Estimating Visitor Use-Value of Arboreta: The Case of the University of Tennessee Arboretum[1,2]

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Abstract

Many studies have estimated demand functions for visits to recreation sites. Several included commonly defined recreation-based areas such as beaches, parks, lakes and rivers, but excluded examination of horticulturally significant sites such as botanic gardens and arboreta. This study estimates user-demand and consumer surplus for visits to the University of Tennessee Arboretum by the travel cost method. Results suggest that travel cost and income of consumers are important determinants of demand, at least in the case of visits to the University of Tennessee Arboretum, and that consumer-use value may be derived from this demand. Consumer-use value is estimated to be $20.43 per person.

Index words: arboreta, botanic gardens, recreation, resource economics, visitor-use value

Significance to the Nursery Industry

Since plant collections such as those at the University of Tennessee Arboretum are scarce, estimates of visitor use-value can be important to management in determining whether to maintain collections for public use. This type of information can also be used in setting entrance fees, as well as assessing the benefits of additional public horticultural programs or other new services for visitors. In addition, if there were an increase in travel costs in the future in the form of gasoline costs or other travel related costs, these data could provide insight about changes in visitor use patterns.

Introduction

Economists are concerned with valuing natural resources for a number of reasons. The most important reason is that there is a general consensus among policy-makers and interested citizens that we should be concerned with proper stewardship of our country's natural resources. Federal, state and local governments often seek to establish resource-use policies that are efficient, that is, such that no person may be made better off without making someone else worse off. Given this efficiency criterion, it is difficult to identify policies which balance both utilization and conservation of natural resources to the satisfaction of everyone. Clearly, trade-offs are necessary and relative values are important.

The values of goods and services traded in the marketplace are reflected by their prices. Clearly, arboretum services are not bought and sold in a competitive market setting. A central problem in estimating the value of natural resources is that many of their services are not commonly traded in competitive markets. Often such goods, e.g., arboretum services, have value in current use, value in the option for future use, or value in existence. Existence value is generated by simply knowing that some commodity exists while use value occurs as a result of the satisfaction derived from resource use (13).

Botanic gardens and arboreta are collections of plants; a great number of which are priceless, but not valueless (12). Even though there are many rare and unique species in the world, choices and decisions are made on a regular basis that implicitly assign a finite value to them. Not only do individual plants have value but groups or families, individuals in a collection, collections themselves and groups of collections have value. Further, the land upon which the collections are located, historical buildings, associated landmarks and the recreation experiences of persons visiting gardens have value.

Evidence of the demand for services provided by botanic gardens and arboreta are reflected in a variety of ways. Many gardening and arboretum associations have been formed; several on the international level. Thousands of persons visit botanic gardens and arboreta each year. A plethora of gardening how-to books, identification manuals and reference materials are published each year and several magazines devote their entire layout to plants. All of these are indicative of a broad interest in botanic gardens and arboreta as museums of living natural resources.

Collectors and breeders of plants generally agree that a large part of the genetic diversity existing even a half-century ago has disappeared and we have run out of disease resistant genes for some of the most destructive pathogens (12). Current rates of resource exhaustion, associated with the rapidly accelerating rate of extinction and disturbance of the earth's ecological systems, contribute to degeneration of this genetic diversity.

Materials and Methods

Many nonmarket valuation techniques are used for environmental and recreation application. The hedonic method, household production method, contingent valuation method and the travel cost method are the most common. Each method has both advantages and disadvantages depending upon the application and data available.

The travel cost method is used to accomplish the objectives of this study. The first step in the travel cost method

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is to estimate from a sample of visitors a regression model for predicting visits per person to the arboretum. This model is called a recreation demand curve. This demand curve predicts quantity of visits made by survey respondents as a function of the price paid per visit and other explanatory variables such as income. Expenditures of money and time for the arboretum trip (total travel costs) are used as proxies for prices visitors pay to enjoy the arboretum.

The next step is to estimate consumers' surplus from this recreation demand curve for the arboretum generated by the sample. Consumers' surplus for an individual is the amount the individual would be willing to pay over and above the amount actually paid to visit the arboretum. For example, suppose a person visits the arboretum three times per year and each trip costs $5. Suppose that if the cost per trip were $7, the individual would have only visited two times, and if the cost were $10, the person would only make one trip. With this example, $5 was actually paid for each of the three visits, but this person would have been willing to pay $2 more ($7–$5) for the second visit and $5 more ($10–$5) for the first visit. The sum of $2 and $5 is a benefit accruing to the visitor over and above the amount actually paid to visit the arboretum three times. Consumers' surplus, when summed over all visitors ($7), is the visitor use-value of the arboretum.

Data Collection. Methods of collecting primary data (as opposed to using secondary data) for recreation demand estimation are found in many sources (2, 3, 5, 7, 15). We chose an on-site survey to collect the necessary data for estimation of the recreation demand curve. The survey was conducted during a 21 day period, March 29, 1987 through April 19, 1987, and was administered during regularly scheduled arboretum hours on weekdays from 8:00 a.m. to 5:00 p.m. and on weekends from 8:00 a.m. to 5:00 p.m. Since visitors were free to enter the arboretum before and after these hours and these hours were not strictly enforced, the estimate of total visits made from this survey can be viewed as a lower bound. The survey was randomly administered to drivers of vehicles as they entered the facility. As vehicles entered the site by the only available entrance and parked in the visitors lot, drivers were approached by a single surveyor and asked to participate in the survey. When the surveyor was finished with that survey, the next driver was then approached. Information was obtained about the number of times the respondent visited the arboretum during the previous 12 months, the number of persons accompanying the respondent on each visit, the zip code of the respondent's residence, household income, time spent traveling to, from and at the arboretum, numbers of years of formal education of the respondent, and the respondent's main reason for visiting the arboretum.

Travel costs for individuals making multiple-purpose trips are difficult to allocate among purposes, and attributing all travel costs to the arboretum visit would bias average consumer surplus estimates upward. Therefore, multiple-purpose trip bias was mitigated by eliminating from the sample 27 vacationers whose main reason for visiting the Oak Ridge area was other than to visit the arboretum. The likelihood of multiple-purpose trip bias was further reduced by eliminating 37 respondents residing outside a radius of 60 miles from the arboretum. These respondents were considered most likely to visit the arboretum as part of a multiple-purpose trip. The estimate of consumer surplus per visit would be biased downward if the respondents truly traveled over 60 miles for the sole purpose of visiting the arboretum.

The remaining 202 surveys were used to estimate the recreation demand curve for visits to the arboretum. It was assumed that the driver's answers were representative of the group of persons visiting the arboretum in that vehicle.

Results and Discussions

Recreation Demand Curve Estimation. The recreation demand curve was estimated using truncated regression (11) with LIMDEP, a computer software package (10). The general model estimated was:

$$LN(V) = \beta_0 + \beta_1 Ln(TTC) + \beta_2 LN(Y)$$

where V is the number of visits to the arboretum per year by the group; Ln is a function that takes the natural logarithm of the argument in parentheses; TTC is total travel cost incurred per group; Y is the respondent's annual household income, and the β_i's are parameters to be estimated.

Monetary travel costs and time costs were summed to form total travel costs for each group. Round-trip fuel expenditures were used to represent monetary travel costs. Fuel expenditures were calculated for each group by multiplying an average fuel economy estimate for the respondent's automobile by the round trip distance in miles to the arboretum from the respondent's origin, and then multiplying the result by the average price per gallon of gasoline. Fuel economy estimates were obtained from Gas Mileage Guide (9) estimates, while the average price of gasoline was obtained from the American Automobile Association Easter Fuel Gauge Report (1). As commonly practiced, time costs were assumed to be one-third of the respondent's hourly wage (8) times the number of hours spent traveling to, from, and at the arboretum.

Other data obtained from the survey for education, main reason for visiting the arboretum, and the cost of visiting substitute sites were not included in the regression for the following reasons. The number of years of education was not included because of its high correlation with income. Dummy variables reflecting the respondent's main reason for visiting the arboretum failed to significantly differentiate demand for arboretum visits possibly because respondents visited the arboretum for a combination of reasons making it difficult for them to identify the main reason for their visits. The cost of visiting substitute sites was not included in the model because 87 percent of the respondents failed to provide sufficient information to identify substitute sites. This information would allow the cost of visiting other sites to be quantified. Excluding the substitute site variable could bias the results. However, the direction and magnitude of the bias, if it exists, cannot be determined (6).

The results of the estimation are:

$$\underset{(-1.55)(-1.77)}{Ln(V) = -2.97 - 0.35\ LN(TTC)} + \underset{(2.09)}{0.47\ Ln(Y)},\ N = 202$$

Numbers in parentheses under the estimated coefficients are asymptotic t-statistics. Their values indicate that total travel cost and income are significantly different from zero at the 10 percent and 5 percent levels, respectively.

Figure 1 depicts the estimated recreation demand curve for annual visits to the arboretum per group. It shows the

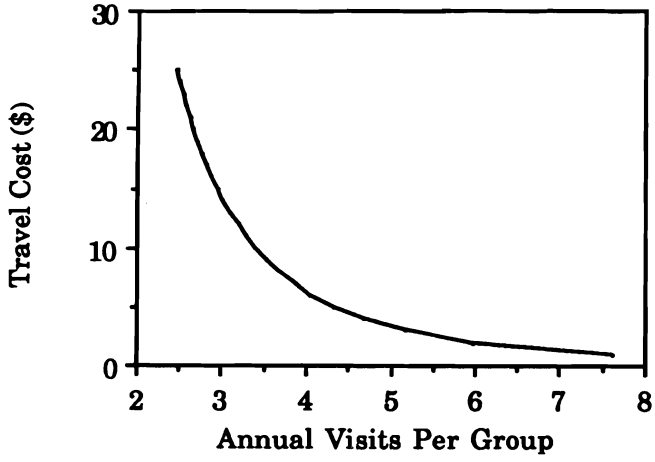

Fig. 1. Estimated demand curve for group visits.

predicted number of visits per group when total travel cost is allowed to vary, holding income constant at its mean. The price elasticity of demand for visits per group is estimated to be −0.35, which is equal to the estimated coefficient of Ln(TTC) when the functional form estimated is log-linear. An elasticity of −0.35 indicates that a one percent increase in total travel costs per group visit would result in a 0.35 percent decrease in visits per group, holding other things constant. Analogously, the estimated coefficient for LN(Y) suggests that a one percent increase in income would result in a 0.47 percent increase in the number of visits to the arboretum per group, other things constant.

Consumer Surplus Estimates. A summary of visitor activity recorded at the arboretum during the survey period is listed in Table 1. This table shows the number of persons signing the visitor log at the visitor's center, the number of group visits actually made (as observed), and the number of persons actually visiting the arboretum (as observed). The ratio of persons visiting the arboretum to the number of persons signing the register was 8.17 and the average number of persons per group visits was 2.5 for the survey period. These ratios were needed, in combination with the per group consumer surplus estimates presented below, to estimate total annual consumer surplus for the arboretum.

Procedures summarized by Bockstael et al. (4) were used to estimate annual consumer surplus per group. Average consumer surplus per group is estimated as the area under the recreation demand curve and above the total travel cost level that corresponds to the mean level of visits per group. For consumer surplus to be estimated, an upper bound on the consumer surplus area must be assumed since the estimated recreation demand curve is asymptotic to the travel cost axis (Fig. 1). The upper bound was arbitrarily set as the total travel cost level that drives visits per group to 1.0. Average consumer surplus per group is estimated as (4):

$$CS = [(TTC^1)(V^1) - (TTC^0)(V^0)]/(b + 1),$$

where, TTC^1 is the level of total travel cost that drives group visits to an arbitrarily low cutoff level; V^1 is the arbitrarily low level of visits used as the cutoff, assumed to be 1.0;

Table 1. Summary of consumer activity during the survey period: March 29 through April 19, 1987[z]

Survey date (1987)	Persons signing visitor log	Actual group visits	Actual persons visiting
March 29	3	20	40
March 30	16	18	53
March 31	6	14	32
April 1	7	6	23
April 2	0	17	38
April 3	0	0	0
April 4	0	0	0
April 6	3	1	3
April 7	16	6	16
April 8	1	11	22
April 9	10	21	51
April 10	6	21	67
April 11	0	82	207
April 12	0	36	61
April 13	13	4	13
April 14	1	6	12
April 15	8	10	25
April 16	1	8	25
April 17	40	21	73
April 18	0	52	137
April 19	0	73	171
Totals	131	427	1,070

[z] $\frac{\text{total actual persons visiting}}{\text{total persons signing visitor log}}$ = ratio of visitors to visitors signing in = 8.17

$\frac{\text{total actual persons visiting}}{\text{total actual group visits}}$ = average number of persons per group visit = 2.5

TTC^0 is the total travel cost level that corresponds to the mean level of visits per group; V^0 is the mean level of visits per group; and b is the coefficient of Ln(TTC) from the previously estimated equation.

Per group annual consumer surplus was estimated to be $352.47. This amount was divided by the mean number of group visits per year (6.9) to estimate average consumer surplus per group visit of $51.08. From the survey, average group size was estimated to be 2.5 persons (Table 1), yielding a consumer surplus estimate of $20.43 per person visit.

The next step in estimating annual visitor use-value of the arboretum was to make an estimate of total annual group visits. The arboretum did not keep a visitation record other than voluntary log-book sign-ins, so the estimation was done by forming a ratio of the number of visitors to the number of visitors signing the visitor log during the survey period (8.17 from Table 1). This ratio was multiplied by the monthly average (of 1984, 1985, and 1986) number of persons signing the visitor logs and aggregating across the 12 month period (Table 2). The result was an estimated total annual use of 6,958 group visits. Multiplying 6,958 by $51.08 per group visit gave an estimate of total visitor use-value for the arboretum of $355,433 per year.

Following the approach taken by Sellar et al. (14), 95 percent confidence bands were constructed for the estimated coefficient of Ln(TTC) in the travel cost model. These upper and lower bounds were then used to shift the recreation demand curve. Consumer surplus estimates based on the upper and lower bound demand curves were obtained. Results gave estimated upper bounds on consumer surplus of $35.12 per person visit, $87.81 per group visit, and $610,982 for total annual use value. Estimated lower bounds on con-

Table 2. Summary of persons signing visitor logs for 1984–1986, estimated monthly and annual visits by persons and groups, and estimated monthly and annual consumers' surplus.

Month	Persons signing visitor log 1984–86 average[z]	Estimated person visits[y]	Estimated group visits[x]	Estimated consumers' surplus[w]
January	42	343	137	6,997
February	44	359	144	7,355
March	129	1,054	433	22,117
April	341	2,786	1,114	56,903
May	585	4,779	1,912	97,665
June	174	1,422	569	29,064
July	170	1,389	556	28,400
August	132	1,078	431	22,015
September	133	1,087	435	22,219
October	280	2,288	915	46,738
November	83	678	271	13,842
December	16	131	52	2,656
Totals	2,129	17,394	6,958	355,433

[z]Information from actual visitor sign-in logs

[y]Estimated person visits (y) = persons signing visitor log (z) multiplied by 8.17

[x]Estimated group visits (x) = $\frac{\text{estimated person visits (y)}}{2.5}$

[w]Estimated consumers' surplus (w) = estimated group visits (x) multiplied by $51.08 per group visit

sumer surplus were $17.46 per person visit, $43.66 per group visit, and $303,786 for total annual use value. Average consumer surplus estimates per group visit were closer to the lower bound than the upper bound because the recreation demand curve is nonlinear and asymptotic to the travel cost axis.

Total visitor use-value was disaggregated by month using the information in Table 2 from columns 1–3 and is presented in column 4. The concentration of consumer surplus in April and May probably reflects the increased number of visitors to see flowering trees and other plants that are accompanied by seasonably warm temperatures. The higher levels of consumer surplus in October may reflect a visitation peak best explained by fall foliage offered by trees at the arboretum as well as seasonably mild temperatures.

The objectives of this study were to measure the demand for visits to the University of Tennessee Arboretum and to estimate the visitor use-value of the arboretum. The demand for visits to the arboretum was estimated to be responsive to changes in total travel costs with an estimated price elasticity of −0.35. Estimates of arboretum value were $20.43 per person visit, $51.08 per group visits, and $355,433 per year for total use. These estimates may be viewed as conservative because of constraints on data collection that produced a conservative estimate of total group visits per year. However, extrapolation based on value data obtained from a three-week spring survey may introduce seasonal bias. Although a three-week fall survey may have produced different results, these numbers do represent one estimate of visitor use-value of the arboretum and its distribution.

Visitor use-value is only one component of total value of the arboretum. Public support for the arboretum that emerged when proposals were made to develop arboretum land for alternative uses is not totally reflected in the $355,433 visitor use-value estimated in this study. Other important aspects of the arboretum's value not addressed in this study are existence value and option value. An account of the arboretum's total value should also include an estimate of its value as a research facility which was not considered here.

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