Valuing National Forest Recreation Access: Using a Stratified On-Site Sample to Generate Values across Activities for a Nationally Pooled Sample.

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I. Introduction

The USDA Forest Service (FS) manages 193 million acres of public land in the United States. These FS resources include vast quantities of natural resources including timber, wildlife, watersheds, air sheds, and ecosystems. Founded in 1905, the FS has been directed by Congress to manage the National Forests and Grasslands for the benefit of the American people. Initially, this guiding principle was to maximize the sustainable yield of timber products from forest lands. Beginning in the 1960's, the FS was directed to manage these forests for multiple uses and benefits, as well as for the sustained yield of renewable resources such as water, forage, wildlife, wood, and recreation.

In 1974, Congress passed the National Forest Management Act (NMFA) and the Forest and Rangeland Renewable Resources Act (RPA) that directs the FS to incorporate economic efficiency into management decisions and to periodically assess the state of forest resources. The next planning cycle has begun and there is a need to update the relevant economic values for the new planning efforts. Related to these Congressional directives, the Forest Service must conduct research into the value of all assets under its control and use those values in guiding resource management (Bergstrom et al. 1994).

In this study, our primary focus is to assess the net economic value (NEV) of recreation on National Forests. More specifically, we measure the willingness to pay for access (WTPA) to recreation opportunities on the National Forests. As Haab and McConnell (2002) point out, "Researchers frequently measure willingness to pay for access to a recreational resource, because policy decisions may entail an all-or-nothing choice between recreational and competing uses of the resource (p. 12)."

To address our main objective of measuring willingness to pay for recreation access on National Forest lands, we develop a national aggregate (multi-site) level recreation demand model for visitors to all National Forests, using on-site survey data and a revealed preference estimation method (travel cost). We are able to estimate WTPA for each of fourteen recreation activities, on per-visit and per-activity day levels.

This report is comprised of six sections and selected tables. It is organized as follows: Section II provides a background discussion of previous RPA valuation assessments and a brief review of the related literature; Section III describes the data used in the analysis; Section IV develops the models and methods used in estimation; Section V presents preliminary models and results; and Section VI provides some concluding remarks.

II. BACKGROUND

History of Forest Service Recreation Values

As described in Bergstrom, Cordell, and Langner (1994), the first RPA assessment was done with existing data and reports using a two-step approach. The original units of measure were in "activity-days" which were defined as one person participating in a National Forest recreation activity for any part of one calendar day (Adams, Lewis, and Drake 1973, as cited in Bergstrom et al. 1994, p.2). The next RPA assessment was conducted in 1980 using secondary data and similar methods to the first RPA assessment (Bergstrom et al. 1994, p.3). The 1990 RPA, conducted in 1989, emphasized aggregate county-level recreation demand and consumption estimation instead of individual-level demand estimation using secondary data and generating values termed "maximum preferred demand" for outdoor recreation activities. The 1990 RPA used the household production theory framework to develop projections of future expected supply of recreation trips (Bergstrom et al. 1994, p.4). To date, the RPA values have been used by policy makers in Congress, the White House, the Department of Agriculture, and the Washington Office of the Forest Service (Bergstrom et al. 1994, p.6).

Subsequent to the 1990 RPA assessment, Rosenberger and Loomis (2001) conducted a benefit transfer study for a set of RPA activities based on a detailed meta-analysis of previously published recreation valuation studies. The Rosenberger and Loomis (2001) benefit transfer study provides a set of benchmark values derived from the full body of recent recreation demand valuation literature from (1968-1998). We rely on their work as a benchmark with which to compare our results.

History of Recreation Demand Models

In a utilitarian framework, the net economic value (NEV) of a good or service is derived from the relationship between an individual's demand function for the good or service and the equilibrium price and quantity consumed. The net economic value per unit is the difference between the individual's maximum willingness to pay as defined by the individual's underlying demand for the good or service and the price actually paid. The NEV is also commonly called consumer surplus (CS). Since access to National Forests for recreation is not typically traded in private markets, NEV must be estimated using nonmarket valuation techniques. In this study, NEV is measured in terms of willingness-to-pay for access (WTPA) to National Forests for recreation. WTPA is interpreted as a visitor's willingness-to-pay above current expenditures to participate in recreation at a National Forest site rather than not recreate at that site. Hence, WTPA is a visitor's maximum net willingness-to-pay to continue accessing the site for recreation (Haab and McConnell 2002).

Revealed preference methods for nonmarket valuation are based on observed behavior. Two of the most popular revealed preference methods used for valuing recreation opportunities are the hedonic method and travel cost method (Freeman 1999). The travel cost method (TCM) is by far the most commonly used revealed preference technique when valuing access to public lands for recreation activities. In its different variants (e.g., zonal and individual models) it has regularly been used since the 1960's to estimate the net economic value of recreation access (Clawson and Knetsch 1966; Freeman 1999).

In order to estimate demand and net economic value for recreation access on National Forests using the TCM, an assumption is made that the cost of travel to the site is a shadow price for recreation. The price-quantity relationship is captured as the relationship between travel cost and the number of visits to the site. Formally, the assumption is referred to as weak complementarity (Haab and McConnell 2002, p.15). The underlying insight is attributed to Harold Hotelling in a 1947 letter to the National Park Service, and later popularized by Clawson and Knetsch (1966). A comprehensive review of the development of recreation demand models and the current state of TCM can be found in Phaneuf and Smith (2004). Additional detail concerning recreation demand modeling and the TCM can be found in, Bockstael and McConnell (1983); Bockstael, Strand, and Hanemann (1987); Bockstael and Strand (1987); Kling (1992) and Freeman (1999). A critique of the travel cost methods can be found in Randall (1994).

III. DATA

In 2000, the FS began an effort to estimate recreation visitation levels on National Forest lands. The National Visitor Use Monitoring Program (NVUM), in its first 4-year cycle, collected data from 120 National Forests and Grasslands (hereafter referred to as National Forests or NFs) using a stratified random sampling procedure (English et al. 2002). In addition to providing a scientific basis from which to estimate visitation to the NF system and to individual NFs, an on-site survey was administered to obtain visitor information on the number of annual visits, primary activity, local area expenditures, satisfaction with facilities, and limited demographic information. The preliminary or master dataset for the first cycle of on-site surveying (2000-2003 inclusive) contains 90,542 individual recreation visitor observations from 7,532 different sites aggregated from 120 National Forests and includes more than 200 variables per observation (English et al., 2002).

For both theoretical and empirical reasons, a number of adjustments were performed on the preliminary dataset. Observations from Alaska and Puerto Rico were deleted from the master sample since visitation to these areas is characterized by patterns that are significantly different from other U.S. forests. Visitors for whom the NF was not the primary purpose of their trip to the area (PRIME=0) were deleted from the master sample because travel cost modeling assumes that all visits to a given recreation-site are for the primary purpose of visiting that site. Incidental visits are not included since methods have not been developed to apportion the costs of the total trip to the incidental (non-primary purpose) visit; likewise foreign observations were also deleted from the sample. Observations with missing values for the following variables were deleted from the sample: annual number of visits to a National Forest (NFV12MO); distance traveled (PRACTD1S); gender (GENDER1); and whether or not the visit involved an overnight stay on the National Forest (ONITE). We also deleted observations where the annual visits were greater than 52 and one-way distance traveled was greater than 720 miles, as well as observations where the number of people traveling in the vehicle was reported as more than 10. After deleting observations from the master sample as described above, the dataset contains 64,894 observations. For key variables including age (AGE), people traveling in the vehicle

(PEOPVEH), and calculated travel time (PRACTIME), missing values were replaced with the weighted sample mean for the variable.

Economic theory suggests that income and substitute prices should be included in travel cost demand models. To provide a proxy for income, U.S. Internal Revenue Service (IRS) data on adjusted gross income, tax returns, and Zip Code for Tax Year 2002 were used. Thus, income (INCES) is represented by the average after tax income as reported by the IRS for the Zip Code in which the individual resides. A substitute distance/price variable was constructed using the Geographic Names Information Service (GNIS) latitude-longitude for each National Forest in the NVUM sample. This information was used to construct a substitute distance (SUBDISTZ) variable that provides a one-way distance from the individual's home Zip Code to the next nearest forest not visited. The substitute variable construction assumed that for each NF visitor, the relevant substitute site would be the nearest NF to the visitors origin exclusive of the forest visited on the current trip.

Table 1 displays descriptive statistics for the data presented in this report. On average, the weighted average number of annual visits to a National Forest was 4.027 with a standard deviation of 10.913. The average weighted one-way travel distance in our sample was 265 miles. Using a conversion factor of $0.12 per mile and 1/3 the wage rate, the average travel cost (including necessary fees) was $119.36. The travel cost constructions are discussed in more detail in Section IV. The average after tax per person income in the sample was $28,480 per year. The average number of people per vehicle was 2.709. Females comprised 32.7% of our sample, and the average age for respondents was 43.01 years. The most frequently listed primary activity was hiking (14.7 %), followed by skiing (13.4%), camping (9.2%), fishing (8.0%), and hunting (7.3%). Further information about the dataset used in this study and adjustments thereto is detailed in Bowker et al. (2005).

IV. MODELING

To estimate the net economic value of recreation access to National Forests with NVUM data, many theoretical and empirical issues must be addressed. The primary focus of this study is to estimate the net economic value (NEV) of recreation on National Forest lands. We estimate the willingness to pay to access the National Forest site. This process involves estimating the parameters of an individual or household demand function and then calculating the welfare measure (termed NEV, WTP, or CS) given the estimated parameters (Haab and McConnell 2002, p.159).

We begin with the utility framework represented by the household production approach (Deaton and Muellbauer, 1980; Bockstael and McConnell 1983) as described by Freeman (1999, p.445-447). For the household, utility is derived from consuming market goods and recreation. Because it takes time to recreate, and recreation is traded for time spent working for wages that can be used in the consumption of goods, there is an opportunity cost of time associated with recreation. Other critical assumptions of this model include: each visit to the site is for the sole purpose of recreating at the site so that non-primary purpose visits are not included in the model; each visit entails the same amount of time spent on-site; travel time is considered utility neutral; and the wage rate is the appropriate opportunity cost of time (Freeman 1999, p.445-447). Using this utility form, a general demand model can be written as:

$$R = \left(P_R, P_S, M, T, H\right) \quad [1]$$

where, R is the number of visits demanded, P_R is the per visit recreation price, P_S is the price of substitutes, M is annual income, T is a measure of time on-site, and H is a vector of individual specific socio-demographic measures. Our empirical models are based on pooling the available NVUM observations across sites and across all four years of sampling to form a single data set that can be segmented into activity groupings. By pooling observations across sites (within and among NFs) and estimating them as a single equation model with dummy variables and dummy interaction terms, we are basically following a varying parameters approach (Vaughan and Russell 1982; Bowker and Leeworthy 1998). The data were collected from more than 7,500 different sites measuring visits to more than 120 forests. We could estimate TCM models for each forest separately; however, this would produce a smaller number of observations per equation and limit our ability to estimate values for activities. Because the primary purpose of this research is to generate values for recreation to all the National Forests, the multi-site pooled model provides a practical application to policy makers and managers.

To apply the theoretical model summarized above, several empirical modeling issues must be addressed. The type of estimator selected must be capable of mitigating the effects of four potential problems: (1) choice based sampling frame and sample weights; (2) over-dispersed non-negative count data; (3) high frequency visitors and endogenous stratification; and (4) spatial scale and aggregation.

The primary goal of NVUM is to accurately estimate visitation to all National Forests. This was achieved with a stratified on-site sampling methodology developed by English et al. 2002. The objective of the stratification was to achieve minimum variance in the estimate of visits. The sampling used a two-stage method. The first sampling stage selected a stratified random sample of times and locations where recreation visitors can be counted as they exited the sites, creating a set of potential sites and times at which to survey. The survey sites were then classified by site type and use level. Finding all the combinations of site-types and use levels then forms the total number of sampling strata. From within these strata and from across the forests to be sampled, random draws were selected from the available sampling days. For each sampling time and location, traffic counts were conducted concurrently with interviews of visitors to calibrate traffic counts to the number of unique visits. Thus, site visit estimates were obtained for each sample day, averaged by strata, and then expanded according to classical random sampling methodology (Cochran 1977). English et al. (2002) provide documentation concerning the NVUM sampling methodology.

The NVUM visit expansion weights (NVEXPAND) were developed in order to describe the characteristics of the estimate of the total number of annual visits to the forest. These weights can be used to expand each sampled observation up to the number of visits it represents in a given stratum. Specifically, in NVUM the unit of measure is a National Forest visit, which is defined as, “one person entering and exiting a National Forest or National Grassland for recreation” (English et al. 2002). The weight, which is calculated for every individual $i = 1 \ldots N$, is then defined as:

$$\text{NVEXPAND}_i = \frac{\left[N \cdot \left(\dfrac{(\text{Exiting traffic}) \times (\text{Proportion last exiting}) \times (\text{Average persons})}{(\text{Number sampled in stratum})} \right) \right]}{(\text{Number of sites visited by } i)} \quad [2]$$

Where: (N) is the number of site days in the stratum; (Exiting traffic) is the average exiting traffic count per day for the stratum; (Proportion last exiting) is the ratio of last exiting recreation vehicles to total count of vehicles; (Average persons) is defined as the average number of people per vehicle for recreating vehicles sampled in the stratum; (Number sampled in stratum) is the number of people sampled in the stratum; (Number of sites visited by *i*) is the total number of sites visited by the individual during the current NF visit. This weight essentially replicates each observation up to the number of visits to the specific National Forest that it represents based upon the total proportion of last exiting vehicles.

Modeling on-site count data poses several challenges. As described by Shaw (1988, p. 211-212) on-site data is characterized by the following: (1) Non-negative integers: the number of visits taken to the site by the individual during a given time period is a count of non-negative integer values; (2) Truncation: only those individuals who participate in recreation and who have taken at least one visit are sampled, thus the sample is truncated at zero and contains only positive observations; (3) Endogenous Stratification: the probability of being included in the sample increases as the number of visits taken by the individual increases.

A key result of Shaw (1988) was defining endogenous stratification, or avidity bias, as being proportional to the number of visits taken. If the density function for the i^{th} person in the population is $f(y_i^* \mid X_i)$, given $y_i = y_i^*$ if $y_i^* > 0$, then the probability of being included in the sample for the i^{th} observation, given $y = t$ and $X = X^0$, is

$$\frac{yF(y)}{\sum_{y=t} f(y=t \mid x_i)} \qquad [3]$$

Using this information Shaw (1988, p. 215-216, Equations 6, 9, 10-12) derives a Truncated Stratified Poisson (TSP) estimator that accounts for the non-negative count data and the avidity bias related to visit frequency. The avidity bias correction described by Shaw (1988) can be applied to any family of discrete distributions. The TSP (or Poisson estimators in general) can yield inconsistent and inefficient parameter estimates if the mean and variance are not equal (Englin and Shonkwiler 1995; Cameron and Trivedi 1998; Greene 2000). Recreation visit data often displays significant dispersion around the mean, i.e., the visits variable has a large variance, typically exceeding the mean. This could result from a segmented user population comprised of high frequency and low frequency visitors. This over-dispersion of visits can lead to unexplained heterogeneity and a form of heteroskedasticity in the demand model (Cameron and Trivedi 1998).

To accommodate this variance in the dependent variable, the Poisson assumption of equal mean and variance is relaxed and a parameter (α) is introduced that captures the unexplained heterogeneity. The most common parameterization of (α) is Cameron and Trivedi's NEGBINII (Cameron and Trivedi 1998, p.71, Equation 3.26). The NEGBINII allows for over-dispersion and is frequently used outside economic applications (Gourieroux, Monfort, and Trognon 1984). While this estimator improves upon the Poisson count data estimators popularized by Hellerstein (1991); and Hellerstein and Mendelsohn (1993), it does not contain an adjustment for the sampling process (endogenous stratification) as discussed above.

Shaw (1988) observed that the probability of being included in the sample is proportional to the number of visits taken, thus the TSP essentially weights the observation by the number of visits. By applying this insight to the NVUM choice based sampling scheme, we can generate the following weight that brings each NVUM observation up to its representative value and accounts for the endogenous stratification. Thus, the choice-based sample weight for NVUM can be defined as:

$$NVY_i = \left(\frac{NVEXPAND_i}{NFV12MO1_i} \right)$$

where

$$NVEXPAND_i = \text{expansion weight for } i \qquad [4]$$

$$NFV12MO1_i = \text{number of annual visits for } i$$

Dividing NVEXPAND by NFV12MO1 adjusts the observation by the probability of being included in the sample, which is proportional to the number of visits taken. This provides a correction for the endogenous stratification, or avidity bias, found in choice based recreation samples.

To accommodate over-dispersion, the choice based sampling frame, and the non-negative count nature of the data, we use a Truncated Negative Binomial (TNB) estimator weighted by NVY. The form of the estimator we use is given by:

$$prob(Y = y \mid Y > 0) = \left[\Gamma\left(\frac{y+1}{\alpha}\right) \Big/ \Gamma(y+1)\Gamma\left(\frac{1}{\alpha}\right) \right] (\alpha\lambda)^{y} (1+\alpha\lambda)^{-\left(y+\frac{1}{\alpha}\right)} \left[1 - F_{NB}(0)\right]^{-1}$$

with conditional mean [5]

$$E(Y|X, Y>0)=\lambda[1-F_{NB}(0)]^{-1} = \left(\frac{e^{\lambda}}{1-e^{-\lambda}}\right)$$

where λ is paramterized as $e^{X'\beta}$

Equation[5] is weighted by NVY during the estimation procedure. The NVY weight adjusts the observation so that it is representative of the target population, thereby correcting for the avidity bias and the stratified random sampling frame. This TNB estimator accounts for the truncation and over-dispersion in the dependent variable. Thus, this estimator addresses the key data issues related to the NVUM sampling process. For a discussion of some of the econometric issues related to count data models, readers are referred to: Cameron and Trivedi (1986); Shaw (1988); Cameron and Trivedi (1998); Gourieroux (2000); Englin and Shonkwiler (1995); Gourieroux, Monfort, and Trognon (1984); Grogger and Carson (1991); Ovaskainen et al. (2001); Ozuna and Gomez (1995); Waldman (2000); and Winklemann and Zimmerman (1995).

Using the general demand function presented in Equation[1] we specified an empirical TCM demand model as follows:

$$\text{Visits} = \text{R}\begin{pmatrix} \text{ONE}, \text{TC}, \text{TC}\cdot\text{ACT}_k^i, \text{ACT}_k^i, \text{PEOPVEH}, \\ \text{HF}, \text{ONITE}, \text{INCES}, \text{GENDER1}, \text{AGE} \end{pmatrix}$$

Where $k = 1...14$ for the aggregated activities. [6]

The dependent variable in Equation[6] is the number of annual recreation visits to a National Forest per individual. Demand for visits is a function of: own price (TC), travel cost-activity interaction terms ($\text{TC}\cdot\text{ACT}_k^i$) for each of the 14 RPA activity groupings, primary activity indicator ACT_k^i, number of people in the vehicle (PEOPVEH), annual income (INCES), gender (GENDER1), age (AGE), and an indicator for staying overnight (ONITE). An additional term has been incorporated to capture the differences between high and low frequency users (HF), where HF=1 if number of annual visits was greater than 15, else zero. The activity variables and price interaction terms are included to generate demand estimates for different activities and are designed to capture any differences in demand resulting from the different primary activity type.

The distance used in the travel cost variable (TC) was calculated using the respondent's Zip Code and the latitude and longitude for the *site/forest* where they were surveyed. The travel cost variable was constructed as

$$TCWH = 2(.12 \cdot PRACTD1S) + 2\left[.33\left(\frac{INCE}{2000}\right)\cdot PRACTIME\right] + RECFEES \qquad [7]$$

Where PRACTD1S is the one-way distance described above, and RECFEES are the self-reported *on-site* recreation fees. A per mile cost of $0.12 was used. This is the current (2004) value listed in AAA travel services and by the IRS for charity and personal vehicle use.

We use 1/3 of the 'wage' rate, where the individual wage rate was calculated as the annual income (INCE) proxy divided by 2,000 hours. Phaneuf and Smith (2004) note that many studies that have estimated an opportunity cost of time have found it to be roughly 1/3 the minimum wage rate, which is often the standard estimate used in the TCM literature (the range is usually 0.25 to 0.50).

We assume time on-site is exogenous and include a proxy (ONITE=1 if the individual stayed overnight, else=0) for time spent on the National Forest. The dummy variable ONITE differentiates the visitors into those who take day visits and those who stay longer.

The main NVUM modules did not collect any information on substitute sites or substitute behavior, so we developed a substitute price proxy based on the heuristic rule that the nearest National Forest to their Zip Code of origin would be the most likely alternative recreation destination. However the own-price and substitute-price variable had a correlation factor greater than 0.95, and in the models where the substitute variable was included, it was not significant at the 0.10 or better level and did not have the expected sign. We feel it is better to acknowledge the potential bias in the estimated coefficient in order to gain increased reliability in the estimated parameters.

Using the estimated models described by Equation[5] and Equation[6], we can estimate the per visit per individual and the per activity day per individual net economic (WTPA) value on the National Forests. This is calculated as the area under the utility and income constant demand curve for the site, where the area under the income constant demand curve provides a good estimate of the willingness to pay for access to the site (Haab and McConnell 2002, p. 159). In general terms we can calculate

$$WTPA = \int_{C_i^0}^{C^*} f(P_R, M, T, H)\,dp \qquad [8]$$

Where $C_i^0 = TC$, the cost of visiting the site, and C^* is the relevant choke price at which price demand goes to zero (Haab and McConnell 2002, p. 159). Under an exponential distribution the relevant choke price is infinite. As given in Haab and McConnell (2002, p.167), for any finite travel cost, the seasonal or annual, WTPA can be defined as

$$WTPA = \int_{C^0}^{\infty} e^{\beta_0 + \beta_{TC} \cdot C} dC = \left[\frac{e^{\beta_0 + \beta_{TC} \cdot C}}{\beta_{TC}} \right]_{C=C^0}^{C \to \infty} = -\frac{\lambda}{\beta_{TC}} \qquad [9]$$

For the per visit WTPA we divide the result of Equation[9] by λ, the predicted number of trips, which simplifies to

$$WTPA = -\frac{1}{\beta_{TC}} \qquad [10]$$

Equation[10] is the essential per visit consumer surplus calculation under an exponential distribution. We calculate the WTPA for each of the ($k = 1...14$) activities; this results in the following calculation for each individual i,

$$CS_k^i = \left(\frac{-1}{(TC + TC \cdot ACT)} \right) \Big/ PEOPVEH_i \qquad [11]$$

After calculating the individual values we adjust the results to incorporate the sampling structure of NVUM. To do this we calculate the following weighted consumer surplus CS_k^w,

$$CS_k^w = \left(\frac{\sum_{i=1}^{N} CS_k^i \cdot NVEXPAND_i}{\sum_{i=1}^{N+D} NVEXPAND_i} \right) \qquad [12]$$

The term in the denominator is the sum of the expansion weights for the given region, including the non-primary purpose and foreign visitors (N+D). The numerator is the sum of the consumer surplus values times its expansion weight, and summed over the sample (for the region-activity combination, excluding non-primary and foreign visitors whose net economic value is conservatively assumed to be zero). This method allows us to derive the average WTPA per individual visit accounting for the stratified on-site sampling methodology of NVUM. Using the same methods as described in Equations [11] and [12] we adjust the WTPA values for the average days per visit for each activity. The activity days are based on the average time on-site for each activity and are counted in day integers

V. RESULTS

As discussed above, we used a weighted truncated negative binomial travel cost model to describe recreation demand to National Forests and to calculate the net economic value or WTPA associated with recreation access. The parameter estimates for the demand models are reported in Table 2. The total number of observations for our national pooled model was 64,894. The model reached stable convergence values, with a likelihood ratio index, or pseudo r-square, of 0.137.

The number of predicted visits per individual was 2.792. It should be noted that the average predicted trip value include both the high-frequency and low-frequency visitors. The estimated coefficient on travel cost is negative and significant at the 0.01 level, with a value of -0.005. The estimated coefficient for ONITE is negative and significant at the 0.01 level, indicating that spending at least one night per visit on the National Forest decreases the number of annual visits, which indicates that time spent on-site decreases the number of annual visits. The number of persons traveling in the vehicle (PEOPVEH) is negative and significant at the 0.10 level, so that as the number of people traveling in the group increases the number of annual visits on average decreases. The estimated coefficient on income (INCES) is positive and significant at better than the 0.01 level. The estimated coefficient on gender (GENDER1) is negative and significant at the 0.01 level for most of the models; this indicates that females on average take fewer annual visits to the National Forests. Age (AGE) is positive and significant at the 0.10, indicating older people make more visits to the NFs. The estimated coefficient on the over-dispersion parameter (α) for the truncated negative binomial model is significant at the 0.01 level and was estimated as 1.636, indicating that the variance and mean of visits are unequal and that the truncated negative binomial estimator is statistically superior to the truncated Poisson in the current study.

The dummy slope shifter variable (HF) for high-frequency visitors (those who take more than 15 visits per year) is significant at the 0.01 or better level, and the estimated coefficient was 2.949. Results suggest the HF dummy variable helps to capture the unspecified heterogeneity present in the count of visits related to the two groups of users, and allows the models to converge more readily. When HF is removed from the model the (α) parameter becomes very large, the models fail to converge, and the consumer surplus values are outside the range of expected values, as the estimated coefficient is attenuated to near zero.

The estimated travel cost coefficient (TC) is negative and significant at the 0.01 level. This estimated coefficient combined with equations [11] and [12] above, generates a base case WTPA value of $98.82 per person per visit. It should be noted that hiking is the base case activity for our estimates since it is the most frequently reported main activity. This base case WTPA, appropriately indexed for units and inflation, is within the range of values in the literature for forest recreation (Rosenberger and Loomis 2001). We calculate the elasticity measure for the base case (hiking) as -0.589040.

Overall, our modeling results are consistent with a priori expectations, economic theory and previous recreation demand studies. Our model performs well in that the key estimated coefficients are significant at the 0.01 level and variables generally have the expected negative sign. It is interesting to note that the estimated coefficient on income is positive. It is likely that using the income variable in the construction of the travel cost variable and including income as a variable in the vector of regressors creates collinearity problems, however other studies use this construction and we therefore include it in our set of results.

One of the main goals of using NVUM data for assessing the value forest recreation was to attempt to estimate activity specific values. Using the travel cost interaction models and methods described in the previous sections we calculate 28 activity based WTPA values (per visit and per day) and 14 own-price elasticity measures. The fourteen activities we examine are: camping (CAMP), scenic driving (DRIVE), fishing (FISH), general recreation (GEN), hiking (HIKE), hunting (HUNT), nature viewing (NAT), off-highway vehicle use (OHV), primitive camping and backpacking (PCAMP), picnicking (PICNIC), cross country and downhill skiing (SKI), snowmobile use (SNOWMB), trail use (TRAIL), and scenic viewing (VIEW). A complete description of these activities and their aggregation can be found in Bowker et al. (2005). Table 3 presents the per person per visit; the per person per activity day WTPA values; and the own-price elasticity values. The per person per visit values range from $40.02 for camping (CAMP) to $210.65 for trail use (TRAIL). In addition to the per visit values we also calculate the per activity day values. These activity day calculations then allow our estimates to be compared with the Rosenberger and Loomis (2001) meta-analysis values. If we examine the camping (CAMP) values we estimate the per person per activity value of $16.62. This compares with the Rosenberger and Loomis (2001, Table 1 p.4) mean value of $30.36 ($36.55 in 2004 dollars). For hunting (HUNT) use, we estimate $68.83, compared with the Rosenberger and Loomis (2001, Table 1, p. 4) mean value of $43.17 ($51.97 in 2004 dollars). It should be noted that the meta-analysis values are not strictly forest or National Forest recreation values, whereas all our values are for access to said activity on the National Forest. In addition to the two types of WTPA values (per visit and per activity day) we also present the own-price elasticity measures for the activities in Table 3. The elasticity estimates indicate that forest recreation has relatively inelastic demand.

VI. CONCLUSIONS

The data collected under the NVUM process have enabled the estimation of the net economic value of recreation on the National Forests. The data contain some unique features not present in other datasets including the large scale, the diversity of sites from where it was collected, and the careful year long sampling frame with resulting sampling weights. A key element not heretofore done is using the same dataset that generates visitation estimates to generate WTPA measures. This is an expansion on the last point made, but it is something that sets NVUM apart from other similar efforts.

In examining our results we see significant differences across activities. Our analysis indicates different activities have significantly different WTPA estimates. This suggests that using one overall forest recreation net economic value will overestimate the value of the resource for some activities and significantly underestimate the NEV for other activities. Using a truncated negative binomial estimator weighted by a compound weight that adjusts for the sampling frame and for endogenous stratification we estimate a series of net economic values (average consumer surplus per person per activity and per person per activity day) for each of fourteen activity groupings. This research contributes a rigorous analysis of forest recreation valuation using the NVUM data set and contributes a large set of RPA comparable net economic values using the current best-practice approach to modeling and estimation.

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Table 1 Descriptive Statistics*

Variable	Description	Mean	StdDev.	Min.	Max.
AGE	Age of respondent; median of age classes used	43.013	13.414	18	75
GENDER1	If female, then GENDER1=1; Else 0	0.327	0.469	0	1
HF	If NFV12MO1>15, HF=1; Else 0	0.045	0.207	0	1
INCES	IRS Average After Tax Income Per Zip Code	2.848	1.534	0	25
ONITE	If stayed overnight on National Forest=1; Else 0	0.241	0.427	0	1
PEOPVEH	Number of People in Vehicle on surveyed visit	2.709	1.480	1	10
PRACTD1S	One way distance from zip code of origin to National Forest site/GNIS centroid	265.152	301.201	0.000	1250
TC	Travel cost variable with opportunity cost valued at 1/3 the income-based wage rate TCWH=(.12*2*practd1s)+((.3333*(INCE/2000))*2*TIME2)+recfees	119.355	147.679	0	4,291
Y	National Forest Visits in the Past 12 Months (NFV12MO+1)	4.027	10.913	1	365
CAMP**	IF CAMPING7=1 OR RESORT7=1 THEN CAMP=1; ELSE CAMP =0;	0.092	0.289	0	1
DRIVE	IF DRIVING7=1 OR H2OMOTR7=1 OR OTHMOTR7=1 OR SITESEE7=1 THEN DRIVE=1; ELSE DRIVE=0;	0.071	0.256	0	1
FISH	IF FISHING7=1 THEN FISH=1; ELSE FISH=0;	0.080	0.271	0	1
GENERAL	IF GENERAL7=1 THEN GENERAL=1; ELSE GENERAL=0;	0.121	0.326	0	1
HIKE	IF HIKE7=1 THEN HIKE=1; ELSE HIKE=0;	0.147	0.354	0	1
HUNT	IF HUNTING7=1 THEN HUNT=1; ELSE HUNT=0;	0.073	0.260	0	1
NATURE	IF GATHER7=1 OR HISTORY7=1 OR NATCENT7=1 OR NATSTUD7=1 THEN NATURE=1; ELSE NATURE=0;	0.040	0.196	0	1
OHVUSE	IF OHVUSE7=1 THEN OHVUSE=1; ELSE OHVUSE=0;	0.027	0.163	0	1

PCAMP	IF PCAMP7=1 OR BPACK7=1 THEN PCAMP=1; ELSE PCAMP =0;	0.038	0.192	0	1
PICNIC	IF PICNIC7=1 THEN PICNIC=1; ELSE PICNIC=0;	0.029	0.169	0	1
SKI	IF DOWNSKI7=1 OR XCSKI7=1 THEN SKI=1; ELSE SKI =0;	0.134	0.341	0	1
SNOWMOB	IF SNOWMOB7=1 THEN SNOWMOB=1; ELSE SNOWMOB=0;	0.013	0.114	0	1
TRAIL	IF BIKING7=1 OR HORSE7=1 OR H2ONMOT7=1 THEN TRAIL=1; ELSE TRAIL=0;	0.039	0.193	0	1
VIEW	IF VIEWNAT7=1 OR VIEWWLD7=1 OR VIEWOFF7=1 THEN VIEW =1; ELSE VIEW=0;	0.126	0.332	0	1
TCCAMP	TCWCAMP=TCWH*CAMP	9.701	48.771	0	2,012
TCDRIVE	TCWDRIVE=TCWH*DRIVE	7.612	43.997	0	1,045
TCFISH	TCWFISH=TCWH*FISH	7.240	38.373	0	1,378
TCGEN	TCWGEN=TCWH*GENERAL	12.670	55.033	0	1,188
TCHIKE	TCWHIKE=TCWH*HIKE	17.845	67.320	0	1,280
TCHUNT	TCWHUNT=TCWH*HUNT	6.587	35.335	0	1,091
TCNAT	TCWNAT=TCWH*NATURE	5.193	36.081	0	1,090
TCOHV	TCWOHV=TCWH*OHVUSE	2.670	26.686	0	837
TCPCAMP	TCWPCAMP=TCWH*PCAMP	4.021	29.027	0	1,251
TCPIC	TCWPIC=TCWH*PICNIC	2.180	21.668	0	1,375
TCSKI	TCWSKI=TCWH*SKI	27.945	111.049	0	4,291
TCSNWMB	TCWSNWMB=TCWH*SNOWMOB	1.436	18.849	0	739
TCTRAIL	TCWTRAIL=TCWH*TRAIL	4.487	33.820	0	2,509
TCVIEW	TCWVIEW=TCWH*VIEW	16.868	66.049	0	1,053

*Weighted by the composite weight NVY=NVEXPAND/NFV12MO1; N=64,894

Table 2 Regression Results Truncated Negative Binomial Weighted by NVY*

ONE	0.463***
	(16.176)
TCWH	-0.005***
	-(77.136)
TCCAMP	-0.001***
	-(7.670)
TCDRIVE	0.000
	-(0.295)
TCFISH	0.000*
	-(1.600)
TCGEN	-0.001***
	-(10.399)
TCHUNT	-0.003***
	-(17.114)
TCNAT	-0.002***
	-(9.303)
TCOHV	-0.002***
	-(5.040)
TCPCAMP	-0.002***
	-(9.307)
TCPICNIC	-0.001***
	-(5.538)
TCSKI	0.002***
	(22.182)
TCSNOWMB	-0.001***
	-(3.893)
TCTRAIL	0.002***
	(13.001)
TCVIEW	-0.001***
	-(14.438)
CAMP	-0.058**
	-(2.123)
DRIVE	-0.034*
	-(1.354)
FISH	0.154***
	(5.576)
GENERAL	-0.120***
	-(5.290)
HUNT	0.395***
	(12.630)
NATURE	-0.223***
	-(6.181)
OHVUSE	0.383***
	(7.291)
PCAMP	0.209***
	(5.591)
PICNIC	0.086***
	(2.293)
SKI	0.296***
	(13.535)

SNOWMOB	0.421***
	(6.962)
TRAIL	-0.043*
	-(1.295)
VIEW	-0.198***
	-(9.098)
ONITE	-0.167***
	-(11.245)
PEOPVEH	-0.051***
	-(14.290)
INCES	0.072***
	(18.537)
GENDER1	-0.132***
	-(11.343)
AGE	0.003***
	(8.290)
HF	2.949***
	(115.045)
Alpha	1.636***
	(39.324)
EXIT	3
NOBS	64,894
LRI	0.137
YHAT	2.792
CSBASE	98.819
ELASTICITY	-0.589040

*tstats in parentheses

Table 3 Consumer Surplus Results

Activity	CS Per Visit	NOBS	CS Per Activity Day	NOBS per Activity Day	Elasticity
CSCAMP	40.02	6083	16.62	5895	-0.6568
CSDRIVE	98.82	3722	47.64	3522	-0.5347
CSFISH	115.87	6506	88.88	6217	-0.4704
CSGEN	53.11	7507	36.63	7251	-0.6740
CSHIKE	118.70	12911	101.34	12235	-0.6004
CSHUNT	94.62	3829	68.83	3546	-0.7098
CSNAT	54.52	2071	45.89	1955	-0.9308
CSOHV	89.87	1958	65.47	1821	-0.6755
CSPCAMP	46.85	3069	20.54	2959	-0.7242
CSPICNIC	53.36	2064	45.74	1996	-0.4603
CSSKI	177.69	4708	163.65	4589	-0.7170
CSSNOWMB	111.48	1483	53.71	1408	-0.6534
CSTRAIL	210.65	3462	169.71	3258	-0.3721
CSVIEW	51.51	6229	43.01	5892	-0.8539