Estimating the Economic Value of Nonconsumptive Wildlife-Associated Recreation
by
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Abstract
In this study we estimate the economic value of nonconsumptive wildlife-associated recreation in the southeast United States. This is useful information for managers of scarce natural resources charged with providing multiple outputs. The data source is the 1991 National Survey of Wildlife-Associated Recreation. The surplus estimates range in a base model from $206 in Florida to $33 in Mississippi. The assumptions in this model were altered to test the sensitivity of surplus estimates. Untruncated models lead to larger estimates than truncated models. More inclusive specifications of the cost variable also resulted in larger surplus estimates. These results suggest a cautious approach in extrapolating results from truncated models beyond a known group of users to the population at large, and point to a need for resolving the definitional ambiguity associated with the cost variable.

INTRODUCTION
With such legislative actions as the Multiple-Use and Sustained Yield Act of 1960 and the Forest and Rangeland Renewable Resources Planning Act of 1974 the central tenet of forest management on public lands has become multiple use management. Nontimber forest products are becoming increasingly important, sometimes creating controversy over the proper production mix for a given forested area.

Nonconsumptive wildlife-associated outdoor recreation is one use that is growing rapidly. Between 1980 and 1990 the number of Americans six years old and older who fished increased by 17 percent, the number of hunters remained constant, and the number of participants in nonconsumptive wildlife-associated recreation, taking trips at least one mile from the home, increased by 63 percent. According to the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation there were 76.1 million participants spending a total of $18.1 billion on wildlife-associated nonconsumptive recreation in 1991. Of these, 30 million people took trips at least one mile from their home (USDI Fish and Wildlife Service 1993). Due to this demand there is pressure on managers to provide recreation opportunities and balance these with alternate resource uses. This may become increasingly complex with continued growth in outdoor recreation, changes in the population structure, and continued pressure for other uses.

The objective of this study is to estimate the economic value of nonconsumptive wildlife-associated recreation in the southeast United States.

Secondary methodological objectives include comparing the estimates and distributions of value measures derived from truncated and untruncated travel cost models, as well as from different specifications of the cost variable and the opportunity cost of time.

THEORY
Economic valuation is based on consumer demand. Consumers are faced with purchasing choices, and they select an attainable composite of goods, services, and amenities that maximizes satisfaction, which is represented by an ordinal utility function. Maximizing this function subject to a budget constraint leads to a set of ordinary demand functions.

The travel cost method follows this utility maximization approach to obtain a demand function for a nonmarket good, such as wildlife-associated nonconsumptive recreation trips. This leads to an ordinary demand function for these trips, which can be characterized as follows (Freeman 1993):

\[ t = f(c, q, Y, p) \]

where
\[ t \] = trips to a site
\[ c \] = total cost of a trip, including time cost
\[ q \] = individual site characteristics
\[ Y \] = total income
\[ p \] = price of other commodities.

An individual's demand for recreation trips is dependent on the cost and quality of a trip, the price of other commodities, as well as budgetary constraints including the opportunity cost of time. The demand functions can be used to estimate economic value by integrating the function from the average observed cost of travel to some maximum choke cost at which the

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number of trips is driven to zero.

\[ CS = \int_{m'} f(\beta, c, q, Y, \mu) \, dc \]

where

- \( CS \) = Marshallian consumer surplus
- \( m \) = average observed cost
- \( m' \) = choke or reservation cost
- \( \beta \) = a vector of coefficients
- \( \mu \) = a vector of error terms.

Weak complementarity is invoked in applications of travel cost models to enable the estimation of resource surplus measures based on demand curves for travel. Travel and site demand are weakly complementary when an increased travel cost that drives travel demand to zero results in zero demand for the site. (Bowes and Loomis 1980).

**METHODOLOGY**

The data source for this study is the National Survey of Wildlife-Associated Recreation (USDI Fish and Wildlife Service 1993), which is a periodic source of data on human use of wildlife resources. Our focus was on the southeast region including Alabama, Georgia, Florida, Kentucky, Mississippi, North Carolina, Tennessee, South Carolina, Virginia, and West Virginia. An observation was deleted if any variables included in the model were missing. This left us with 4344 observations, of which 1731 involved trips greater than one mile from the home to observe, feed, or photograph wildlife.

We use the individual travel cost method. A concern arises with this method when information on nonparticipants is not available. In this case the data are truncated at zero, and truncated estimators have been developed to account for this (Shaw 1988). However, truncated estimators may not be appropriate when the goal of the study is to extrapolate to the general population because nonparticipants may not have the same demand parameters as participants (Hellerstein 1991).

Yen and Adamowicz (1993) found differences in consumer surplus between truncated and untruncated estimators, as well as wider confidence intervals on the truncated surplus measures. They suggest that the cost of collecting additional information on nonparticipants may be relatively small compared to the benefits of more accurate and precise surplus estimates. Loomis, Creel, and Park (1991) observed that truncated estimators may be appropriate when the objective is consumer surplus estimates for a known group of users, but not appropriate if the objective is a consumer surplus estimate that reflects the potential entry of nonvisitors.

The presence of nonparticipants in the National Survey allows the examination of this issue. All respondents engaged in some form of nonconsumptive wildlife recreational activity. Thus, those in the survey who did not take any trips are residential wildlife-associated recreation consumers (i.e. they observed, photographed, or fed wildlife within one mile of their home), who are considered to be a relevant population for potential entry. Truncated estimators are used to derive surplus measures from a data set consisting of trip-takers, and untruncated estimators are used on the entire data set. The resulting estimates and distributions are compared. Table 1 presents a list of the variables. The cost assigned to nonparticipants is the average cost of trips taken in their home state.

**Table 1. List of variables included in the analysis.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Expenditures and time cost per trip.</td>
</tr>
<tr>
<td>Subcost</td>
<td>Average reported expenditures and time cost per trip in alternate states.</td>
</tr>
<tr>
<td>Hab</td>
<td>Millions of acres of forest and rangeland by state per capita.</td>
</tr>
<tr>
<td>Income</td>
<td>Household income in thousands</td>
</tr>
<tr>
<td>Age</td>
<td>Individual's age in years.</td>
</tr>
<tr>
<td>Agesq</td>
<td>Quadratic term for the variable Age.</td>
</tr>
<tr>
<td>Sex</td>
<td>1 if male; 0 if female.</td>
</tr>
<tr>
<td>Urban</td>
<td>1 if live in an urban area; 0 otherwise.</td>
</tr>
<tr>
<td>White</td>
<td>1 if white; 0 otherwise.</td>
</tr>
</tbody>
</table>

Dummy variables for state of recreation trips: 1 if trip was in specified state (Fl, Ga, Nc, Sc, Al, Ky, Ms, Tn, or Wv); 0 otherwise.

Omitted category: trips in Virginia.

Note: Product terms between state dummy variables and cost are denoted by Flct, Gact, Ncct, Scct, Alct, Kycr, Mscct, Tnct, and Wvct.

Determining the portion of total costs to include in the cost variable can be arbitrary, and this choice can influence the results (English and Bowker 1996). The cost variable is defined here as an individual's reported costs (lodging, transportation, guide fees, access fees, and equipment rental) per trip. Reported costs reflect only the respondent's share of cost on trips whose primary purpose was nonconsumptive wildlife use. To investigate the effect of cost specification on surplus results two different
cost definitions were used. The first, full cost, is that described above. The second includes the minimum necessary costs of a trip, which are transportation costs and access fees. Dummy variables are constructed for the state in which an individual’s trip was taken, and used to form an interaction term that enables the cost coefficient, and therefore the surplus estimate, to vary across states.

Cessario and Knetsch (1970) observed that trips decrease with distance to a site not solely because of travel cost but also because of travel time. The problem is how to value a person’s time. A common approach, suggested by McConnell and Strand (1981), is to use some fraction of an individual’s wage rate multiplied by the time spent traveling. Rockel and Kealy (1991) found that increasing the fraction used increases the resulting estimate of consumer surplus, and the choice of the fraction can be arbitrary. We follow this procedure by dividing two-way mileage by 50 miles an hour and then multiplying by the wage rate fraction. The mileage variable in the survey is defined as the distance to the site visited most often. This is assumed to be a typical trip distance for that observation. Three different wage rate multipliers (0, 0.25, and 0.50) are used to assess their effect on surplus estimates.

Another unresolved issue is substitute opportunities. Failure to include substitutes in a model may bias resulting surplus. (Freeman 1979). Our substitute variable is the average cost, weighted by number of trips, of nonconsumptive recreation trips to other states within the region. For nonparticipants and participants in only one state, it is the average cost of all trips taken outside of their state. As in the alternate cost definitions (reduced versus full, and differing opportunity costs of time), the specific definition of the state substitute variable changes with the assumptions of the model.

The dependent variable is the number of trips taken by an individual in a specific state for the primary purpose of observing, feeding, or photographing wildlife at least one mile from the home. Since some people took trips in more than one state, trips to additional states are counted as separate observations. This procedure has precedence (Rockel and Kealy 1991, Layman et al 1996), but its effects to our knowledge have not been investigated. It may lead to problems of non-independence of the exogenous variables because a trip in one state for an individual tightens the income and time availability for that individual in other states. However, we stack the observations with no adjustments. The effect of this practice is a potential issue for future study.

Hay and McConnell (1979) found that acres of recreation land and commercial forest per capita are a significant predictor of recreation. They state that this is a justification for the use of scarce natural resources in the provision of recreation opportunities. Rockel and Kealy (1991) found that total forested acres are positively related to recreation participation. To account for recreation supply in this study we use the amount of forest and rangeland per capita. Definitions of forest and rangeland can be found in Powell et al (1993). Additional variables that may serve as demand shifters are also included. These are income, age, sex, residence (urban vs. rural), gender, and race.

The visitation function (6) can be estimated in practice for a sample of n individuals by a general specification of the demand for recreation trips in matrix form:

\[ T = f(C, SB, I, D) \]

where

- \( T \) = number of trips of individual I to site j
- \( C \) = cost of one trip to site including time cost
- \( SB \) = cost of substitute sites
- \( I \) = individual characteristics of site
- \( D \) = individual demographic information.

A recent innovation for the estimation of this function is the use of count data models, which account for the discrete and nonnegative distribution of recreation trips. Failure to account for this using ordinary least squares will lead to bias. (Hellerstein 1991). Hellerstein and Mendelsohn (1993) discussed a theoretical basis for count data models. They state that "Given their strong econometric properties and sound theoretical foundation, in many circumstances count models should become the model of choice." Another advantage of count data models is that they naturally account for heteroskedasticity (Winkelmann 1994).

The poisson model is restricted by the assumption that the mean and variance of the dependent variable are equal. If the variance is greater than the mean then the data are subject to a form of heteroskedasticity termed overdispersion, which causes the standard errors to be understated making the less restrictive negative binomial model more appropriate. It has an additional parameter (\( \alpha \)) that represents the rate of overdispersion. As \( \alpha \) approaches zero the mean and variance of trips are equal, and as the magnitude of \( \alpha \) increases so does the difference between the mean and variance of trips. When the data come from a truncated distribution the poisson and negative
binomial models are misspecified leading to biased parameter estimates. Models for truncated data have been developed to account for this distribution. (Grogger and Carson 1991).

RESULTS AND DISCUSSION

Table 2 presents model results from the untruncated negative binomial model with reduced cost (transportation and access fees) and time valued at twenty-five percent of the wage rate. The negative binomial model was chosen because the data exhibit overdispersion based on a t-test of the dispersion parameter (Yen and Adamowicz 1993). The signs of all the coefficients agree with theoretical expectations, supporting the inverse relationship between cost and number of trips. The age coefficient is positive, but the age-squared coefficient is negative. This indicates that participation rises with age up to a certain point where it begins to decline. Only the income coefficient was not significant at the .1 level. Those who live in urban areas are likely to take fewer trips than those in rural areas. Whites are likely to take more trips than minorities, as are males than females. The supply variable is positive, meaning that an increase in habitat suitable for recreation will result in an increase in participation. The coefficient for the substitute variable is also positive. This suggests that if the cost of a trip to one state increases visitors may substitute a trip to a different state. The coefficients on the interaction variables represent the difference in slope between a given state and the base state, Virginia. All of the interaction terms remain in the model to maintain consistency because the significant terms changed with changes in modeling assumptions.

Table 2 shows the base scenario from which modeling assumptions were altered. Other models estimated are truncated and untruncated negative binomial models with full cost and reduced cost and with the time cost defined at fifty, twenty-five and zero percent of the wage rate. Full cost includes expenditures on lodging, transportation, access fees, and equipment rental while reduced cost includes only transportation and access fees. The coefficient of income is positive but not significant in all of the untruncated models but is negative and significant in the truncated models. A possible explanation is that the decision-making process for participants is different than that for nonparticipants. The significant cost slope shifters change with modeling assumptions, but Florida’s is always significant and Tennessee’s is never significant. Age and age sq are insignificant only in the full cost, truncated, zero percent wage model. The coefficient of the supply variable is positive and significant in every model except the full cost, untruncated, zero percent wage model, and the reduced cost, untruncated, zero percent wage model. The coefficient of subcost is positive and significant in every model except the full cost, untruncated, zero percent wage model. All other variables present in the base model remain the same sign and remain significant in all models.

Mathematical approximation was used to derive point estimates of consumer surplus per trip using the following formulas (Yen and Adamowicz 1993)

\[
\text{CS} / \text{trip} = -1 / \beta_c.
\]

\[
\text{Var(CS)} = \frac{\text{var}(\beta_c)}{\beta_c^4}.
\]

These formulas are applicable for trips in Virginia. Following are the formulas for the remaining states

\[
\text{CS} / \text{trip} = -(\beta_c + \beta_{al})^{-1}
\]

\[
\text{Var(CS)} = \frac{\text{var}(\beta_c) + \text{var}(\beta_{al}) + 2 \text{cov}(\beta_c, \beta_{al})}{(\beta_c + \beta_{al})^2}
\]
\[ \beta_k = \text{cost coefficient of the base state} \]
\[ \beta_{ik} = \text{ith state's interaction term coefficient}. \]

The CS estimate was multiplied by the number of trips in each state then summed across states to calculate the value of natural resources in providing nonconsumptive wildlife recreation in the southeast United States. This value from the base model was 4.5 billion dollars, which represents only value to residents of the southeast region. In addition this estimate does not take into account nonconsumptive wildlife recreation within one mile of the home or recreation by those under sixteen. The surplus estimate represents net economic value that would be lost if recreation opportunities were lost. The estimate ranged with the modeling assumptions from 2 billion to 8.5 billion dollars.

Consumer surplus estimates per trip and standard deviations for each state from the base model are presented in Table 3. The estimates range from $33 in Mississippi to $206 in Florida. Included in table 3 is the range of the extreme surplus estimates for all models. The surplus estimates were sensitive to all three methodological adjustments. The estimates from the truncated models are lower than the untruncated. The reduced cost models lead to lower surplus estimates than the full cost models. Also, larger wage multipliers lead to larger estimates of consumer surplus. The only anomaly in these trends is the surplus estimate for the state of Alabama from the reduced cost, untruncated, zero percent wage model and the reduced cost, untruncated, twenty-five percent wage model, where the zero percent wage yields the larger surplus estimate.

The standard deviations of these estimates follow the same trends as the surplus estimates. The reduced cost, truncated, and lower cost of time models, all else equal, yield smaller standard deviations than their respective alternate assumptions. One exception is the truncated reduced cost model at zero percent of wage and the same model at twenty-five percent of wage. In this case the twenty-five percent wage model yields the lower standard deviations.

**CONCLUSIONS**

This study estimates the value of nonconsumptive wildlife-associated outdoor recreation in the southeast United States. A negative binomial travel cost model is applied to estimate trip demand. Consumer surplus for 1991 is 2 billion to 8.5 billion dollars depending on modeling assumptions. This is a measure of the current value of nonconsumptive wildlife recreation in the southeast. The value per trip in the base model ranges from $33 in Mississippi to $206 in Florida. These per trip estimates can be used to calculate benefits associated with management practices that increase participation rates. Conversely, benefit losses associated with a decrease in participation can also be calculated. These changes in benefits can be compared with benefits from alternative resource uses so policy makers can take into account the economic efficiency of alternative policies.

**Table 3. Consumer surplus estimates per trip from base model (numbers in dollars).**

<table>
<thead>
<tr>
<th>State</th>
<th>Surplus per trip</th>
<th>Standard deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>166*</td>
<td>30</td>
<td>63 - 229</td>
</tr>
<tr>
<td>Florida</td>
<td>206*</td>
<td>36</td>
<td>79 - 391</td>
</tr>
<tr>
<td>Georgia</td>
<td>68</td>
<td>12</td>
<td>37 - 148</td>
</tr>
<tr>
<td>Kentucky</td>
<td>45*</td>
<td>11</td>
<td>27 - 101</td>
</tr>
<tr>
<td>Mississippi</td>
<td>33*</td>
<td>8</td>
<td>22 - 51</td>
</tr>
<tr>
<td>North Carolina</td>
<td>89</td>
<td>9</td>
<td>53 - 182</td>
</tr>
<tr>
<td>South Carolina</td>
<td>82</td>
<td>17</td>
<td>38 - 175</td>
</tr>
<tr>
<td>Tennessee</td>
<td>87</td>
<td>28</td>
<td>33 - 174</td>
</tr>
<tr>
<td>Virginia</td>
<td>81</td>
<td>14</td>
<td>32 - 147</td>
</tr>
<tr>
<td>West Virginia</td>
<td>48</td>
<td>20</td>
<td>14 - 103</td>
</tr>
</tbody>
</table>

*Estimate is significantly different for Virginia.

Truncated models lead to lower standard deviations and surplus estimates than untruncated models. Therefore, truncated estimators may not accurately project to the general population. We found the surplus estimates to be sensitive to definitions of out-of-pocket costs and the opportunity cost of time. More inclusive definitions of travel cost and larger wage multipliers lead to larger estimates of consumer surplus. The average difference for all states is $130. This sensitivity of consumer surplus to definitional assumptions reveal a need for resolving the ambiguity in defining trip-related costs.

**Literature Cited**


