A Travel Cost Analysis of Nonconsumptive Wildlife-Associated Recreation in the United States

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ABSTRACT. Increased emphasis on sustainable resource management in forestry has effectuated a demand for various nontimber values. Nonconsumptive wildlife recreation is an important nontimber service produced on forest and rangeland. Travel cost models and data from the 1991 National Survey of Fishing, Hunting and Wildlife-Associated Recreation are used to estimate the demand and value for nonconsumptive wildlife-associated recreation in the United States. Resulting welfare measures are shown to be sensitive to assumptions about the cost of travel time, pecuniary costs, and functional form. Consumer surplus estimates range from 18.7 to 327.5 dollars per trip, while aggregate estimates of consumer surplus resulting from access to nonconsumptive wildlife recreation range from 5.8 to 66.4 billion dollars annually. Availability of information about nonparticipants allows comparison of truncated and untruncated demand models. Contrary to previous findings, consumer surplus estimates from truncated models are smaller than for untruncated counterparts. Trip demand is found to be adversely affected by per capita decreases in forest and rangeland. Models include interaction variables to avoid forcing hunting or fishing as potential substitutes for the large number of people who do not hunt or fish. Hunting and nonconsumptive wildlife recreation are complementary activities, while the results for fishing are mixed. For. Sci. 46(4):496–506.

Additional Key Words. Nontimber values, wildlife recreation, travel cost, truncation, consumer surplus, substitute activities.

An increasingly diverse society is placing greater demands on public forests for a wide variety of products, both traditional and nontraditional, priced and unpriced (Dennis 1998). These products cover a broad spectrum including biodiversity, forest health, wood products, wildlife habitats, and recreation opportunities. Moreover, multiple-use management on public forestland is mandated by the Multiple-Use and Sustained Yield Act of 1960, as well as the Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA) and the National Forest Management Act of 1976 (NFMA). These laws require that nontimber outputs, such as preservation, wildlife, and outdoor recreation, be considered along with timber in resource allocation decision-making on national forests (Pearse and Holmes 1993). Hence, resource managers are faced with decisions that balance society's diverse needs, wants, and values while trying to ensure long-run ecosystem sustainability and integrity. This can often lead to conflict and litigation as individuals and stakeholder groups differ markedly over the choice of management strategy and the resulting output mix. Managers therefore need information that provides quantifiable measures of public preferences and values associated with different management outcomes to make effective planning and policy decisions.

Many forest outputs are not traded in markets, and prices are thus unavailable as indicators of value. To evaluate tradeoffs between market and nonmarket goods in resource management, a number of methods have evolved. The methods fall into two basic categories, those that rank outcomes and those that obtain monetary values. Conjoint analysis is one ranking method which has been applied to forest management with some success. Zinkhan et al. (1997) describe

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the technique as a survey method that measures the joint effect of two or more product or service attributes on consumer preferences in utility units. They demonstrate the use of the technique on a hypothetical forest in which an optimal park design is developed based on a sample's preferences for accommodations, fees, boat launch access, and wildlife habitat. Dennis (1998) uses conjoint analysis, based on a sample of area residents, to identify an optimal management level for such attributes as timber harvesting, wildlife habitat, hiking trails, snowmobile trails, and ORV trails in a portion of the Green Mountain National Forest.

Alternatively, money metrics of value for nonmarket goods may be desired. While variations of conjoint analysis have been developed to estimate monetary values for forest attributes (Holmes et al.1998), two more popular methods used to estimate monetary values for nonmarket goods are the contingent valuation method (CV) and the travel cost method (TC). Both methods estimate consumer surplus or net willingness to pay. As a benefit or welfare measure, consumer surplus is the amount by which an individual's willingness to pay for a good exceeds what the individual must pay for the good. While not directly comparable to market price, consumer surplus is accepted for use in benefit/cost calculations which comprise part of the economic efficiency analyses done for RPA planning (Pearce and Holmes 1993, USDA Forest Service 1995).

In CV studies, individuals are directly queried about their willingness to pay for a good or service. The technique has been applied in forest-related research to value such things as tradeoffs between old growth habitat for the spotted owl and timber harvesting (Rubin et al. 1991), pine beetle damage to recreation sites in the Colorado Rocky Mountains (Walsh et al. 1989), and reducing fire risk in old growth forests (Loomis and Gonzalez-Caban 1998). The hypothetical nature of CV allows it to be used to compare existing situations to proposed alternatives and also to estimate less tangible entities like existence, option, and bequest values (Pearse and Holmes 1993). However, CV's hypothetical nature can also lead to criticism about its validity.

In this study, the travel cost method is used with data from the 1991 National Survey of Fishing, Hunting and Wildlife-Associated Recreation to estimate demand for and value of nonconsumptive wildlife-associated recreation access in the United States. Unlike CV, the travel cost method is based on actual behavior. The technique relies on establishing a relationship between the costs incurred by travelers to a site and the number of trips taken. Hof (1993, p. 54) demonstrates that this relationship can be exploited to derive consumer surplus for access to a site or for a given experience. TC has been used extensively in forest-related recreation research to value site access as well as changes in site quality (Walsh et al. 1989, Richards et al.1990, Mendelsohn et al. 1992, Christensen et al. 1993, Casey et al. 1995, Englin et al. 1996, Boxall et al. 1996). The technique is not without shortcomings, many of which are discussed herein. Moreover, unlike the conjoint and CV methods which can be used to obtain off-site values, TC is limited to applications involving site use.

Nonconsumptive wildlife-related recreation is very popular. For example, 76.1 million people participated in nonconsumptive wildlife-related recreation in 1991, spending a total of $18.1 billion (USDI 1993). Nationally, Bowker et al. (1999) project a 61% increase in participants and a 97% increase in days spent on nonconsumptive wildlife recreation annually over the next 50 yr. However, most economic studies of wildlife have focused on hunting and fishing (see for example, Kealy and Bishop 1986, Balkan and Kahn 1988, Creel and Loomis 1990, Luzar et al. 1992, Yen and Adamowicz 1993, Sarker and Surrey, 1998). Bergstrom and Cordell (1991) use a zonal TC and the Public Area Recreation Visitors Study data to estimate the national net economic value per day of various outdoor activities including wildlife observation. Rockel and Kealy (1991) use the travel cost method (TC) and the 1980 National Survey of Fishing, Hunting, and Nonconsumptive Wildlife-Associated Recreation to estimate the average annual willingness to pay for access to nonconsumptive wildlife recreation in the United States. Boyle et al. (1994) use contingent valuation and the 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation to estimate the net economic value of nonconsumptive recreation per day in each state. Bayless et al. (1994) use a variation of the individual TC method to estimate the demand and consumer surplus for wildlife viewing trips.

The primary objective of this study is to estimate the demand and annual consumer surplus for access to nonconsumptive wildlife recreation in the United States, in aggregate and on a per trip basis. These numbers should be of interest to resource managers in at least a couple of ways. First, qualitative differences among forests notwithstanding, per trip estimates of consumer surplus can be used in benefit-cost analyses as a first approximation for the benefits of providing wildlife viewing access. Second, understanding more about the underlying structure of demand allows managers a better understanding of potential market shifts resulting from policy or demographic shifts.

As secondary objectives, a number of methodological issues are addressed that should be of interest to researchers working with travel cost models in nonmarket valuation. These issues fall into two categories. The first deals with researcher-imposed judgments such as the opportunity cost of time, composition of travel costs, and specification of substitute activities. While a number of studies have explored these issues (Wilman and Pauls 1987, Rockel and Kealy 1991, Layman et al.1996, English and Bowker 1996) and they are unlikely to be fully resolved any time soon, this study provides some guidance in dealing with them. The second category pertains to the extrapolative reliability of truncated demand models. Recreation demand estimation is complicated when information about nonparticipants is unavailable. Data on recreation trips that include only participants are truncated at zero. Creel and Loomis (1990) demonstrate that failure to account for truncation can lead to bias. Truncated models have evolved to address this problem. However, the reliability of these models has been questioned (Yen and Adamowicz 1993). They find that truncated recreation demand models lead to overestimates of consumer surplus. In this study, the extrapolative reliability of truncated models is further explored by comparing results from untruncated models on an untruncated portion of the data to results from truncated models on a truncated portion of the data. The findings are somewhat contrary to those of Yen and Adamowicz (1993).

Data Source

The nonconsumptive portion of the 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR) is the primary source of data for this study. A detailed description of the survey can be found in USDI Fish and Wildlife Service (1993). It is collected in two phases and serves as the major source of information on national wildlife use. The first phase is a screening interview in which households provide socioeconomic information and identify wildlife-related recreation participants. The second phase is focused on selected participants from the screening survey. Here, detailed information is collected about participation and expenditures on hunting, fishing, and nonconsumptive wildlife recreation. The nonconsumptive portion encompasses those in the screening survey who indicated participation or potential participation in nonconsumptive wildlife recreation. Data are collected for residential and nonresidential participation. Nonresidential nonconsumptive wildlife recreation consists of trips taken by those 16 yr or older to a site at least 1 mi from the home for the primary purpose of observing, feeding, or photographing wildlife. Residential nonconsumptive wildlife recreation must be done within 1 mi of home and also includes maintaining natural areas or plantings for wildlife.

To reduce recall bias, respondents were interviewed three times during 1991, a change from previous surveys that were conducted only once per year. Each observation in the screening survey includes a weight that reflects the number of people in the general population represented by that observation. Several adjustments were made to this weight in the detailed survey, including one to account for the overrepresentation of nonconsumptive participants in the second phase sample. The nonconsumptive portion of the survey contains 22,723 observations. These observations represent 76.1 million people, or the 40% of the population of the United States in 1991 who participated in residential and nonresidential nonconsumptive wildlife recreation.

Empirical Model

Although the demand for a site or experience may be modeled as aggregate or market demand, the most common practice is to estimate demand at the level of the individual and to calculate aggregate value as the sum of the individuals' values (Freeman 1993, p. 445). Value is usually approximated by consumer surplus, which is the integral of the area beneath the individual's demand curve and above the price. In lieu of an identifiable market price, average trip expenditure is used. As Freeman (1993, p. 456) shows, this model has been extended wherein all observations to multiple sites are modeled with a single equation. Using the same approach, Rockel and Kealy (1991) were the first to estimate a national TC model of the demand for nonconsumptive wildlife recreation. The conceptual model used in this study is comparable in that one equation is used to estimate the national demand for recreation trips. The general specification of demand for recreation trips is:

$$Y_{ij} = f\,(\,C_{ij}, S_{ij}, R_j, D_j\,) \tag{1}$$

where Y_{ij} is the number of trips by the ith individual to state j, C_{ij} is the cost of ith individual's trip to state j including time cost, S_{ij} is the ith individual's substitute variables including costs of alternate activities in state j and cost of nonconsumptive recreation in alternate states, R_j is resource supply information for state j, and D_i is a vector of socioeconomic variables for individual i.

The dependent variable is the number of trips taken by an individual to a given state for the primary purpose of observing, feeding, or photographing wildlife. Due to data limitations, the procedure used by Rockel and Kealy (1991) is followed, wherein destinations are aggregated to the state level. Because some respondents took trips to more than one state, trips to additional states are counted as separate observations.

Rockel and Kealy (1991) model participation using linear and semilog functional forms of Heckman and Cragg models, which correct for sample selection bias. Since their study however, count data models have become the standard in recreation demand estimation (Creel and Loomis 1990, Yen and Adamowicz 1993). These models account for the integer nature of trips by modeling the number of trips taken as a result of a series of discrete choices. Thus, they account for distributions that are discrete and nonnegative. Ordinary least squares leads to bias under these conditions (Hellerstein 1991). Hellerstein and Mendelsohn (1993) state that, "given their strong econometric properties and sound theoretical foundation, in many circumstances count models should become the model of choice." An advantage of count data models listed by Windelmann (1994) is that they naturally account for heteroskedasticity and the skewed distributions of nonnegative data.

Negative binomial and Poisson count data models are considered for this study. The choice between negative binomial and Poisson models is based on the presence of overdispersion in the data. Following Yen and Adamowicz (1993), the negative binomial probability distribution can be represented as:

$$P(Y_i = y_i; y_i = 0,1,2\ldots) = \frac{\Gamma(y_i + 1/\alpha)}{\Gamma(y_i + 1)\Gamma(1/\alpha)}(\alpha\lambda_i)^y i(1+\alpha\lambda_i)^{-(y_1+1/\alpha)} \tag{2}$$

where $\lambda_i = \exp\,(\,ß\,, C_i, S_i, R_i, D_i)$, ß is a vector of coefficients, Γ represents the gamma function, α is the over-dispersion parameter, the expected value, $E(Y_i)$, is λ_i , and the variance, $\mathrm{Var}(Y_i)$ is λ_i $(1 + \alpha\lambda_i)$. An asymptotically significant α indicates the presence of overdispersion, making the negative binomial model appropriate. When the overdispersion parameter α is zero, both $E(y_i)$ and $\text{Var}(y_i)$ are equal to λ_i, and the Poisson model is appropriate (Yen and Adamowicz 1993).

When the data come from a truncated distribution, the mean function of the count data model is misspecified. Creel and Loomis (1990) state that using an untruncated estimator on truncated data will result in "biased and inconsistent" parameter estimates. When the data are truncated, the probability distribution applies only to values above zero. Grogger and Carson (1991) present count models for truncated data. A zero-truncated negative binomial probability distribution is represented as:

$$P(Y_i = y_i; y_i = 1,2,3\ldots) = \frac{\Gamma(y_i + 1/\alpha)(\alpha\lambda_i)^{y_i}(1+\alpha\lambda_i)^{-(y_i+1/\alpha)}}{\Gamma(y_i+1)\Gamma(1/\alpha)P(Y_i > 0)} \quad (3)$$

where

$$P(Y_i = 0) = (1+\alpha\lambda_i)^{-(1/\alpha)}$$
$$P(Y_i > 0) = 1-(1+\alpha\lambda_i)^{-(1/\alpha)}$$
$$E(Y_i) = \frac{\lambda}{1-(1+\alpha\lambda_i)^{-1/\alpha}}$$
$$\text{var}(y_i) = \frac{E(y_i)[1-(1+\alpha\lambda_i)^{-1/\alpha}]^{1+\alpha}E(y_i)}{[(1+\alpha\lambda_i)^{-1/\alpha}]^{\alpha}}.$$

Truncated estimators may be appropriate when the objective is to estimate economic value for a known group of users (Loomis et al. 1991). However, truncated estimators may not be appropriate when the goal of the study is to extrapolate the demand to the general population because nonparticipants may not have the same demand parameters as participants (Hellerstein 1991). In a travel cost study of big game hunting in Canada, Yen and Adamowicz (1993) compare truncated estimators based on truncated data and untruncated estimators based on untruncated data collected from bighorn sheep license holders in Alberta. They find much larger consumer surplus estimates with wider confidence intervals from their truncated estimators. They suggest that the cost of collecting additional information on nonparticipants may be relatively small compared to the benefits of more accurate and precise economic value estimates that untruncated models provide.

Survey respondents to the nonconsumptive wildlife recreation portion of the FHWAR can be classified into one of two groups, trip takers and those choosing not to. Those not taking trips are residential wildlife consumers only (i.e., they observe, photograph or feed wildlife, or maintain natural areas or plantings specifically for wildlife within 1 mi of their home). However, they are assumed to be part of the relevant population for potential participation in nonresidential activities. Those who are neither trip takers nor residential wildlife consumers are not considered as potential market entrants. An untruncated estimator is applied to the entire data set (trip takers and nontrip takers) to estimate a travel cost demand function from which consumer surplus can be derived. Alternatively, a truncated estimator is used to estimate a demand function for the portion of the data set consisting of only nonresidential participants (trip takers). This comparison allows testing whether Yen and Adamowicz's results are generalizable.

Independent Variable Construction

Variables included in the analysis are listed in Table 1. The cost of a trip is constructed by dividing the individual's total number of trips in a particular state into her total expenditures in that state. Because of discrepancies in the literature about which trip costs to include (English and Bowker 1996), the model is estimated with two versions of this variable. Full cost (TRIPCOSTF) includes food, lodging, transportation, and fees, which include guide fees, access fees, pack trip, and equipment rental. Reduced cost (TRIPCOSTR) includes what are considered the minimum necessary costs of a trip, which are transportation costs and fees. Trip cost for those not taking trips is the average cost for state residents of a nonconsumptive trip in their state. This assumes that, if nonparticipants should decide to participate, it would occur in their home state. The specification does not account for those who may not participate because the wildlife they desire to view is not located in their home state; however, it seems more logical than arbitrarily assuming the trip would be in another state.

The cost of a trip may also include the opportunity cost of travel time. However, there is no consensus about the appropriate measure of this cost. According to Freeman (1993), using the wage rate as a measure of time cost may not be appropriate because some participants do not have the opportunity to work additional hours at that rate. A common approach is to use some fraction of the wage rate, and several studies have found that results are sensitive to the fraction used (Wilman and Pauls 1987, Rockel and Kealy 1991, Layman et al. 1996). The opportunity cost of travel time is calculated in both the full and reduced versions of TRIPCOST by multiplying round trip time by fractions of the wage rate. The wage rate is obtained by dividing annual household income by average annual working hours. Following Bowker et al. (1996), three different fractions (0, 1/4, and 1/2) are used as wage multipliers. Rate of travel is another assumption made in many travel cost studies. The rate chosen in the literature varies. For example, Layman et al. (1996) use 60 mi/hr, Englin et al. (1996) use 50 km (31 mi) per hour, Rockel and Kealy (1991) use 45 mi/hr, Casey et al. (1995) and Boxall et al. (1996) use 80 km (50 mi) per hour. This study uses 50 mi/hr. Mileage, as reported in the survey, is the distance to the location visited most often by the individual within a state. Although reported expenditures are for all trips within a state, the mileage and cost of time are related only to the most frequently visited location within a state.

Some observations displayed unusually high transportation costs. In preliminary analyses, these had a large influence on the results. It is assumed that these excessive costs are due to multipurpose trips (Mendelsohn et al.1992) or recording errors. Therefore, the top 5% of cost observations are

Table 1. List of variables included in the analysis.

TRIPCOSTF	Full reported expenditures plus the cost of time per trip. Cost categories include transportation, fees, food, and lodging.
TRIPCOSTR	Reduced reported expenditures plus the cost of time per trip. Cost categories include transportation and fees.
HUNTCOSTF	Full average cost of hunting in state where nonconsumptive trip was taken plus the cost of time per trip. Cost categories include transportation, fees, food, and lodging.
HUNTCOSTR	Reduced average cost of hunting in state where nonconsumptive trip was taken plus the cost of time per trip. Cost categories include transportation and fees.
FISHCOSTF	Full average cost of fishing in state where nonconsumptive trip was taken plus the cost of time per trip. Cost categories include transportation, fees, food, lodging, bait and ice, and boat rental, launching, mooring, storage, maintenance, insurance, and fuel.
FISHCOSTR	Reduced average cost of fishing in state where nonconsumptive trip was taken plus the cost of time per trip. Cost categories include transportation, fees, bait and ice, and boat rental, launching, mooring, storage, maintenance, insurance, and fuel.
SUBCOSTF	Full average cost of trip (reported expenditures and time cost per trip) to alternate states. Cost categories include transportation, fees, food, and lodging.
SUBCOSTR	Reduced average cost of trip (reported expenditures and time cost per trip) to alternate states. Cost categories include transportation and fees.
HUNT	1 if has ever hunted; 0 otherwise.
FISH	1 if has ever fished; 0 otherwise.
INT HUNT	Interaction term; HUNT * HUNTCOST.
INT FISH	Interaction term; FISH * FISHCOST.
INT HUNTTRIP	Interaction term; HUNT * TRIPCOST.
INT FISHTRIP	Interaction term; FISH * TRIPCOST.
SUPPLY	Acres of forest and rangeland per capita in state trip was taken.
INCOME	Household income in thousands of dollars.
AGE	Individual's age in years.
AGESQ	Age squared in hundreds of years.
RACE	1 if white; 0 otherwise.
URBAN	1 if lives in an urban area; 0 otherwise.

deleted. Because they assume automobile travel in the calculation of time cost, Rockel and Kealy (1991) focus on the contiguous United States to avoid erroneous calculation of time cost for visits to Alaska and Hawaii. Automobile travel is assumed in the calculation of time cost in this study. However, inspection of the data reveals that reported mileage for trips in Alaska and Hawaii, by nonresidents of those states, was not inordinately high. It seems visiting nonresidents distinguish specific trips for wildlife viewing as a separate part of their trip to Alaska or Hawaii. High mileages do occur throughout the data set, which may call into question the assumption of automobile travel. Further, as Smith and Kopp (1980) point out, as distance traveled to a recreation site increases, it may be more likely that recreationists are taking trips for more than a single purpose and taking longer trips. Thus, the top 5% of mileage observations are also deleted. This procedure follows Hellerstein (1991) and Bowker et al. (1996), who deleted observations over 1,000 road miles from their study areas in an attempt to avoid respondents on long multipurpose trips. The adjusted data include 20,699 observations, of which 3,799 are from respondents taking trips to more than one state.

Rockel and Kealy (1991) provide evidence that hunting may substitute for nonconsumptive wildlife recreation. Walsh et al. (1992) use the cross-price of hunting and fishing in their logit model predicting nonconsumptive wildlife trips. Both coefficients are positive, but neither is significant. Hay and McConnell (1984) find some evidence that nonconsumptive wildlife recreation and hunting are complements. This study includes the statewide average of hunting and fishing costs per trip in the state where the nonconsumptive trip was taken or, in the case of nonparticipants, in their state of residence. If the nonconsumptive trip was in the individual's home state, then hunting and fishing cost is the average trip cost for a resident of that state. If the nonconsumptive trip was outside the individual's home state, then hunting and fishing cost is the average nonresident trip cost.

The variable HUNTCOSTF includes expenditures on transportation, food, lodging, and equipment rental, as well as fees for guides, pack trips, and access. FISHCOSTF includes the same categories as HUNTCOSTF as well as expenditures on bait and ice, and boat rental, launching, mooring, storage, maintenance, insurance, and fuel. To remain consistent with the variables TRIPCOSTF and TRIPCOSTR, HUNTCOSTR includes expenditures on transportation, equipment rental, and fees. FISHCOSTR includes the same categories as HUNTCOSTR, adding boat costs, bait, and ice. Hence, the full costs for hunting, fishing, and nonconsumptive recreation include all cost categories available, and the reduced costs include all cost categories except food and lodging. Opportunity cost of time is included in HUNTCOST and FISHCOST similarly to TRIPCOST, as a fraction of the wage rate (0, 1/4, or 1/2). The models are estimated with consistent assumptions about all cost components. For example, if TRIPCOSTR is used with opportunity cost of time calculated at one-quarter the wage rate, then

HUNTCOSTR and FISHCOSTR are also used with opportunity cost of time at one-quarter the wage rate.

Because the majority of people do not hunt and many do not fish, previous research forcing hunting and fishing prices into nonconsumptive recreation demand equations could be subject to specification bias. Knowledge of the respondents' previous hunting and fishing activities can be used to better account for substitution possibilities. To avoid forcing hunting and fishing as substitutes for those who have never hunted or fished, and are therefore assumed unlikely to do so, dummy variables indicating whether a person has ever fished (FISH) or hunted (HUNT) are included in the model along with the interaction terms (INT HUNT and INT FISH). This construction allows a hunting trip to be a potential substitute for a nonconsumptive trip only for current or previous hunters, and a fishing trip as a potential substitute only for current or previous anglers.

The HUNT and FISH variables can be used to create price interaction terms allowing price response to vary across groups (Bowker and Leeworthy 1998). Here, INT HUNTTRIP is an interaction term of HUNT with TRIPCOST that allows the slope of the travel cost relationship, and consequently price elasticity and consumer surplus, to vary between hunters and nonhunters. A fishing analogue called INT FISHTRIP is also created.

Another potential substitute is nonconsumptive recreation at other locations. To account for this, the average cost of nonconsumptive recreation trips to alternate states weighted by number of trips is used. For those who took a trip to only one state, the substitute cost used is the average cost of trips from their state of residence to all states except the one visited. It is assumed that nonparticipants would first take a trip in their home state. The substitute cost used for nonparticipants is the average cost of trips from their state of residence to other states. This substitute cost variable is consistent with the other cost variables in that it includes full and reduced cost definitions and the opportunity cost of time. SUBCOSTF includes the same cost categories as TRIPCOSTF, and SUBCOSTR includes the same cost categories as TRIPCOSTR.

There is support in the literature for including resource availability in modeling nonconsumptive wildlife recreation trips (Rockel and Kealy 1991). The variable SUPPLY is defined as acres of forest and rangeland per capita in the state where the trip was taken. Powell et al. (1993) define forestland as land that is "at least 10% stocked by forest trees of any size, and land that formerly had such tree cover and will be naturally or artificially regenerated." Rangeland is land on which the "native vegetation is predominantly grasses, grass-like plants, forbs, or shrubs. This includes natural grasslands, shrublands, savannas, most deserts, tundra, alpine plant communities, coastal marshes, and wet meadows, and many riparian types." This supply measure is crude and is limited by the fact that it does not include ocean shore. It is further limited in that the heterogeneous nature of various habitats is not accounted for. However, it does include coastal marshes, wet meadows, and many riparian types, and it represents the best available data given the national scope of this study.

Additional variables that may be demand shifters are also included. Household income (INCOME) is included and is assumed relevant for the decisions of all household members. Household income is commonly used in travel cost and outdoor recreation participation studies (Yen and Adamowicz 1993, Walsh et al. 1992, Casey et al. 1995). Following Hay and McConnell (1979) and Rockel and Kealy (1991), AGE and age squared (AGESQ) are included in the model to account for a nonconstant marginal change over the range of the variable. The binary variable RACE is included to determine the effect of race on nonconsumptive recreation participation. As the urban or rural character of respondent's location of residence may influence participation, URBAN is included as an intercept shifter that indicates whether a respondent resides in an urban or rural setting.

Model Estimation Results

Results for the truncated and untruncated models with TRIPCOSTR (transportation and fees) and time valued at 25% of the wage rate are reported in Table 2. The negative binomial model was chosen over the Poisson model because the data exhibit overdispersion based on an asymptotic *t*-test of the dispersion parameter. In the untruncated case, only INT HUNT is not significant at the 0.05 level, while the remaining variables are significant at the 0.01 level. Most coefficients have signs that agree with expectations, supporting an inverse relationship between TRIPCOSTR and number of trips. The coefficient for AGE is positive, while the AGESQ coefficient is negative. In this model, participation rises with age up to a certain point where it begins to decline. The coefficients for URBAN and RACE are negative and positive respectively. Those who live in urban areas are likely to take fewer trips than others, and whites are likely to take more trips than nonwhites. These coefficients for URBAN and RACE retain their signs and significance in the truncated case. The positive coefficient for SUPPLY in both models indicates that a decrease in forest and rangeland per capita will result in a decrease in trips. This finding is consistent with the notion that congestion dampens demand for outdoor recreation.

The untruncated income coefficient is negative and significant, which contradicts theory. However, many travel cost studies have found negative or insignificant income coefficients (Creel and Loomis 1990, Rockel and Kealy 1991, Yen and Adamowicz 1993). One explanation posited for this result is that higher income groups have less time to engage in recreation (Boxall et al.1996). An additional explanation may be a two-stage decision-making process. That is, the coefficient for INCOME in the truncated model is significant at the 0.1 level and positive as expected because INCOME may have a different impact on the frequency and participation decisions. The same explanation may be posited for the coefficients of the AGE and AGESQ variables, which also have different signs in the two models, though AGE is not significant in the truncated case. Older people may be retired and have more available time, so once becoming participants, they take more frequent trips.

Table 2. Model estimation results.

Variable	Untruncated (n = 20,699) Coefficient	t-ratio	Mean	Truncated (n = 10,303) Coefficient	t-ratio	Mean
TRIPCOSTR	–0.775E–02	–5.610	13.95	–0.246E–01	–35.391	19.02
INT HUNTTRIP	–0.640E–02	–2.778	6.31	–0.522E–02	–4.812	9.24
INCOME	–0.236E–02	–4.336	38.06	0.106E–02	1.672	39.48
AGE	0.1190E–01	3.375	42.16	–0.776E–02	–1.446	38.74
AGESQ	–0.284E–01	–8.365	20.35	0.164E–01	2.737	16.95
URBAN	–0.206	–7.907	0.25	–0.142	–4.579	0.25
RACE	0.411	10.931	0.94	0.289	4.181	0.96
SUPPLY	0.131E–02	3.295	23.05	0.182E–02	6.784	29.20
HUNT	0.655	20.324	0.42	0.523	13.629	0.48
FISH	0.152	5.276	0.77	0.232	6.512	0.82
INT HUNT	–0.133E–02	–1.838	12.11	–0.124E–02	–4.754	19.76
INT FISH	0.396E–02	5.935	20.15	–0.395E–02	–11.371	28.12
SUBCOSTR	0.492E–02	17.869	39.55	0.275E–02	12.473	48.74
Constant	0.420	4.542		0.726	5.129	
α	4.993	78.210		5.631	13.597	
Log-likelihood	–37,930.45			–27,953.64		
Chi-squared	172,631.40			93,268.96		
Pseudo-R^2	0.69			0.63		

The coefficients for HUNT and FISH in both models are positive and significant, indicating that those who have participated in these consumptive activities are likely to take more nonconsumptive trips than those who have not. INT HUNTTRIP's coefficient is negative and significant in both models, which indicates a difference in the effect of cost on trip demand between hunters and nonhunters. INT FISHTRIP was found to be insignificant in preliminary analyses and is left out of the reported model. In the untruncated case, the coefficient for the interaction term of HUNT and HUNTCOST is negative and significant while the FISH and FISHCOST interaction term's coefficient is positive and significant. For current or previous hunters, there is a complementary relationship between hunting trips and nonconsumptive trips, and for current or previous anglers, fishing trips serve as a substitute for nonconsumptive trips. This complementary relationship between hunting and nonconsumptive use may be explained in part by the common categories of expense for hunting and nonconsumptive trips. For example, the per trip cost for both activities includes expenditures on transportation. Presumably, if the cost of gas rises for a hunting trip, it rises for a nonconsumptive trip as well. Moreover, although the survey informs hunters not to count a "scouting trip" as a nonconsumptive outing, there remains the possibility that hunters do include scouting trips. Likewise, hunters often observe nongame wildlife during a hunting trip. Thus, the complementary relationship may be a function of hunters taking fewer scouting trips or combining hunting and nonconsumptive activities as their per trip cost rises. Fishing and nonconsumptive trips share the same common costs as hunting and nonconsumptive recreation, but there are several other categories, including boat costs and bait, that are unique to fishing. Thus, the cost of a fishing trip can rise with little or no effect on the cost of a nonconsumptive trip. This may explain why a substitute relationship is found here. However, in the truncated case INT HUNT and INT FISH are negative and significant; hunting and fishing are complementary activities to nonconsumptive recreation. This change in fishing's status could again be due to some difference in the participation and frequency decision-making processes. The relationship between fishing and nonconsumptive recreation may differ between active nonconsumptive participants and those who do not currently participate. Another explanation is that fishing can generally be done for longer periods during the year while big and small game hunting usually have relatively short seasons. Finally, SUBCOSTR's coefficient is positive and significant in both models, which supports a substitute relationship between trips to alternate states. As the cost of a nonconsumptive trip to alternate states increases, individuals increase their trips in the primary state.

Consumer Surplus Estimates

Consumer surplus is a widely accepted measure of net social benefit (Pearse and Holmes 1993). It represents the difference between individual willingness to pay and actual expenditure for a good or service. Summing this over the entire population yields aggregate consumer surplus. When using TC models, consumer surplus is obtained by calculating the integral above the average trip expenditure and below the estimated demand function. With count data models, the procedure most often used is to calculate per trip consumer surplus (Creel and Loomis 1990). The per trip measure can be multiplied by the estimated number of trips in a year to obtain the aggregate consumer surplus of access to a given site or sites, in general or for a specific activity. Following Yen and Adamowicz (1993), the formulas to estimate per trip consumer surplus for the base case (nonhunters) and its variance are respectively:

$$\text{Point estimate } (CS) = -(\beta_{TC})^{-1} \quad (4)$$

$$\text{var}(CS) = \text{var}(\beta_{TC}) / \beta_{TC}{}^{4}. \quad (5)$$

where β_{TC} is the estimated travel cost coefficient, and *CS* is the consumer surplus per trip.

By allowing the slope of the travel cost relationship to vary between hunters and nonhunters with the slope interaction term (INT HUNTTRIP), an estimate of per trip consumer surplus for hunters and its associated variance may be derived as:

$$\text{Point estimate } (CSH) = -(\beta_{TC} + \beta_{INT})^{-1}$$

$$\text{var}(CSH) = \frac{\text{var}(\beta_{TC}) + \text{var}(\beta_{INT}) + 2\,\text{cov}(\beta_{TC}, \beta_{INT})}{(\beta_{TC} + \beta_{INT})^4} \quad (6)$$

where β_{INT} is the estimated coefficient on the slope interaction term for hunters, and *CSH* is the consumer surplus per trip for hunters. Application of these formulas to the results in Table 2 yields a per trip surplus of $129 for nonhunters and $71 for hunters in the untruncated model, and $41 for nonhunters and $34 for hunters in the truncated model. A lower surplus for hunters taking a nonconsumptive trip may be due to the complementary relationship between hunting and nonconsumptive recreation. Nonconsumptive activities can be integrated with hunting trips.

The models in Table 2 represent the base scenario from which modeling assumptions are altered to compare their effects on surplus estimates. Additional models with TRIPCOSTR and TRIPCOSTF are estimated with different opportunity costs of time. Results for these models are not reported here, but the per trip surplus results and standard deviations from all the models are reported in Table 3. The wage rates listed are the fractions used to estimate the opportunity cost of time. Again, TRIPCOSTR includes fees and transportation expenditures, while TRIPCOSTF includes fees and transportation expenditures, as well as expenditures on food and lodging. As expected, the use of TRIPCOSTF yields higher surplus estimates. Full cost yields an average of approximately twice that of reduced cost. Altering the opportunity cost of time leads to similar results. A one-half wage rate model with reduced cost yields an average three times the consumer surplus of the zero wage rate model with reduced cost, and a one-half wage rate model with full cost yields an average one and a half times the consumer surplus of the zero wage rate model with full cost.

An important note is the comparison of the truncated and untruncated results. The consumer surplus estimates from the truncated models are on average less than half of the estimates from the untruncated models. This contradicts the finding of Yen and Adamowicz (1993), in which surplus estimates from truncated models exceeded those from their untruncated counterparts by a factor of three. The standard deviations of these estimates in the present study exhibit the same three trends as the surplus estimates. Truncated models, lower time costs, and reduced out-of-pocket trip costs result in smaller standard deviations. The largest difference appears between truncated and untruncated models. Yen and Adamowicz (1993) find much larger standard deviations in their truncated models.

Aggregate consumer surplus is obtained by multiplying the per trip estimate for hunters and nonhunters by their respective number of trips taken in the United States in 1991, which is 138,400,000 for nonhunters and 130,380,000 for those who hunt or have hunted in the past. These numbers were calculated by multiplying the average number of trips taken by nonhunters and hunters by the number of people in each group respectively. The aggregate consumer surplus from the untruncated, reduced cost, 25% time cost model is 27.1 billion dollars. This estimate accounts only for recreation access more than 1 mi from the home, includes only those 16 yr or older, and includes only trips where the primary purpose was nonconsumptive wildlife-associated recreation. Depending on model assumptions, the aggregate estimate ranges from 5.8 to 66.4 billion 1991 dollars.

Rockel and Kealy (1991) estimate a range of consumer surpluses from 12.9 to 271.9 billion in 1991 dollars. The majority of this variability is attributed to different functional forms. In a contingent valuation study using data from the 1991 FHWAR, Boyle et al. (1994) report economic value by state as the mean value per participant per year. Aggregating these state values over the number of participants and summing across states yields an aggregate estimate of 13.3 billion 1991 dollars. This estimate is within the range found in this study.

Table 3. Consumer surplus per nonconsumptive trip in dollars under differing modeling assumptions.

		Untruncated		Truncated	
		Estimate	SD	Estimate	SD
Reduced tripcost					
0 wage rate	Hunters	37.4	12.1	18.7	1.5
	Nonhunters	63.2	9.7	24.4	0.8
1/4 wage rate	Hunters	70.6	23.0	33.6	2.4
	Nonhunters	129.0	23.0	40.7	1.1
1/2 wage rate	Hunters	121.4	39.6	60.2	4.4
	Nonhunters	227.2	47.0	72.3	2.2
Full tripcost					
0 wage rate	Hunters	109.2	35.7	59.3	5.4
	Nonhunters	218.4	38.9	72.6	2.5
1/4 wage rate	Hunters	128.7	40.2	67.2	5.4
	Nonhunters	262.2	46.2	84.4	2.6
1/2 wage rate	Hunters	161.6	48.2	83.9	6.2
	Nonhunters	327.5	59.0	106.7	3.1

Conclusions

Data from the 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation are used with count data travel cost methods to estimate demand and consumer surplus, per trip and in aggregate, for nonconsumptive wildlife-associated recreation access. The sensitivity of the results to a number of unresolved methodological assumptions is also explored. Aggregate consumer surplus for nonconsumptive wildlife recreation access in 1991 varies from 5.8 to 66.4 billion dollars depending on modeling assumptions. This compares to 13.3 billion 1991 dollars in the Boyle et al. (1994) contingent valuation study, and a range of 12.9 to 271.9 billion 1991 dollars in the Rockel and Kealy (1991) study. With knowledge of the range and the rationale behind the range, policy makers can use their judgment as to which range of values and set of assumptions to accept when formulating policy.

Nonconsumptive wildlife recreation is a popular policy issue. Congress passed the Fee Demo Program in 1996 to assess the feasibility of paying for recreation programs on federal lands with user fee receipts. The Conservation and Reinvestment Act of 1999 is being considered as a means of providing funding for nongame wildlife conservation, education, and recreation. This study provides information useful in considering current legislation, such as an assessment of the Fee Demo Program, as well as consideration and drafting of future legislation. From a management perspective, monetary measures of nonmarket benefits such as consumer surplus assist in defining the tradeoff between alternate resource outputs. For example, increased timber production on national forests may impose a loss (or gain) in wildlife viewing opportunities. Per trip estimates of consumer surplus from this study along with projected changes in visitation can be used as a first approximation of the nonmarket benefits lost (or gained) by nonconsumptive wildlife recreationists from such management choices. In addition, the per trip consumer surplus may be useful as a baseline estimate for local or district forest managers who do not otherwise have access to such information.

While the usual caveats of applying national model results to specific areas apply, results related to a number of socioeconomic variables should be of interest to resource managers and planners. Race is a significant predictor of trips. This result, that whites take more nonconsumptive wildlife recreation trips at a given price than nonwhites, is consistent with existing literature. It suggests that, without changes in tastes and preferences, simply increasing the provision of nonconsumptive wildlife recreation opportunities on forest and rangeland is unlikely to increase the diversity of forest users. Dwelling in urban areas is also a significant predictor of trip-taking behavior. Results show that, even after accounting for other factors including price and race, urban dwellers take fewer trips for nonconsumptive wildlife associated recreation than do their suburban and rural counterparts. Hence, if managers are interested in increasing the proportion and frequency of urbanites in forest recreation, creating nonconsumptive wildlife recreation opportunities may be less effective than creating other types of recreation opportunities.

The cost of hunting and fishing is included in the analysis to account for possible substitute activities. In addition, slope and intercept shifters indicating whether a person has hunted or fished in the past are included. In this way, the interrelationship of different outdoor activities may vary for different classes of participants. This study finds that those who currently or previously participated in consumptive wildlife activities such as hunting and fishing are likely to take more nonconsumptive trips than those who have not. Further, there is a complementary relationship between hunting and nonconsumptive recreation, and a substitute relationship between fishing and nonconsumptive recreation in the untruncated case. In the truncated case, the relationship between fishing and nonconsumptive recreation changes to complementary. These interconnections between outdoor activities have important management implications because a management action to increase or improve one activity is likely to affect other activities as well. Finally, there is a difference in consumer surplus between hunters and nonhunters, which is consistent across all models. The lower consumer surplus per trip for hunters may be because hunters are able to include nonconsumptive activities as part of a hunting trip.

This study directly compares surplus measures from untruncated and truncated count data models applied to untruncated and truncated data respectively. Yen and Adamowicz (1993) find different consumer surplus estimates using truncated and untruncated models in a small sample of hunters, with truncated estimators yielding the larger estimates. This study also finds inconsistencies between truncated and untruncated models, although truncated estimators yield smaller consumer surplus estimates. This would suggest that caution is necessary when using truncated models, and that the difference in surplus estimates may be positive or negative. It can be difficult and expensive to determine a relevant population and sample nonparticipants, but as Yen and Adamowicz state, the cost of gathering extra data may be worth the effort in terms of more accurate surplus estimates. They also state that this would provide more precise surplus estimates. Results from the present study show truncated models may provide smaller consumer surplus variances.

Standard untruncated count data models do not completely address frequency and participation decisions (Haab and McConnell 1996). Participation levels are zero for individuals who have not participated over the study's time horizon and for those who have chosen never to participate. This study treats the relevant population of nonparticipants (i.e., residential participants) as potential trip-takers whose current level of trips is zero. A potential avenue for future research with travel cost models is zero-inflated count data models, which account for this two-stage decision process of whether, and then how much, to participate.

In spite of advances in statistical models that account for the integer nature of trip-taking behavior, this study demonstrates that demand models and resulting consumer surplus estimates remain sensitive to researcher-imposed assumptions. Incorporating count data models which account for truncation would also appear to have limitations. Truncated estimators may work well for a subpopulation of users, but extrapolating results to larger populations containing potential users appears risky at best. Regardless of the statistical model, results remain susceptible to large fluctuations based on relatively arbitrary assumptions. Estimates using all available components of cost (full cost) are approximately twice as much as estimates using only transportation and access fees. This is an important result because there are no standard components of the cost variable. The results are also sensitive to the definition of the opportunity cost of time. With no universally accepted guidelines for the incorporation of the opportunity cost of travel time into the model, researchers must make their own assumptions on a case by case basis.

These findings have serious implications about the reliability of consumer surplus estimates from travel cost studies. Nevertheless, these models continue to be used to value nontimber products of forests, particularly related to recreation use (e.g., Englin et al.1996, Sarker and Surry 1998, Boxall et al. 1996). Large fluctuations in estimated nonmarket values are important when decisions based on required benefit/cost analyses could be reversed because of arguable assumptions. While there is a need for resolving the definitional ambiguity of the travel cost variable and opportunity cost of time, these issues remain problematic after roughly 30 yr of travel cost demand modeling. Such problems make it all the more important that researchers be explicit regarding modeling assumptions and the resulting sensitivities of parameter and benefit estimates to these assumptions.

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