlated most highly with overall satisfaction with the tree ($r = .573$, $p < .001$). The more specific annoyance factors correlated to a much lower degree with overall satisfaction. All coefficients were statistically significant.

Discussion

The most important finding of the factor analysis

is that tree benefits cluster while annoyances do not. This suggests that arborists need not spend a great deal of time distinguishing between the various benefits associated with street trees. Determining that a tree is rated positively by local residents seems sufficient as a guide to initial selection and replacement. Tree flowers are not associated with other good features and for many respondents, are a net liability. The problems associated with fallen flowers and the seed pods that follow outweigh the aesthetic value of flowers on the tree.

A somewhat different situation exists in regard to negative features. Because the liabilities appear in separate factors, knowing that the tree is rated negatively overall does not indicate the source of the problem. The analysis shows the importance of surface features in householder satisfaction with street trees, particularly ground disturbance and debris from fallen tree parts. The terrestrial plane has been largely excluded in slide simulations. However, after the benefits package, this is the next most important cluster in householders' views of street trees. It is a more important contributor to total attitudinal variance than disfigurement due to disease, or insects which many

Table 2. Correlations of Factors with Overall Satisfaction (N = 816).

Factor	*Correlation with overall satisfaction (r)*	*p*
I Benefits	.573	.001
VI Debris: leaves & limbs	-.245	.001
III Disease & exudations	-.215	.001
VII Suckers	-.203	.001
II Ground disturbance	-.172	.001
IV Reduced visibility	-.168	.001
V Debris: flowers & fruit	-.100	.001

Table 1. Items comprising factors for all 14 surveys (N = 816)

	Attributes loading .50 on Factors 1-7						
Attribute	*general benefit*	*ground disturbance*	*disease & exudation*	*reduced visibility*	*debris:flowers & fruit*	*debris:leaves & limbs*	*suckers*
reduces noise	.81	—	—	—	—	—	—
slows wind speed	.78	—	—	—	—	—	—
increases privacy	.74	—	—	—	—	—	—
increases sense of community	.73	—	—	—	—	—	—
pleasing to the eye	.73	—	—	—	—	—	—
increases property values	.73	—	—	—	—	—	—
gives shade	.68	—	—	—	—	—	—
marks change in season	.65	—	—	—	—	—	—
fall color	.57	—	—	—	—	—	—
roots too close to surface	—	.83	—	—	—	—	—
sidewalk damaged by tree roots	—	.79	—	—	—	—	—
roots clog sewers	—	.66	-	-	-	-	-
fallen leaves in autumn	—	.56	—	—	—	—	—
insects in the tree	—	—	.76	—	—	—	—
diseases on tree	—	—	.71	—	—	—	—
sap drips from tree	—	—	.67	—	—	—	—
reduces personal security by limiting visibility	—	—	—	.84	—	—	—
makes street dark	—	—	—	.82	—	—	—
blocks view	—	—	—	.77	—	—	—
flower parts fall from tree	—	—	—	—	.74	—	—
fruit or seed pods fall from tree	—	—	—	—	.69	—	—
leaves fall continuously throughout summer	—	—	—	—	—	.64	—
fall limbs	—	—	—	—	—	.50	—
branches or suckers at base	—	—	—	—	—	—	.68
roots send up suckers	—	—	—	—	—	—	.63
variance accounted for	17.2%	9.9%	8.8%	8.3%	6.1%	5.6%	5.2%

householders are willing to live with, unlike clogged sewers or broken sidewalks, which are seen as serious inconveniences and safety problems.

This factor analysis offers the possibility for economies in future studies of householder attitudes. The clustering of benefits suggest that not all of these items need to be included. It is important to retain at least some representatives of each of the separate annoyance factors, and a balance between number of positive and negative items on the questionnaire. Listing a few potential benefits and many potential liabilities could create the impression to the uninitiated that tree problems are more numerous than their benefits when in reality they are merely more independent of one another on a statistical basis.

Economy of presentation is not the only objective in survey research. There may be educational value for the respondents as well as for municipal authorities in demonstrating that householders believe that street trees increase property values, reduce noise, increase privacy, and enhance sense of community, even though all of these items are subsumed under a general benefit factor. A positive evaluation in all of these dimensions may strengthen the priority assigned to street trees in budget allocations. For their educational value as well as preserving balance, it seems justified to retain a significant number of benefits on the questionnaire. A reasonable compromise for those who would like to shorten the list of benefits and annoyances would be to reduce the number of benefits to six, corresponding to the six annoyance factors which would each be represented with a single item, e.g., surface roots, insects, reduced visibility, floral debris, fallen leaves, and suckers.

The stability of the major tree factors in independent replications with different respondents and different trees increases their usefulness for further research and assessment. However, certain methodological caveats need to be stated. Although the total number of respondents was large compared to most street tree investigations, all of the data were collected in northern California. There was nothing in any of the studies related to snow or ice. Further research in other regions might come out with slightly different factors although it is presumed that the general benefits factor will remain intact and that the annoyances will be separated into smaller catagories.

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Professor and Director
Center for Consumer Research
University of California
Davis, CA 95616 and
Department of Psychology
University of California
Davis, CA 95616