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Research article

Valuing setting-based recreation for selected visitors to national forests in the southern United States☆

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ABSTRACT

In this study we estimate selected visitors' demand and value for recreational trips to settings such as developed vs. undeveloped sites in U.S. national forests in the Southern United States using the travel cost method. The setting-based approach allows for valuation of multi-activity trips to particular settings. The results from an adjusted Poisson lognormal estimator corrected for truncation and endogenous stratification reveal that economic value per trip estimates are higher for wilderness compared to day-use developed settings, overnight-use developed settings, and general forest areas. Estimates of these economic values are important to resource managers because their management decisions and actions typically control recreational settings. For example, managers control developed campground capacity in a national forest, but typically not the number of campers below the capacity constraint and the number and types of activities visitors engage in during a multi-activity trip to a developed campground (within limits since some activities such as discharging a firearm are not permitted in a developed campground).

1. Introduction

We present a conceptual model and empirical estimates of recreation demand and consumer surplus for visitors to national forests in the Southern United States for different setting types. Manfredo et al. (1983) define settings as "places where activities take place and include all physical (e.g., topography, water, wildlife, fish, meadow), social (e.g., number of other people, types of other people), and managerial (e.g., fee systems, permits, facilities) resources and conditions of these places" (p. 264). This definition identifies three facets of recreation demand and supply: preferences and demand for an activity opportunity, an experience opportunity, and a setting opportunity (Driver and Brown, 1978, 1975).

The National Visitor Use Monitoring Program (NVUM) of the U.S. Department of Agriculture (USDA) Forest Service classifies settings into four categories: Wilderness (WILD), Overnight-use Developed Settings (OUDS), Day-use Developed Settings (DUDS), and General Forest Areas (GFA). WILD areas are officially designated wilderness subject to the provisions of the U.S. Wilderness Act of 1964. DUDS have facilities for day-use activities including picnicking, boating, and developed-trail hiking. OUDS have facilities for overnight stays for activities such as developed camping. GFA are areas which have undeveloped facilities for activities like nature viewing, hunting, developed and undeveloped-trail hiking, and some motorized sports (English et al., 2002).

Given that resource managers are often interested in knowing about visitors' preferences for specific activities, modeling main-activity-based trips has been emphasized in previous studies (Creel and Loomis, 1990; Breffle and Morey, 2000; Scarpa et al., 2007). In contrast, the setting-based approach offers a framework to relate specific recreational experiences to preferences for different settings. As explained below, we believe there are certain advantages to using the setting-based approach to value outdoor recreation in national forests as compared to the main-activity approach.

As pointed out by Manfredo et al., 1983, certain recreational experiences cannot be defined or classified based only on one individual activity since visitors may engage in several activities during the same trip (p. 265). This "multi-activity trip" has long been recognized in the literature (e.g., see Loomis et al., 2000). According to NVUM results, most national forest visitors participate in several different recreation activities during the same trip (USDA Forest Service., 2013).

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Multi-activity trips are a resource management concern because recreation managers typically manage and have more control over settings or sites rather than activities which are chosen by visitors (McCool, 2006). For instance, the USDA Forest Service, with the consent of the U.S. Congress, can designate an area within a national forest as an official “Wilderness Area” and then manage it as such (e.g., building no roads into the area). Official Wilderness Area designation places certain restrictions on activities that can occur there (e.g., motorized recreation is prohibited), but within these restrictions visitors are free to engage in many different activities while visiting the area. For example, a trip to a wilderness (WILD) setting may include different combinations of mountain climbing, fishing, horseback riding, hiking, nature study, photography, and backpacking.

The motivation for managing settings in national forests by changing the physical, social, and managerial attributes of different sites is based on the USDA Forest Service Recreation Opportunity Spectrum (ROS) (Clark and Stankey, 1979; Driver and Brown, 1978). Under ROS, by managing certain setting attributes, managers can provide different opportunities and beneficial outcomes to enhance a visitor's recreational experience (Brown and Ross, 1982). The ROS spectrum goes from very natural and primitive settings—that provide more opportunities for solitude, risk taking, and self-reliance—to very developed and urban settings that provide more opportunities for security, comfort, and socializing (USDA Forest Service, 2015).

There are a number of studies that model primitive opportunities provided by WILD settings (Baker, 1996; Casey et al., 1995; Englin and Shonkwiler, 1995; Hellerstein, 1991; Loomis, 2000). The study described in this paper adds to the current repository of economic estimates for WILD settings, while deriving new estimates for developed and general settings in national forests. We use the travel cost method to estimate the empirical models. A visitor is viewed as choosing trips to settings based, in part, on site qualities and travel costs from home to each locale (Ward and Loomis, 1986).

Knowing the economic value of trips to particular settings can facilitate assessment of tradeoffs involving setting or site management. For example, combined with data on the quantity of trips to particular settings such as provided by NVUM results, setting-based economic value (e.g., consumer surplus) per trip estimates can help answer the question: “Should more management resources including scarce budgets and staff efforts be allocated to setting type A vs. setting type B?”

The remainder of this paper is organized as follows. In the next section we present our general theoretical framework and model. This section is followed by a presentation of the empirical model and data. Results and discussion ensue, followed by a brief summary and conclusions.

2. Theoretical model

Setting-based recreation trip demand and the value of recreation site access are estimated using the Travel Cost Model (TCM). The TCM uses costs incurred by an individual or group traveling from their origin (e.g., primary residence) to the destination as a proxy for the trip price. Price (travel cost) and quantity (number of trips) data can then be used to estimate a demand function that is applied to measure trip demand and values (Freeman, 2003).

The setting-based recreation travel cost demand function corresponds theoretically to a Marshallian demand function of the general form:

$$y_i^k = y^k(p_i, z_i, q_k). \quad (1)$$

where the dependent variable y_k represents annual trips to the k_{th} recreation setting by individual i or group i, p_i represent the full travel cost of a trip to an individual or group, z_i represents socio-economic characteristics of an individual or group including income, and q_k represents setting characteristics. Because recreation trips by nature are non-negative integers, the dependent variable in (1) takes on non-negative integer values. Thus ordinary least-squares (OLS) regression is inappropriate to estimate the demand model. The basic model that satisfies the non-negative integer, or count data process, is the Poisson model (Hellerstein, 1991).

However, when a variable is over-dispersed (i.e., the conditional mean and variance are not equal), as is often the case with recreation trips, then the Poisson model's simple parameterization must be replaced by a model which captures this over-dispersion. Such models include the Poisson lognormal model (Greene, 2007, p. 8) and the more commonly used Negative Binomial model (Greene, 2007, p. 5). The difference in these models lies in the distributional assumption of the unobserved factor, ε. The unobserved factor follows a normal distribution in the Poisson lognormal model, and a gamma distribution in the Negative Binomial model. For our analysis, we chose to model annual trips as a Poisson lognormal model.

We introduce the unobserved factor ε as a normally distributed random variable with mean zero and standard deviation σ equal to 1,

$$\begin{aligned}&\widehat{\lambda} = \exp\left(x'\beta + \sigma\varepsilon\right) \quad \varepsilon \sim N(0,1)\\&x = (p_i, z_i, q_k)\end{aligned} \quad (2)$$

The demand model and corresponding economic value estimations are governed not only by the nature of the error distribution of the demand function, but also by the sampling procedure (Haab and McConnell, 2002). The two most common sampling schemes are random sampling of the population or on-site sampling of visitors. While on-site surveys provide a convenient mechanism for insuring that a sample includes site users, the resulting sample is no longer representative of the recreationist population as a whole.

The probability distribution for the on-site visitors is different from the one specified for the general population (Moeltner and Shonkwiler, 2005). This is because of the joint effect of truncation (exclusion of non-users) and endogenous stratification (over-sampling frequent visitors). Truncation and endogenous stratification can result in biased and inconsistent estimates. To correct for this joint effect in on-site surveys, the distribution of trip data collected on-site becomes the product of the population distribution and the odds of being included in the sample (Egan and Herriges, 2006; Englin and Shonkwiler, 1995; Shaw, 1988). For our analysis, we use an adjusted Poisson lognormal model, corrected for truncation and endogenous stratification that corresponds to the univariate case in Egan and Herriges (2006) where j = 1 and h (ε) follows a standard normal distribution:

$$\begin{aligned}&g(\tilde{y}|x) = \frac{\tilde{y}}{\delta}\int \frac{\exp\left(-\widehat{\lambda}\right)\left(\widehat{\lambda}\right)^{\tilde{y}}}{\tilde{y}!}\frac{\exp\left(-1/2\varepsilon'\varepsilon\right)}{(2\pi)^{1/2}}d\varepsilon, \quad \tilde{y} = 1,2,\ldots\\&\delta = \lambda\exp\left(\sigma^2\Big/2\right)\end{aligned} \quad (3)$$

Maximum likelihood estimates for our adjusted Poisson lognormal model, corrected for truncation and endogenous stratification, are obtained by maximizing the unconditional log likelihood function with respect to the model parameters. The integrals in the log likelihood function do not exist in closed form. Therefore, we approximated these integrals using the mean–variance adaptive Gauss-Hermite quadrature approach suggested by Liu and Pierce (1994).

The corresponding mean for the adjusted Poisson lognormal model, corrected for truncation and endogenous stratification, which corresponds to Equation (23) in Egan and Herriges (2006) becomes,

$$E(\tilde{y}|x) = 1 + \delta \exp\left(\sigma^2\right). \quad (4)$$

Average consumer surplus per trip is given by the area under the demand curve (Creel and Loomis, 1990), which equates to the negative inverse of the estimated travel cost coefficient, $CS = -(1/\beta p)$. The β_p coefficient in the Poisson lognormal model has a semi-elasticity interpretation. For example, $100\beta_p$ is the semi-elasticity of the expected value of y given x with respect to p: for small changes in p (Δp), the percentage change in the expected value of y given x is roughly $(100\beta_p)\ \Delta p$ (Wooldridge, 2010).

3. Data description

Data for estimating the demand model specified above were obtained from the USDA Forest Service's NVUM program which began in 2000. During on-site interviews, information was collected from visitors on their annual number of trips to national forests (where sampled) for outdoor recreation, primary and ancillary activities on the trip, and other socio-economic variables. Home zip codes of visitors were collected for the calculation of the implicit price variable (travel cost). The original master dataset has information on all 10 USDA National Forest regions and 120 national forest units across the United States. Although there are 155 national forests, some national forests within states were combined, resulting in 120 sampling units (forests) for the NVUM survey.

The NVUM survey is based on a stratified random sampling design (English et al., 2002). Each national forest in the survey sample is divided into 12 strata according to site-type and exit use volume. Site types or settings, as described above, include DUDS, OUDS, GFA, and WILD. Site use includes Low (L), Medium (M), and High (H) based on exit volume.[1] Random samples of site-days are drawn from each stratum. During each of these site-day combinations (site type and use level), exit interviews of randomly selected groups were conducted.

Data for the Southern United States (USDA Forest Service Region 8) (Fig. 1) were selected because our study was part of the broader "Southern Appalachian Assessment" conducted through the Southern Appalachian Man and the Biosphere Cooperative.[2] Since we pooled national forests in the Southern region for estimation, our multiple-site model is similar to Ward and Beal's (2000) regional multiple-site TCM. Our pooled data represents a cross-section of visitors who were interviewed in NVUM Round 1 which started in 2000 and lasted through 2003.[3] The data includes 6126 sample observations. Table 1 provides the description of data variables and Table 2 provides summary statistics of these variables by setting type.

4. Empirical modeling

The sampling unit for NVUM is a "group," which can be a single person or a party of persons traveling together such as a family[4] (Zarnoch et al., 2005). NVUM measures recreation trips to a national forest on a 12-month basis. Trips can be either solely for the purpose of recreation or incidental. Incidental purposes may be ancillary trips (e.g., primary purpose was to visit family or another recreational site in the general area). Visitors were asked if the trip was for the primary purpose of recreation. Following TCM protocol, only visitors who were visiting for the primary purpose of recreation were included in our analysis.

Our analysis only included a post-survey selected sample of visitors as we dropped observations with annual trips greater than 52. Englin and Shonkwiler (1995) dropped observations with annual trips greater than 12, allowing one trip per month. Egan and Herriges (2006) dropped observations with annual trips greater than 52, allowing one trip per week. We found visitors with more than 52 annual trips, and those with 52 or less annual trips, came from different populations and, therefore, could not be modeled in one estimation equation because of unobserved heterogeneity in preferences (Baerenklau, 2010; Parsons, 1991).[5]

Observations with annual trips greater than 52 constitute only 9% of our total sample with 0.5% (33 observations), 7% (46 observations), 3.2% (199 observations), and 4% (249 observations) for WILD, OUDS, DUDS, and GFA settings, respectively. We did not have enough observations in our dataset to model relatively high-frequency visitors in a separate regression equation for each setting. Thus, following Egan and Herriges (2006), we dropped observations where annual trips were greater than 52.

Our empirical demand equation was specified as:

$$TRIPS_i^k = f(TC_i, SUBTC_i, PEOPVEH_i, INCOME_i, FEMALE_i, AGE_i, SITE\ EFFECTS_k, TIME\ EFFECTS) \quad (5)$$

We define our variables in Table 1 and summary statistics are presented in Table 2. Since consumer demand for recreation at different settings is characterized by heterogeneous preferences, we estimate separate demand equations and values for different settings.[6] In (3), the dependent variable ($TRIPS_i^k$) represents the

[1] The definitions of "low," "medium," and "high" use in the NVUM survey varied by national forest. For example, national forests in North Carolina defined "low," "medium," and "high" use as 6–40, 41–100, and 101–200 groups visiting a site per day, respectively. Detailed descriptions of the NVUM survey can be found at the U.S. Forest website: http://www.fs.fed.us/recreation/programs/nvum/.

[2] The data were collected at 13 national forests including Chattahoochee-Oconee, George Washington-Jefferson, Cherokee, Francis Marion, Ozark, Ouachita, Kisatchie, Daniel Boone, Land Between the Lakes National Recreation Area, National Forests of Alabama, National Forests of Florida, National Forests of Mississippi, National Forests of North Carolina, and National Forests of Texas.

[3] Future research should consider panel data models, which can take advantage of data collected in subsequent NVUM rounds (Rounds 2 and 3) not available at the time of this study.

[4] With NVUM sampling, the respondent is randomly chosen among the traveling party or group (last birthday, over 18 years old.).

[5] We conducted a maximum likelihood analogue of the Chow test to test this assumption. More formally, this tested the difference in the parameters across the two samples: High frequency visitors (>52) and lower frequency visitors (=<52). The test results for all four models were consistent with our argument that high-frequency visitors come from a different population and cannot be modeled in one estimation equation.

[6] We conducted a Chow test to test this assumption. We tested for the difference in the parameters across the four samples: WILD, OUDS, DUDS, and GFA. The test results were consistent with our argument that consumer demand for recreation at various settings is different for all four models. Our likelihood ratio test statistic has a value of 409.89 and p < 0.001. Therefore, we rejected the null hypothesis that the parameters across four settings are similar.

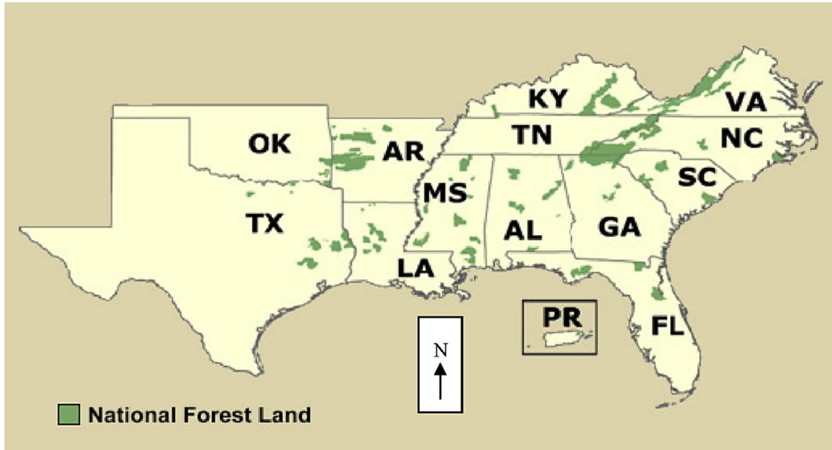

Fig. 1. Map of the southern region in the United States.
Source: USDA Forest Service

Table 1
Definition of independent variables.

Variables	Definition
Price variables	
Own Price (*TC*)	Imputed cost or price of traveling to the target recreation site in USD.
Substitute Price (*SUBTC*)	Imputed cost or price of traveling to the substitute recreation site in USD.
Socio-Economic variables	
AGE	Respondent's age in years
INCOME	Annual income in thousand USD
FEMALE	Indicator (dummy) variable which takes a value one if the respondent is a female and zero otherwise.
PEOPVEH	Number of people in the vehicle when interviewed at a recreation site.
Site-specific effects	
Site dummy 1-13	Site-Specific Unobserved Effects
Time-effects	
Time dummy 1-4	Time-Effects. Indicator (dummy) for 2000, 2001, 2002, and 2003.

Table 2
Descriptive statistics of variables included in setting model estimation.

Summary statistics/Variables		TRIPS	TC	SUBTC	INCOME	AGE	PEOPVEH
GFA	Mean	13.928	26.264	56.033	21.544	42.452	2.276
	Std. Dev.	13.616	42.441	46.350	7.462	13.346	1.276
	Min	1.000	0.000	5.596	9.910	17.500	1.000
	Max	52.000	403.810	372.817	90.831	75.000	10.000
OUDS	Mean	7.719	28.387	56.566	22.448	42.684	2.719
	Std. Dev.	9.808	36.647	39.925	8.034	12.927	1.387
	Min	1.000	0.205	7.126	9.033	17.500	1.000
	Max	52.000	334.907	441.173	106.902	75.000	10.000
DUDS	Mean	9.648	33.777	64.439	22.803	42.038	2.799
	Std. Dev.	12.373	52.786	54.920	9.390	13.590	1.552
	Min	1.000	0.000	5.596	8.006	17.500	1.000
	Max	52.000	745.278	759.328	161.766	75.000	10.000
WILD	Mean	7.349	37.806	63.262	26.015	38.618	2.642
	Std. Dev.	9.712	39.563	42.502	11.734	12.439	1.432
	Min	1.000	0.201	5.596	12.409	17.500	1.000
	Max	52.000	358.215	444.114	129.084	75.000	10.000

annual number of trips from group i to setting k in a specific national forest. Socio-economic variables include the number of people in the vehicle ($PEOPVEH_i$), annual group income ($INCOME_i$), age (AGE_i), and an indicator for a female survey respondent ($FEMALE_i$).

Unfortunately, the NVUM first-round survey did not collect income information from respondents due to government privacy restrictions. To provide a rough proxy for group income, U.S. Internal Revenue Service (IRS) data on adjusted gross income, tax returns, and zip code for Tax Year 2002 were used.[7] Thus, income ($INCOME_i$) is represented by the average after-tax income as reported by the IRS for the zip code in which the person interviewed resides. The price of a recreational trip is equal to travel costs for

[7] Future studies should attempt to use a more accurate measure of group income (which could be composed of just one person) such as would result from, for example, directly asking an income question in the survey.

group i (TC_i) estimated as the sum of driving and time costs following the equation[8]:

$$TC^i = Dist.*\$0.131/mile + 0.33*\frac{Income}{2000}*\frac{Dist.}{40mph} \quad (6)$$

In (4), driving costs are a function of round-trip distance (*Dist.*)[9] from a group's origin to the destination, the average operating costs per mile for a typical sedan-type car in 2003 of $0.131/mile as defined by the American Automobile Association (AAA, 2003) and the number of passengers per vehicle. Time costs are a function of travel time estimated by dividing round-trip distance by an average speed of 40 mph (Rosenberger and Loomis, 1999) and the opportunity cost of time, which was evaluated at one-third of the wage rate (Baerenklau, 2010). The wage rate was estimated by dividing the proxy income measure described above per annum by 2000 based on a 40-h week for 50 weeks in a year (Hynes and Greene, 2013). All three variables (round-trip distance, income, and time) are considered exogenous.

We did not include on-site time in our travel cost calculations. On-site time is both a cost and an input to the final utility gained from recreation. McConnell (1992) shows that if an individual chooses on-site time, then standard estimation and welfare calculations continue to hold. In recent work, Landry and McConnell (2007) provide an estimation of a hedonic price relationship between on-site cost and quality associated with on-site time.

The distance from a visitor's zip code of origin to the nearest national forest other than the interview site (*Sub.Dist.*)[10] was used to construct the following substitute price proxy:

$$SUBTC^i = Sub.Dist.*\$0.131/mile + 0.33*\frac{Income}{2000}*\frac{Sub.Dist.}{40mph} \quad (7)$$

Site-specific effects ($SITE\ EFFECTS_k$) are included to capture unobserved site-specific heterogeneity. In recreational demand models, these site-specific effects could be attributes of a particular site which are unobserved. Murdock (2006) mentions site characteristics for fishing including regulations, water quality, fish consumption advisories, physical characteristics, adjacent land use, and the presence of facilities. Time effects (*TIME EFFECTS*) are included to control for shifts in demand from 2000 to 2003.[11]

[8] Entrance fees are also a legitimate trip cost. We know that some of the DUDS and OUDS settings in our dataset charge entrance fees. However, we were not able to incorporate entrance fees into our travel cost variable because data on entrance fees at these sites were not collected in the NVUM survey. In the NVUM survey, the sampling unit was a recreational group, which is why the dependent variable in (11) represents trips per group (where a group can be composed of one person or multiple persons, such as a family). Similarly, the dependent variable in (12) represents travel cost per group (NVUM sampling unit).

[9] The *Dist*. variable is constructed using PCMILER software to generate a one-way distance from home zip code to the sample forest point latitude-longitude using road distances; for the 2004 data series, the self-reported one-way distance was used instead of the PCMILER distance. For observations where the Forest Service-generated latitude-longitude was missing, the Geographic Names Information Service (GNIS) forest geolocation information was used to calculate distances.

[10] A substitute distance variable is constructed using the GNIS latitude-longitude for each national forest in the NVUM sample. This information was used to construct a substitute distance (*Sub.Dist.*) variable that provides one-way distance from the individual's home zip code to the next nearest national forest not visited. The substitute variable construction assumed that for each national forest visitor the relevant substitute site would be the nearest national forest to the visitor's origin, exclusive of the national forest visited on the current trip.

[11] We conducted a joint significance test for time and site effects. Our results are statistically significant at the 1% level. Time and site effects are jointly significant in explaining trips to settings. We have, therefore, retained time and site effects.

5. Results and discussion

5.1. Estimation results

Table 3 provides the estimation results for the adjusted Poisson lognormal models for each setting corrected jointly for truncation and endogenous stratification.[12] We report the Akaike information criterion (AIC) and the Bayesian information criterion (BIC).[13] The adjusted Poisson lognormal model provides the best fit to the observed data because it minimized the AIC and BIC. In order to adjust for site heterogeneity, we estimated a site-specific fixed effect model for each setting.[14] Results without site-specific effects are reported in Table A1.

The variance−mean ratio for the trip variable and the likelihood ratio test indicated the presence of over-dispersion in all four setting-based recreation demand models. The variance−mean ratio was 13.312, 12.462, 15.869, and 12.834.[15] The likelihood ratio based over-dispersion test with chi-square values of 1200, 7969, 1400, and 3533 for GFA, OUDS, DUDS, and WILD, respectively, exceeded the critical value for the presence of over-dispersion in our demand models, thus rejecting the null hypothesis of equi-dispersion at a 1% significance level for all models.

For all four models, the negative and significant estimated coefficients for own travel costs indicate that the number of trips is inversely related to own travel costs for each model. An increase in travel costs by one unit reduces trips by 0.75%, 1.01%, 1.19%, and 1.24%, respectively, for the WILD, DUDS, GFA, and OUDS models. The relatively lower marginal effect of travel costs for DUDS and GFA compared to OUDS trips may be because trips to the former tend to be more frequent and of shorter duration compared to trips to the latter. However, comparison of WILD results with the OUDS model is counter-intuitive. The estimated coefficient on the travel cost variable for the WILD model is relatively lower as compared to the OUDS model, despite WILD trips being less frequent than OUDS trips. This is corroborated by our summary statistics (Table 2) and also predicted trips to the WILD settings (Table 3). This may be a

[12] The Ns for the four models do not sum to the original 6126 observations because of adjustments made for trips which were not for the primary purpose of recreation, outliers, and missing data for some independent variables which resulted in it being dropped from the estimation (see 4. Empirical Modeling section.).

[13] Our AIC and BIC values for On-site Poisson lognormal model are 32,364 and 32,560.88 respectively. Corresponding values for the on-site Negative Binomial model are 32,790 and 32,986.88 respectively. We have reported these values assuming one model for all settings.

[14] We tested a varying parameter specification for all four models. This specification included quality variables and interaction of quality variables with the travel cost variable. Our quality variables for undeveloped settings included the following: miles of trails in a national forest as a proxy for access to GFA (*TRAILS*) and acres of designated wilderness area in a given national forest (*DESIGW*) as a proxy for access to WILD areas. Quality variables for undeveloped settings included the total number of tent camping sites in a national forest (*TENT*) for the OUDS model, total number of recreation areas in a national forest with picnic tables as a proxy for total number of day-use sites (*PICNICTAB*), and total number of recreation areas in a national forest with swimming areas as a proxy for high attraction day-use sites (SWIMMING). With these specifications, we generally did not find evidence that changes in site quality significantly changed consumer surplus, at least for the specific site quality characteristics included in our models. On the recommendation of an anonymous reviewer, we therefore included the site-fixed effects instead of specific site quality variables. The benefit of including site-fixed effects is that the estimated parameters will not suffer any bias due to unobserved site-specific heterogeneity. This would not be a major loss as the focus of the paper is to identify the economic value of trips to different settings. In future research, more specific and perhaps appropriate site quality variables such as forest elevation, types of trees, and miles of streams might result in statistically significant effects of changes in site quality on the economic value of trips to different setting types.

[15] These values are calculated by squaring standard deviation reported for the variable TRIPS and dividing by its mean for each setting.

Table 3
Estimated travel cost demand coefficients for recreation trips to different recreational settings in southern U.S. National forests.†

Variables	WILD	OUDS	DUDS	GFA
TC	−0.00748***	−0.0124***	−0.0101***	−0.0119***
	(0.00210)	(0.00171)	(0.00133)	(0.00147)
SUBTC	−0.00328	0.00564***	0.00148	0.00549***
	(0.00209)	(0.00188)	(0.00141)	(0.00157)
INCOME	−0.00159	−0.0150***	−0.0150***	−0.0150***
	(0.00386)	(0.00425)	(0.00358)	(0.00425)
FEMALE	−0.117	−0.187***	−0.0754	−0.223***
	(0.0886)	(0.0652)	(0.0587)	(0.0720)
AGE	0.00750**	−0.000321	−000004	0.00162
	(0.00312)	(0.00234)	(0.00204)	(0.00200)
TIME1	0.120	0.0935	−0.0369	−0.203
	(0.138)	(0.132)	(0.0967)	(0.134)
TIME2	−0.0808	0.00564	0.204	0.0589
	(0.197)	(0.112)	(0.133)	(0.118)
TIME3	0.322*	−0.201**	0.353***	−0.0389
	(0.175)	(0.0984)	(0.100)	(0.0845)
PEOPVEH	−0.0903***	−0.0444**-	−0.0732***	−0.104***
	(0.0283)	(0.0219)	(0.0178)	(0.0215)
SITE1	−0.151	0.170	0.112	0.0928
	(0.262)	(0.198)	(0.240)	(0.287)
SITE2	0.377	0.317*	0.243	0.386*
	(0.257)	(0.179)	(0.225)	(0.211)
SITE3	0.433*	0.682***	0.725***	0.322
	(0.263)	(0.228)	(0.226)	(0.227)
SITE4	0.591**	0.178	0.335	0.114
	(0.281)	(0.175)	(0.219)	(0.213)
SITE5	−0.226	0.170	0.666***	0.480
	(0.284)	(0.243)	(0.231)	(0.441)
SITE6	0.488	0.176	0.0915	0.111
	(1.013)	(0.230)	(0.261)	(0.274)
SITE7	−0.0989	0.524***	0.463*	0.346
	(0.346)	(0.182)	(0.241)	(0.222)
SITE8	0.371	0.274	0.697***	0.235
	(0.247)	(0.176)	(0.214)	(0.211)
SITE9	0.125	0.372**	−0.290	−0.150
	(0.316)	(0.179)	(0.236)	(0.226)
SITE10	−1.250	0.388**	−0.254	0.516**
	(0.982)	(0.197)	(0.226)	(0.225)
SITE11	−0.209	0.168	−0.141	−0.196
	(0.316)	(0.219)	(0.243)	(0.243)
SITE12	0.254	0.611***	0.409*	0.298
	(0.258)	(0.209)	(0.224)	(0.218)
Constant	1.754***	1.820***	2.119***	2.532***
	(0.288)	(0.230)	(0.239)	(0.238)
Sigma	.8507***	.9127***	.975***	.927***
	(.030)	(.023)	(.021)	(.021)
Observations	710	1294	1746	1472
Number of id	710	1294	1746	1472

Standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1.
†Note: GFA, OUDS, DUDS, and WILD are acronyms for: General Forest Area, Overnight Use Developed Setting, Day-Use Developed Setting, and Designated Wilderness, respectively. Results without site-specific effects are included in the Appendix.

result of WILD regions being relatively more remote and less accessible.

The estimated coefficient on the substitute price variable is positive for the OUDS, DUDS, and GFA models. For the WILD model, the coefficient is negative, but statistically insignificant. A positive coefficient on the substitute price variable suggests that an increase in the price of travel to a substitute site increases demand for trips to the target (primary) site. Such a result is consistent with economic theory related to substitute price relationships for normal goods.

Among socio-economic variables, the estimated coefficient on a respondent's age is statistically insignificant across all models except the WILD model where the coefficient on the age variable is positive and statistically significant. This result seems counter-intuitive since wilderness recreation likely involves more physically challenging activities such as hiking longer distances to gain access to primitive camping sites. The coefficient on the indicator variable for female visitors is negative across all models. However, it is statistically significant only in the OUDS and GFA models. These two models suggest that female respondents, on average, take 19% and 22% fewer trips *ceteris paribus*, than male respondents to OUDS and GFA settings, respectively.

The estimated coefficient on the variable representing number of people in the vehicle is negative and statistically significant across all setting models suggesting that, as group size increases, the number of annual trips decreases. This result appeals to intuition as it seems likely that larger groups, such as a big family, would tend to take fewer outdoor recreational trips per year compared to smaller groups such as a small family (including couples with no children and individuals.)

The estimated coefficient on the income variable is negative across all settings. If recreational trips to a national forests are normal goods, we expect an increase in income to have a positive marginal effect on trips demanded. However, many travel cost studies have found negative or insignificant income coefficients (Creel and Loomis, 1990; Rockel and Kealy, 1991; Yen and Adamowicz, 1993). In our study, the fact that income is integral in formulating the travel cost variable might have some confounding statistical effects. Also, the negative income coefficient may just be an artifact of our limited IRS-based income data, particularly considering this variable was not statistically significant across all models. In future studies, individual or household-specific income data (e.g., when a group is defined as a family) may produce different, more theoretically consistent, and statistically significant results.

5.2. Recreation trip demand and value

Using the estimated recreation demand models for the four settings, we estimated the average trip demand for selected national forest visitors in our sample. The estimates show an average predicted recreation trip demand of 7, 8, 9, and 15 trips per group for WILD, OUDS, DUDS, and GFA settings, respectively. The estimates show a relatively higher average trip demand for GFA settings. Shrestha et al. (2007) also found similar results for undeveloped recreational sites in the Apalachicola River region in Florida.

Using the estimated demand models for each setting type and the accepted calculation for consumer surplus ($-1/\beta$), we estimated the mean economic value (consumer surplus) per group per trip for selected visitors[16] to the different setting types in Region 8 national forests. These value estimates, along with their associated 95% confidence intervals, are reported in Table 4. Confidence intervals were estimated using the Delta method (Oehlert, 1992.)

Consumer surplus (CS) per group per trip was estimated at approximately $176, $107, $130, and $111 for WILD, OUDS, DUDS, and GFA settings, respectively (Table 4). Also reported in Table 4 is consumer surplus per person per trip, derived by dividing the group value by reported group size for each observation, and then averaging across all observations. Note that all CS values calculated in this study are in 2015 dollars, and all estimates obtained from Loomis (2000) and Rosenberger and Loomis (2001) were also converted to 2015 dollars. The confidence intervals suggest that all CS values are statistically different from zero, and that trips to WILD settings have the highest (and statistically different) consumer surplus value compared to the other three setting types.

Our consumer surplus estimates for setting-based recreation are

[16] Consumer surplus estimates only apply to visitors who trip 52 times or less over a 12-month period.

Table 4
Consumer surplus per group and person per trip to different recreational settings in southern U.S. national forests (2015 US dollars.)†.

	Settings			
	WILD	OUDS	DUDS	GFA
Consumer surplus/trip	$176.38	$106.73	$130.17	$110.95
95% CI	$ 79.48	$ 77.80	$96.70	$ 84.06
	$273.29	$135.59	$63.64	$137.84
Consumer surplus/person/trip	$85.76	$49.73	$62.09	$63.15

†GFA, OUDS, DUDS, and WILD stand are acronyms for: General Forest Area, Overnight Use Developed Setting, Day-Use Developed Setting, respectively. Consumer surplus estimates only apply to visitors who visit 52 times or less over a 12-month period.

reported on a per trip basis. A relatively high CS per trip in our study may be attributable partly to multi-day trips. Using mean length of the recreation trip in days, we obtain a more reasonable CS estimate per day. Since this information is not available for our dataset because of the large number of missing values, we use the most recent national NVUM report (2012) for mean length of recreational trips in days for different settings (USDA Forest Service., 2013). According to this report, the average length of stay for trips is 11.4 h, 43.4 h, 9.5 h, and one day (by definition) for WILD, OUDS, GFA, and DUDS, respectively.

Our average CS estimate of about $86 per person per trip day suggests a somewhat higher average value of wilderness recreation access in our study region compared to previous research with an average value of $60, and ranging $3 - $330, per person per day reported in the Loomis (2000) review. However, our average value estimate is well within the Loomis (2000) range of value estimates.

Although our estimates are for multi-activity trips, for comparison purposes we also discuss how our estimates relate to single-activity trip estimates presented in previous studies.

Our average CS value of about $50 per person per trip to OUDS converts to about $28 per person per day. A major activity at OUDS is camping. In a comprehensive review of recreational valuation studies conducted by Rosenberger and Loomis (2001), the average estimated value per person per day for camping across 22 previous studies was about $46 with a range of $3 to $283.

GFA settings in national forests are, for the most part, undeveloped (except most may have gravel roads and rough trails) with hunting being a primary use, especially in the Southern United States. The average value per person per day for big and small game hunting reported in the Rosenberger and Loomis (2001) review is about $60 with a range from about $6 to $320. Thus, our estimated value of about $63 per person per trip (or day) for GFA recreation compares very well to the average value of hunting per person per day reported in Rosenberger and Loomis (2001).

In our study, trips to day-use developed sites are one-day trips by definition. A major activity at DUDS in national forests is picnicking. The average value per person per day for picnicking reported in the Rosenberger and Loomis (2001) review is about $53 with a range from about $11 to $180. Thus, our estimated value of about $62 per person per day for DUDS recreation compares very well to the average value of picnicking per person per day reported in Rosenberger and Loomis (2001).

6. Summary and conclusions

We estimated trip demand and value for selected visitors to four settings in Southern U.S. national forests. Estimated average annual trips and values per person per trip varied across the four setting types modeled. We find evidence that value per person per trip is highest for WILD which represents designated wilderness settings. In the case of wilderness settings, higher economic value perhaps suggests that fewer substitutes are available. Within the ROS framework, this may be because visitors desire a unique experience opportunity for solitude, challenge, and self-reliance in a pristine setting.

A key message of this study is that land managers typically manage settings and not activities, especially on a long term or strategic basis. While there are obviously many societal benefits accruing from public lands, recreation benefits constitute a major share. Long term planning to optimize all benefits (and costs) requires information on recreation benefits and how they may vary by altering the provision of forest settings. Two ingredients are necessary from the benefits side. First, managers need to know how visitation is affected. On-site surveys like NVUM can directly provide such information.

Second, information on the value per unit of visitation to a setting is required to combine with the visitation estimates to provide total benefit estimates that can be compared across setting types. In the case of WILD, the higher per visitor per day recreation value must be balanced with a much lower density of use. An advantage of the setting-approach for calculating total benefits is that unlike indirect approaches it precludes the need to estimate proportions of activities by setting, especially when most recreation visitors or groups typically engage in multiple activities per visit.

As a caveat, because of data limitations encountered in this study including relatively weak income and site quality variables, we urge caution in the application of our estimated economic values in policy and management. Additional research with better data is needed to confirm the external validity of our specific recreation setting value estimates. Future setting-based studies, along with the present study and other previous setting-based studies, will produce a library of valuation estimates. This library can facilitate USDA National Forest and other natural area policy and management, for example, by providing information for comparing the economic benefits and costs of a spectrum of recreational opportunities and experiences from primitive/rural to modern/urban.

Appendix

Table A1
Regression results for on-site poisson model with time effects.

	WILD	OUDS	DUDS	GFA
TC	−0.00333*	−0.0102***	−0.00986***	−0.00926***
	(0.00172)	(0.00131)	(0.00112)	(0.00115)
SUBTC	−0.00908***	0.00335***	0.000101	0.00169*
	(0.00153)	(0.00121)	(0.00103)	(0.00101)
INCOME	0.00257	−0.0147***	−0.00899**	−0.0144***
	(0.00363)	(0.00412)	(0.00349)	(0.00417)
FEMALE	−0.165*	−0.191***	−0.137**	−0.256***
	(0.0888)	(0.0644)	(0.0595)	(0.0717)
AGE	0.00694**	−0.000378	−0.00115	0.000781
	(0.00310)	(0.00234)	(0.00207)	(0.00202)
PEOPVEH	−0.105***	−0.0482**	−0.0851***	−0.105***
	(0.0282)	(0.0216)	(0.0180)	(0.0218)
TIME1	0.0209	0.0767	0.101	−0.169
	(0.0931)	(0.107)	(0.0793)	(0.104)
TIME2	−0.200	−0.00608	−0.133	−0.0920
	(0.164)	(0.0943)	(0.124)	(0.104)
TIME3	0.196	−0.191**	−0.154**	−0.123*
	(0.146)	(0.0791)	(0.0690)	(0.0664)
Constant	2.137***	2.199***	2.508***	2.918***
	(0.179)	(0.158)	(0.134)	(0.134)
sigma	.945***	.923***	1.007	.945***
	(.021)	(0.023)	(.021)	(.021)
Observations	710	1294	1746	1472
Number of id	710	1294	1746	1472

Standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1.

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