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A PROPOSED METHODOLOGY FOR ESTIMATING ECOREGIONAL VALUES FOR OUTDOOR RECREATION IN THE UNITED STATES

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Abstract

This paper provides a methodology for the estimation of recreational demand functions and values using an ecoregional approach. Ten ecoregions in the continental U.S. were defined based on similarly functioning ecosystem characters. The individual travel cost method was employed to estimate the recreational demand functions for activities such as motorboating and waterskiing, developed and primitive camping, coldwater fishing, sightseeing and pleasure driving, and big game hunting for each ecoregions. Estimates of per trip net economic value range from $12.93 to $218.38 while per day estimates range from $4.31 to $109.19. While our ecoregional approach differs conceptually from previous work, our results appear consistent with the previous travel cost method valuation studies.

Key words: Recreation, Ecoregion, Travel Cost method, Truncated Poisson Model

Introduction

The U.S.D.A. Forest Service manages vast tracts of publicly-owned land and water resources across the U.S., especially in the South and the West. The Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA), as amended by the National Forest Management Act of 1976 (NFMA), was passed to make resource management by the U.S. Forest Service rational and accountable. The planning has been perceived at two levels: national and local. Assessment describes the current forest and rangeland situation which include timber and human recreation, and analyzes the environmental, social and economic trends that will likely affect the situation over the next 50 years. Based on the findings of the assessment, the Secretary of Agriculture recommends the Congress a 50 year RPA program for the forest service. The recommended program is a strategic plan that establishes long term resources management goals. In the planning process, alternative plans are developed to reflect different emphasis on the various resource management goals and different strategies for meeting societal needs over next 50 years (U.S. Department of Agriculture, Forest Service, 1989).

For the 1980 and 1990 RPA efforts, the recreation activity values were based primarily on values reported by previous studies of outdoor recreation demand. Comprehensive reviews of previous outdoor recreation demand studies are provided by Sorg and Loomis (1984), Bergstrom and Cordell (1991), McCollum and others (1990), and Walsh and others (1988). In some of these studies, the authors reviewed the demand for a single activity provided at a single site. Bergstrom and Cordell (1991) estimated a multi-regional multi-site outdoor recreation demand model for the United States. They used regional zonal travel cost model (ZTCM) for analyzing the general demand for and value of publicly provided outdoor recreation and assessing the effects of regional variations in population characteristics and recreation opportunities on outdoor recreation demand in the United States.

Our main purpose in this paper is to provide a methodology for estimating recreation values in the United States using ecoregional approach. The paper begins with the description of ecoregional classification. Next, the methodology and estimation procedure using the individual travel cost method (ITCM) is discussed. Results and implications are then highlighted.

Ecoregional Classification

The classification of land and forest sites is a major challenge of the 80's and 90's. Not only is more intensive multiple use resource management anticipated but enacted legislation (such as the National Environmental Policy Act of 1970, the Federal Land Policy and Management Act of 1976, and the National Forest Management Act of 1976) mandates a structured ecological data base to facilitate the decision making. Ecoregions are large ecosystems of regional extent that contain a number of smaller ecosystems. They are geographical zones that represent geographical groups or associations of similarly functioning ecosystems. An ecoregional classification is one that expresses interrelationships between (1) vegetation and physiography, (2) vegetation and soils, and (3) physiography and soils (Barnes and others, 1982). In developing the classifications, the complex gradients of an area are divided into ecosystem units that recur in landscape-units and can be distinguished by major differences in physiography, soils, and vegetation. Each of these three ecosystem factors provides information for building the classification and mapping the ecosystem units. Regional boundaries may be delineated on the basis of analysis of the environmental factors that most probably acted as selective forces in creating variation in ecosystems (Bailey, 1983).

The purpose of the ecological land classification is to divide the landscape into variously sized ecosystem units that have significance both for development of resources and for conservation of the environment. More specifically, such units are the bases for estimating ecosystem productivity and the probable responses to management practices. Thus, ecoregions have at least two important functions for management. First, a map of such regions enables the establishment of site-productivity relationships derived from field experiments and experiences between different ecoregions. Second, they provide a geographical framework in which similar responses may be expected within similarly defined sites. Methods of site classification involving such a geographical framework have been employed with success for over 50 years in Europe.

Based on Bailey's classification by geomorphology, stratigraphy, soil types, climate, altitude, wildlife, and other characteristics, and subsequent modifications, ecoregions in the United States are classified as follows: Marine, Tropical/Subtropical desert, Tropical/Subtropical steppe, Temperate steppe, Temperate desert, Mediterranean, Rocky mountains, Hot continental, Eastern Warm continental, Western warm continental, Appalachian mountain, Subtropical, Savanna, and Prairie. Based on the above classification, and combining some of those small ecosystems with similar attributes, ten ecoregions in the continental U.S. were defined for the purpose of RPA program assessment. Figure 1 provides a map of the continental United States with the boundaries for these ecoregions which are labeled as follows:

1. Pacific Northwest Marine
2. Desert Southwest
3. Great Basin Steppe
4. Rocky Mountains
5. Midwest Prairie and Steppe
6. Ozark and Ouchita Mountains
7. Northeast and Great Lakes
8. Southeast and Subtropical, South Florida
9. Appalachian Mountains
10. New England, Warm Continental

General Methodology

There is general agreement among economists that the appropriate measure of the value of outdoor recreation to an individual is consumer's surplus or net economic value (Dwyer and others (1977); Stoll and others (1987); Rosenthal and others (1986); U.S. Water Resource Council (1983)). Economists have devised various ways to empirically obtain these surplus measures. In general, the travel cost method (TCM) is one of most widely used nonmarket valuation techniques, particularly for estimating the value of outdoor recreation activities. This method is based on reported behavior and an assumed complementary relationship between travel consumer's surplus and site consumer's surplus, i.e., where travel and resource demands interact so that when travel prices are high travel demand is driven toward zero. Originally, the TCM was developed to provide values for recreation sites. Subsequent applications have been directed to predicting changes in recreation behavior, valuing changes in site attributes, and valuing specific recreation activities.

The most frequently used TCM approaches are the zonal and individual approaches. The empirical procedure for the zonal approach is usually broken into two stages: zonal per capita participation rates are regressed on travel cost and other relevant socioeconomic variables and stage one parameters are then used to derive trip/travel cost functions for each zone which may in turn be summed across price intervals to obtain an aggregate or second stage demand function. The aggregate demand function may then be used as the basis for obtaining Marshallian consumer's surplus estimates. A crucial requirement for using the zonal approach is to have relatively homogenous populations in each zone and to know with considerable certainty the amount of the visitation at each site. Recent applications of the zonal approach include Hellerstein (1991) and Bergstrom and Cordell (1991). In this study, we use the individual rather than zonal approach. The individual approach is conceptually similar to the zonal approach. However, the travel cost relationships are based solely on individual observations. The unit of observation is an individual's consumption of trips. An individual demand curve is derived by estimating the statistical relationship between an individual trip and the distance traveled from place of residence to a recreation site. By focusing on individual observations, the individual approach allows for more statistically efficient and theoretically consistent analysis of the individual recreation consumption behavior. The individual approach has been used in recent literature by a number of economists including Adamowicz and others (1989), Creel and Loomis (1990), Wilman and Pauls (1987).

Methods

The individual travel cost method is quite often employed as a method to estimate the recreation demand for the whole site which provides many recreation activities to a visitor. However, management at a larger scale often requires more aggregate information about activities across landscapes or ecoregions. In the present study, demand functions are estimated for various activities within a number of ecoregions. The basic conceptual model is specified as:

$$TRIPS_{ij}^{ke} = f(INC_i, TC_{ij}, SUBST_i, Z_i) \qquad \textbf{(1)}$$

where,

$TRIPS_{ij}^{ke}$

represents annual trips by individual i to the site j in ecoregion e for activity k, INC_i is annual household income of individual i, TC_{ij} is the travel cost per trip from individual i's origin to site j, $SUBST_i$ is price of a logical substitute, and Z_i is a vector of other socio-demographic variables for individual i. For each individual, definition of a trip depends on the declared main activity. During onsite surveys, individuals were asked about the number of trips taken in a year to the site for their main activity.

Ten ecoregions were defined following Bailey's classification scheme as explained before. Over 300 sites were grouped into specific ecoregions. Each ecoregion contained up to a maximum of 28 activities. Empirical individual demand functions were estimated using truncated count data estimators as described in Creel and Loomis (1990) and Grogger and Carson (1991). These models were chosen because the dependent variable, the number of trips taken over the season or year, is a nonnegative integer. Also, the data were collected onsite excluding nonusers and potential users. Estimators based on truncated count data distributions are appropriate. Creel and Loomis (1990) have found that accounting for truncation at zero for the dependent variable makes a substantial difference in the coefficient estimates, and subsequently benefit estimates, regardless of the choice statistical model.

The statistical model fitted using the truncated Poisson (TP) is given by

$$P(Y_i = y_i | Y_i > 0) = \frac{\exp(-\lambda_i)\lambda_i^{y_i}}{y_i![1-\exp(-\lambda_i)]}, \quad y_i = 1,2,...,\quad i = 1,2,...,n \tag{2}$$

For maximum likelihood estimation, the loglikelihood function is:

$$lnL = \sum_{i=1}^{n}[-\lambda_i + y_i x_i \beta - \ln(y_i!) - \ln(1-\exp(-\lambda_i))]. \tag{3}$$

Consumer’s surplus estimate is given by

$$E(CS) \in S \frac{-1}{\beta_{ic}} \frac{-1}{\hat{\beta}_{ic}}, \frac{Var(\hat{\beta}_{ic})}{\beta_{ic}^3} \tag{4}$$

$$= \frac{-1}{\beta_{ic}}[1 + \frac{Var(\hat{\beta}_{ic})}{\beta_{ic}^2}] \tag{5}$$

$$Var(CS) = \frac{Var(\hat{\beta}_{ic})}{\hat{\beta}_{ic}^4} \tag{6}$$

and the expected mean and variance are given as
Following convention, λ_i is parameterized for estimation as

$$\ln \lambda_i = X_i\beta + u_i \tag{6}$$

where Y_i
is a random variable, trip taken by a visitor which is a rare event. X_i represents the vector of explanatory variables, β is the parameter vector and u_i is random disturbance.

Data

Data for the study were obtained from the Public Area Recreation Visitors Study (PARVS) and the CUSTOMER survey. PARVS and CUSTOMER are ongoing multi-agency efforts to collect data on the use of public areas for outdoor recreation. The major component of these efforts is on-site interviews of recreationists conducted at public recreation areas. The analysis reported in this paper was based on PARVS and CUSTOMER survey data collected at over 350 sites across the ecoregions of the U.S. between 1985 and 1992. These sites included National Parks, National Forests, National Rivers, U.S. Army Corps of Engineers and Tennessee Valley Authority Reservoirs, and numerous state recreation areas.

In the onsite interviews, respondents were asked to provide information about themselves and their recreation patterns. Data were collected on the respondent's personal and household characteristics, the main activity, origin, trip expenditure, distance and time of travel, and whether the current trip was multipurpose or not. Data were also collected on the respondent’s 12 month trip profile. The 12-month trip profile includes number of trips taken, list of sites visited and activities taken, and length of each trip. Origins for the individuals were recorded as both county names and zip codes. Recorded origins included almost 80 percent of all counties in the United States. Counties not represented were primarily very sparsely populated counties in the Midwest and those comprised mainly of public land located in the West.

In this study, per trip travel cost is defined as a composite of variable operating costs and the opportunity cost of time in travel. The literature is ambiguous as to exact specification of travel costs. In general, most research supports the inclusion of variable operating costs and some measure of the opportunity cost of time in travel. Issues pertaining to the exact value of time in travel and time on site, along with such things as vehicle depreciation, recalled vs. inferred expenses, and complementary spending continue to be the subject of considerable debate and further research and are beyond the scope of this paper. Variable operating costs were computed as the product of origin to site driving distance (computed with ZIPFIP) and a cost factor of 6.25 cents per kilometer. Following others, the opportunity cost of time in travel was calculated as the product of 25 percent of the wage rate and the estimated time in transit (assuming 80 kmph average speed) from the origin to the site.

The substitute variable price variable (SUBST) was also calculated as a composite of distance and time costs. Here, a substitute site was identified for each individual. The site was determined as the site closest to the individual’s origin which offered the opportunity for the same main activity. The calculation of variable mileage and time costs is as above. In addition, a binary variable (NON) to differentiate local from nonlocal participants was included. The classification was made based on the roundtrip distance of 160 miles.

Results

The ITCMs were estimated using a maximum likelihood routine for the truncated Poisson models (LIMDEP). Truncated negative binomial estimation was attempted but not presented as the maintained hypothesis of no overdispersion could not be rejected. A total of 28 equations across activities and ecoregions were estimated. Preliminary results for some of the land and water-based activities in this study include motorboating and waterskiing, developed and primitive camping, and coldwater fishing. Because of data limitations, all activities were not necessarily represented across all ecoregions. We included only activities for which ecosystem representation exceeded 100 observations.

Estimated demand equations are shown in Tables 1 through 3. Each table consists of parameter estimates with standard errors, and likelihood ratio statistics. Likelihood ratio statistics (LRS) indicate that these models strongly explain recreation demand. The negative sign on the travel cost, variable implies a negatively sloped demand function, which is consistent with economic theory. This variable was found highly significant in most of the activities and ecoregions except in the case of developed and primitive camping in the Ozark and Ouchita Mountains (ecoregion 6) and the Northeast and Great Lakes (ecoregion 7) for which the sign was correct but insignificant. The INC variable had an expected positive sign in water-based activities models in most of the ecoregions. It had a negative sign but is statistically insignificant in activity models such as developed and primitive camping. This indicates that the INC variable is perhaps not an important factor in explaining the demand for some outdoor activities.

The SUBST variable, as defined earlier, is the distance from an individual i's origin to the nearest alternative site offering the same activity. The variable has a negative sign in 60 percent of the estimated equations, many of which are significant. This contradicts theoretical priors and merits further examination. It may well be that for certain recreation activities, activity rather than site substitution is the norm.

The nonlocal binary variable (NON) was significant in the majority of the activities and ecoregions. This implies an autonomous difference in the consumption behaviors of local and nonlocal visitors at most sites. Given the spatial nature of travel cost models and the need for distance variation, this issue is often overlooked in TCM studies. In general, inclusion of this variable induced price coefficients lower in absolute values indicating a more elastic demand. Modeling difference in activity demand without compromising distance-based price variation is an important area for future research.

Value Estimates

Average consumer's surplus or net economic value per trip was calculated as

$$CS = \frac{1}{-\beta_{tc}}, \tag{8}$$

where, β_{tc} is the estimated coefficient on travel cost. These values and their 90 percent confidence intervals are reported in Tables 4 through 6. Also, reported are consumer's surplus per trip, associated 90 percent confidence intervals, and consumer's surplus per day. Consumer's surplus per day is calculated by dividing consumer's surplus per trip by average activity days per trip in each ecoregion. These per day estimates indicate the average welfare impacts on individuals of increased outdoor recreation days in the respective activities across ecoregions.

Net economic value per trip in the case of motorboating and waterskiing ranges from \$29.55 to \$182.44. Per day values range from \$9.85 to 45.61. The per trip values are noticeably higher in the Desert Southwest and the Rocky Mountains. This may be due to long driving distances to reach sites resulting in trips of longer duration.

Per trip estimates in the case of developed and primitive camping range from \$31.95 to \$152.04 while per day estimates range from \$6.39 to \$38.01 (excluding statistically Insignificant estimates). Per day value and per trip values are the highest in the Rocky Mountains. This may be due to the abundance of higher quality camping sites in this region relative to sites in other ecoregions.

In the case of coldwater fishing, per trip estimate ranges from $51.40 to $62.91 whereas per day estimate ranges from $20.97 to $25.70 (excluding statistically insignificant estimates in the Great Basin Steppe). No identifiable differences were found among value estimates, either on a per trip or per day basis across ecoregions.

Comparison to Previous Valuation Studies

Walsh and others (1988) provide a comprehensive review of previous studies which estimated the net economic value of outdoor recreation activities. Most of the studies reported by Walsh and others (1988) used single activity, single site TCM modeling approach. They came up with an average value for each activity. The value estimate in the study by Bergstrom and Cordell (1991) represents the value of an activity to a typical site from a typical community across the United States, i.e., an aggregate value estimate of a particular activity. The present study uses an ecoregional approach wherein a surplus estimate, per trip as well as per day, represents the value of an activity from an individual's origin i to a typical site situated in a particular ecoregion. The estimates are given for all the ecoregions where sufficient data were available. The above three value estimates, thus, are fundamentally different. Taking these conceptual differences into consideration, the estimates generated by the present study appear reasonably consistent with previous studies in most cases. The final choice of which value estimates to use in a particular policy or a management situation depends on the nature of the policy or management question or issue of concern.

Summary and Conclusions

As the popularity of outdoor recreation continues to grow in the country, resource management agencies, legislators, and non-government interest groups are becoming more interested in the demand for and value of outdoor recreation (Bergstrom and Cordell, 1991). In the past, general outdoor recreation values developed on a national basis have been based on composite values such as average values calculated from previous single site demand studies.

A method for deriving ecoregional values of standard outdoor recreation is presented in this paper using the data from a particular ecoregion for a specific activity as unit of estimation. A sample of land and water-based activity value estimation results using the individual travel cost method are presented in this paper. Several important determinants of the demand for outdoor recreation were identified. These include regional differences in the value of recreation, difference in recreation behavior of local visitors as well as nonlocal visitors, and inclusion of time value in the travel cost variable.

Resource management agencies, legislators, and other interested parties will continue to demand information on the general determinants and value of outdoor recreation in the United States. The consumer's surplus estimates and the demand equations reported in this paper provide a measure of the social welfare impacts of changes in outdoor recreation consumption. These results provide information which is useful for evaluating recreation policies, programs, and resource management alternatives.

Although subject to a number of limitations, the modeling approach presented in this paper provides useful estimates of the economic value of outdoor recreation across ecoregions in the United States. The results suggest that outdoor recreation values do vary across ecoregions in the United States. For policy and planning efforts, such as the U.S. Forest Service RPA program, more research of the type reported in this paper is needed to improve the ecoregional estimates of the economic value of the outdoor recreation. The results of such studies can be used to help identify priorities for recreational planning and policy across ecoregions where the value of different recreational activities may be different. A major need for facilitating future research is to develop more comprehensive recreational use data sets across ecoregions. Also, there is a need for further research to address some of the modeling problems.

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