Estimating Wildlife Viewing Recreational Demand and Consumer Surplus

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Abstract

Motivated by the increasing popularity of wildlife viewing and a growing emphasis on management for nontimber outputs, wildlife viewing demand was assessed. Specific objectives included determining factors affecting participation and frequency of use, and furthermore, deriving 2006 nationwide wildlife viewing consumer surplus estimates. With the travel cost method as the theoretical basis, the empirical estimation method employed was a two-step sample selection model that included a probit first step and a negative binomial second step. Consumer surplus per trip estimates ranged from $215.23 to $739.07 while aggregate national estimates ranged from $44.5 billion to $185.1 billion. Results reveal that age, race, and urban residence affect participation and frequency similarly. This research can help policymakers in particular better understand determinants of wildlife viewing participation and frequency. The value of wildlife viewing access can be used to justify funding initiatives aimed at protecting or managing for this use.

Key words: consumer surplus, sample selection, travel cost method, wildlife viewing

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Introduction

America's forests are utilized for a variety of uses by numerous individuals with often different needs and wants. Similar to other forms of non-consumptive and non-rival recreation such as hiking and bicycling, wildlife viewing has increased in popularity in recent decades. From 1996 to 2006, the number of wildlife viewing participants increased from 62.8 million to 71.1 million (USDI 2006). In comparison, during this same period, the number of hunters and fishermen decreased from 39.6 million to 33.9 million (USDI 2006). When compared especially to consumptive forms of recreation such as hunting and fishing, wildlife viewing appears to be growing in popularity.

As identified by the US Fish and Wildlife Service's 2006 Fishing, Hunting, and Wildlife Associated Recreation survey, wildlife associated recreation generated approximately 122 billion dollars worth of expenditures in 2006. This amount was roughly one percent of the nation's gross domestic product (USDI 2006). In 2006, wildlife viewing expenditures totaled roughly 45.6 billion dollars with nearly 28 percent of this amount being related to trip expenditures and 21 percent directed to the purchase of wildlife viewing equipment (USDI 2006). Undoubtedly, wildlife viewing is an important economic component of the uses of the nation's natural resources.

Goods and services provided by natural resources can be classified as either market or non-market goods. To evaluate demand for non-market goods, methods such as contingent valuation (CV) and the travel cost method have been utilized by many researchers. In contrast to CV studies which are based on an individual's stated preferences, the travel cost method is a revealed preferences approach that relies on the actual behavior of recreationists (Zawacki et al. 2000). In theory, the travel costs incurred by recreationists to a site can be used to determine a proxy price for access that they would be willing to pay (Pearse and Holmes 1993). As demonstrated by previous researchers, the outcomes from travel cost demand analyses can be utilized to derive consumer surplus estimates (Zawacki et al. 2000).

Despite its popularity, few studies have explicitly examined wildlife viewing demand. Recent studies such as Zawacki et al. (2000) and Marsinko et al. (2002) focused solely on wildlife viewing trip frequency. As a result, factors affecting an individual's decision to become a wildlife viewing participant were not examined. Since only trip takers were considered as part of the relevant population in the truncated datasets of these studies (Zawacki et al. 2000, Marsinko et al. 2002), selection bias concerns arose since everyone is not a potential wildlife viewing trip taker in reality. Rockel and Kealy (1991) studied wildlife viewing participation and trip frequency but utilized a sample selection approach that did not take into account the count data nature of the trip frequency variable. In addition, survey data utilized by previous studies has become outdated. For instance, Rockel and Kealy (1991) utilized 1980 survey data while Zawacki et al. (2000) and Marsinko et al. (2002) utilized data from 1991.

In order to fill a knowledge gap left by previous studies, the objective of this study was to determine recreational demand and consumer surplus associated with nationwide wildlife viewing for the year 2006 using a sample selection model. The first component involved determining factors that influence an individual's decision to become a wildlife viewing participant. Similar to Rockel and Kealy (1991), Zawacki et al. (2000), and Marsinko et al. (2002), the second component of the study involved determining factors affecting the number of trips a wildlife viewing participant takes. Using the demand models created from the study's second component, consumer surplus estimates were obtained.

Potential implications involving policymakers exist as a result of better understanding recreational wildlife viewing demand. Policymakers and managers of parks and refuges could potentially introduce measures such as entrance fees to better take into account the value of uses such as wildlife viewing (USDA 2007). These revenue creating measures can potentially be used to protect the wildlife resources of the park and manage for recreational uses such as wildlife viewing. A better understanding of determinants of wildlife viewing participation and trip frequency can be particular useful in light of recent trends affecting natural resources. Such trends include increased pressure on resources due to population growth, increased urbanization, and increased forest conversion into urban and developed uses (USDA 2007).

Methods

Data source

Data from the 2006 National Survey of Fishing, Hunting, and Wildlife Associated Recreation (FHWAR) was utilized. Carried out consistently every five years since 1955, the FHWAR is a very detailed assessment of the following three major areas of wildlife recreation: hunting, fishing, and wildlife watching (USDI 2006). The 2006 FHWAR contains a wide variety of thorough information relating to wildlife recreation participation, trip expenditures, equipment expenditures, and demographics. Consisting of three major datasets, the 2006 FHWAR comprises of a screening file containing 144,509 records, a sportsperson file containing 21,942 records, and a wildlife watching file containing 11,285 records.

Empirical model

Two empirical models were established. First, in order to identify wildlife viewing participants and to avoid potential selection bias concerns, the following model was constructed:

$$X_i = f(D_i, S_{ij}) \quad (1)$$

where X_i is the individual's decision to participates in a wildlife viewing trip, D_i is a set of demographics, and S_{ij} are potential substitute or complementary variables and their associated prices. Hunting and fishing were the potential substitutes or complements of consideration.

In order to estimate demand for wildlife viewing trips, the following model similar to the one created by Zawacki et al. (2000) was adopted:

$$Y_{ij} = f(C_{ij}, S_{ij}, D_i) \quad (2)$$

where Y_{ij} is the number of wildlife viewing trips a participant takes to a state, C_{ij} is the individual's trip costs to the state, S_{ij} are potential substitute or complementary variables (hunting and fishing) and their associated prices, and D_i is a set of demographics.

Estimation technique

In order to estimate wildlife viewing participation and demand, a sample selection estimation technique was utilized. The basic logic of sample selection estimation is that an outcome variable is observed only when a certain criterion of the selection variable is met (Greene 2008, pp. 882-887). For this research, the selection component was wildlife viewing participation while the outcome component was wildlife viewing trip frequency. Since the selection variable was binary and the outcome variable was a count, the first stage was estimated using a probit regression model and the second stage was measured using a count-data model (Sun et al. 2008).

Borrowing the framework from the previous study by Sun et al. (2008), the participation decision can be modeled by the following:

$$z_i^* = g(w_i);\ z_i = 1 \text{ if } z_i^* > 0 \qquad (3)$$

where z_i is the realization of an unobserved variable (z_i^*) indicating participation and w_i is a set of explanatory variables used to predict participation. This binary dependent variable indicates whether or not an individual at least 16 years old has taken a trip of at least one mile away from his or her home for the purpose of viewing wildlife.

The second stage, or frequency of participation, can be expressed by the following model:

$$y_i = f(x_i);\ y_i \text{ is only observed when } z_i = 1 \qquad (4)$$

where y_i is trip frequency contingent on participation and x_i is a set of explanatory variables predicting frequency (Sun et al. 2008). With Poisson regression, the essential assumption is that the conditional mean and conditional variance of the distribution are equal (Greene 2008, pp. 906-911). When overdispersion does exist, the use of a negative binomial regression model is favored (Greene 2008, pp. 906-911).

With two-step sample selection estimation techniques, the selection and outcome components must be estimated jointly. As demonstrated by Sun et al. (2008), estimating the components jointly can be approached using techniques such as full information maximum likelihood (FIML) and Greene's two-step method. For this study, the FIML approach was utilized. With FIML estimation, the distributions of the first and second step equations are defined jointly (Greene 2008, pp. 383-384). Unlike Greene's two step non-least squares approach, the correction associated with the FIML approach is performed internally rather than through the use of an inverse mills ratio. In addition, the significance of the parameter rho (ρ) can be used to ascertain whether the use of a sample selection model was appropriate.

Consumer surplus

Using the demand equation, individual per trip and aggregate consumer surplus estimates were obtained. Consumer surplus is essentially the difference between a consumer's willingness to pay for a product and the actual amount the consumer has to pay to obtain the product (Mendes and Proenca 2007). In the count-data regression model, a point estimate of an individual's consumer surplus can be obtained by calculating the negative reciprocal of the cost coefficient (Yen and Adamowicz 1993). Aggregate consumer surplus estimates were obtaining by multiplying individual consumer surplus estimates by the number of wildlife viewing trips (232 million) that took place in the year 2006 (USDI 2006).

Construction of cost variables

Similar to previous literature (Zawacki et al. 2000, Rockel and Kealy 1991), reduced and full versions of wildlife viewing trip costs were created. A reduced version of the wildlife viewing trip costs variable included transportation costs (private vehicle, public transportation, and air) and fees (guide, public access, and private access). The full trip cost version contained the categories associated with the reduced version and added the categories of lodging and food.

Similar to previous literature (Zawacki et al. 2000, Marsinko et al. 2002), an individual's hunting and fishing trip costs were represented in this study as the statewide average of hunting and fishing costs where the wildlife viewing trip took place. For wildlife viewing non-participants, an individual's hunting and fishing trip costs were represented as the statewide average of the individual's state of residence since it is assumed that, if a non-participant decided to take a wildlife viewing trip, it would take place in his or her state of residence (Zawacki et al. 2000). Similar to wildlife viewing, reduced and full versions of hunting and fishing trip costs were created. In contrast to wildlife viewing and hunting, reduced trip costs for fishing contained the categories of transportation, fees, bait and ice, and essential boating costs such as launching, mooring, and fuel. Interaction terms were created to avoid forcing hunting and fishing costs on individuals who do not hunt or fish.

A provision for the opportunity cost of time was included in each of the cost variables. Following Zawacki et al. (2002), individual per trip opportunity cost of time estimates were calculated by multiplying trip time by a fraction of the wage rate. Wage rate estimates were obtained by dividing household income by the total hours of a full work year. Similar to Zawacki et al. (2002), this study used the wage rate multipliers 0.25 and 0.50.

Sample construction

After variable transformations were made, a sample of the data was constructed in order to carry out data analysis. After removing records with missing observations, records associated with the top five percent of trip costs observations were removed in accordance with a procedure used by previous researchers (Zawacki et al. 2000, Rockel and Kealy 1991). Of the remaining observations, a random sample of 25% of the remaining records was used for the analysis of this study. 25% of the remaining usable data produced a sample size of 23,111. Since ten percent of the relevant population took a wildlife viewing trip away from home in 2006 (USDI 2006), the sample was constructed to coincide with this finding. As a result, out of the total sample of 23,111 individuals, ten percent or 2,311 took a wildlife viewing trip away from home.

Empirical Results

Information related to demographics, hunting and fishing experience, wildlife viewing participation, and wildlife viewing trips took can be found in Table 1.

Table 1. Sample demographics, hunting and fishing experience, and dependent variables.

Variable	Explanation	Mean	Std. Dev.
Demographic Variables			
Age	In years	46.24	17.53
Age squared	In years	2445.58	1736.51
Sex	1if male; 0 if female	0.48	–
Married	1 if currently married; 0 otherwise	0.62	–
Household income	In thousands of dollars	58.27	28.94
Some college to BA/BS	1 if education is up to 4 year degree; 0 otherwise	0.43	–
Graduate degree	1 if education is graduate degree; 0 otherwise	0.12	–
White	1 if white; 0 otherwise	0.85	–
Urban residence	1 if urban residence; 0 if rural	0.67	–
Employment	1 if employed; 0 otherwise	0.66	–
Fishing and Hunting Experience			
Ever hunted	1 if ever hunted in lifetime; 0 otherwise	0.23	–
Ever fished	1 if ever fished in lifetime; 0 otherwise	0.53	–
Dependent Variables			
Trip taker	1 if trip away from home is taken; 0 Otherwise	0.10	–
Trips to site	Number of trips to state	8.14	21.20

Trip costs associated with wildlife viewing, hunting, and fishing were organized by costs and wage rate specifications and are presented in Table 2. Overall, wildlife viewing had the lowest trip costs while hunting had the highest. Trip costs for wildlife viewing, hunting, and fishing followed expected patterns as full costs values were greater than reduced costs values and costs containing the half wage rate specification were greater than costs containing the quarter wage rate specification. The largest trip costs values contained the full costs and half wage rate specifications.

Table 2. Wildlife recreation trip costs organized by costs and wage rate specification.

Variable	Costs	Wage Rate	Mean ($)	Std. Deviation ($)
Wildlife	Reduced	Quarter	57.59	79.22
viewing	Reduced	Half	74.22	95.78
	Full	Quarter	140.54	280.36
	Full	Half	157.17	291.55
Hunting	Reduced	Quarter	148.73	244.50
	Reduced	Half	168.79	251.22
	Full	Quarter	226.55	327.06
	Full	Half	246.61	343.34
Fishing	Reduced	Quarter	100.34	96.53
	Reduced	Half	116.72	102.08
	Full	Quarter	173.81	169.97
	Full	Half	190.18	175.89

Model Selection

Four models were constructed to take into account trip costs and wage rate specifications. Issues concerning multicollinearity arose with regard to the variables sex and household income. The potential of multicollinearity and a lack of literature support to justify the inclusion of sex in the models led to the omission of this variable. The variable household income was positively correlated with such variables as marital status, graduate level education, and employment. Ultimately, the final model excluded the three variables since economic theory suggests that income should be a significant factor and variables such as employment and marital status have no relevant potential policy implication. The education variable signifying some college experience up to the completion of a bachelor's degree was found to be insignificant in preliminary analysis and was omitted from the second step due to a lack of literature support to justify its inclusion.

For the count data second step, the negative binomial overdispersion parameter theta was found to be significant in all four models (Table 4). Preliminary analysis involving the dispersion parameter alpha also indicated the presence of overdispersion. Essentially, the presence of overdispersion indicates that the dependent variable number of trips taken is positively skewed since the majority of participants took a few trips while a small number of participants took a large number of trips. Since the overdispersion parameter was significant, the use of a negative binomial regression model was appropriate for all of the sample selection models. The parameter rho (ρ) was significant in all models indicating the appropriate use of the sample selection model (Table 4).

Wildlife Viewing Participation

Results modeling an individual's decision to participate in a wildlife viewing trip can be found in Table 3. All models indicate that age positively impacted participation while age squared was negative. These combined results indicate a quadratic relationship and show that an individual's likelihood of participation increased with age but decreased once an individual reached a certain age. Education was found to be a positive and significant factor. Individuals possessing some college education up to the completion of a bachelor's degree were found to have a higher probability of participation. In addition, white individuals were more likely to participate than those of other ethnicities. Household income was found to be a positive and significant factor as well. As a result, an individual's likelihood of participation increased as household income increased. A significant demographic variable that negatively impacted participation was urban residence. As a result, individuals who lived in rural areas were found to have a higher probability of participating than individuals who lived in urban areas.

The impacts of other forms of wildlife recreation were considered in the participation model as well. According to results from all four models, an individual who had ever fished in his or her lifetime was less likely to participate in a wildlife viewing trip than an individual who had never fished. Costs associated with hunting and fishing were considered in the models as well. Hunting and fishing costs were found to be positive and significant in all four models indicating that as hunting and fishing costs increased, the likelihood of an individual choosing to participate in a wildlife viewing trip increased. As a result, increasd hunting and fishing costs for an individual led to an increased probability of an individual becoming a wildlife viewing participant.

Table 3. Determinants of wildlife viewing participation estimated by a probit regression model.

	Reduced 0.25	Full 0.25	Reduced 0.50	Full 0.50
Variable	Coefficient	Coefficient	Coefficient	Coefficient
Constant	-3.231[a]	-3.193[a]	-3.219[a]	-3.189[a]
Age	0.051[a]	0.049[a]	0.051[a]	0.049[a]
Age squared	-0.001[a]	-0.001[a]	-0.001[a]	-0.001[a]
Household income	0.002[a]	0.002[a]	0.002[a]	0.002[a]
BA/BS degree	0.107[a]	0.102[a]	0.108[a]	0.103[a]
Race	0.526[a]	0.522[a]	0.523[a]	0.521[a]
Urban residence	-0.146[a]	-0.151[a]	-0.148[a]	-0.152[a]
Ever hunted	0.029	0.070[c]	0.015	0.063
Ever fished	-0.450[a]	-0.469[a]	-0.550[a]	-0.530[a]
Int Hunting costs	0.003[a]	0.001[a]	0.002[a]	0.001[a]
Int Fishing costs	0.013[a]	0.008[a]	0.012[a]	0.008[a]
Log-likelihood	-6289.40	-6162.90	-6281.27	-6165.46
$\chi 2$	2446.75	2699.75	2463.01	2694.63

a and c indicate significance at the 1% and 10% level respectively; n = 23,111

Wildlife Viewing Demand

Results modeling the number of wildlife viewing trips of at least one mile away from the home an individual made in 2006 can be found in Table 4. Similar to participation, age was a positive factor while age squared was a negative factor. Race was found to be a significant and positive factor for all models as white individuals were likely to take more trips than individuals of other ethnicities. A significant demographic variable found to negatively impact the number of wildlife viewing trips taken by a participant was urban residence. Household income was found to be a negative and insignificant factor affecting trip frequency.

Similar to participation, the impacts of other forms of wildlife recreation were considered in the wildlife viewing frequency models as well. The variable ever hunted was found to be positive and significant for all four models. As a result, an individual who had ever hunted in his or her lifetime was likely to take more wildlife viewing trips than an individual who had never hunted. Hunting costs were found to be negative but insignificant in all four models indicating the possibility of a weak complementary relationship between wildlife viewing and hunting. Fishing costs were positive and insignificant. The insignificance yet positive signs of the fishing costs variables indicate that fishing and wildlife viewing potentially are weak substitutes.

Trip costs associated with wildlife viewing, hunting, and fishing were included in the wildlife viewing demand models as well. In agreement with assumptions related to the travel cost method, wildlife viewing trip costs was a negative and significant factor that influenced the number of trips a participant took. As a result, participants were likely to take fewer wildlife viewing trips as trip costs associated with wildlife viewing increased.

Table 4. Determinants of wildlife viewing demand estimated by a sample selection model.

	Reduced 0.25	Full 0.25	Reduced 0.50	Full 0.50
Variable	Coefficient	Coefficient	Coefficient	Coefficient
Constant	-0.623	-0.800[b]	-0.576	-0.789[b]
Age	0.043[a]	0.044[a]	0.043[a]	0.044[a]
Age squared	-4.589E-04[a]	-4.575E-04[a]	-4.470E-04[a]	-4.548E-04[a]
Household income	-0.001	-0.001	-2.020E-04	-0.001
Race	0.269[c]	0.280[b]	0.259[c]	0.279[b]
Urban residence	-0.132[b]	-0.124[b]	-0.135[b]	-0.125[b]
Ever hunted	0.343[a]	0.345[a]	0.334[a]	0.348[a]
Ever fished	0.114	0.185[a]	0.108	0.176[b]
Int Hunting costs	-2.142E-04	-2.615E-04	-2.443E-04	-2.699E-04
Int Fishing costs	6.380E-04	3.646E-04	5.603E-04	3.703E-05
Trip Costs	-4.646E-03[a]	-1.366E-03[a]	-3.969E-03[a]	-1.353E-03[a]
Overdispersion (θ)	0.087[a]	0.074[a]	0.089[a]	0.073[a]
ρ	0.491[a]	0.498[a]	0.482[a]	0.495[a]
Log-likelihood	-12763.46	-12640.41	-12751.97	-12638.87
$\chi 2$	29802.58	29704.30	29855.92	29631.85

a , b, and c indicate significance at the 1%, 5%, and 10% level respectively; n = 2,311

Consumer Surplus

Consumer surplus estimates organized by trip cost and wage rate specification can be found in Table 5. Overall, individual per trip consumer surplus estimates ranged from $215.23 to $739.07. As expected, the most conservative per-trip consumer surplus estimate was found using the reduced costs and quarter wage rate specification. The model specification containing the most robust individual consumer surplus estimate involved the full costs and half wage rate specifications. According to the results, models that contained the full cost versions of the trip costs variables produced much larger consumer surplus estimates than models that contained the reduced cost versions of the trip costs variables. Compared to trip cost specification, wage rate specification did not have as a significant impact on consumer surplus estimates. Aggregate consumer surplus estimates ranged from $44.5 billion to $185.1 billion and followed the same patterns demonstrated by the consumer surplus individual per trip estimates.

Table 5. Wildlife viewing individual per trip and aggregate consumer surplus estimates.

Costs Specification	Wage Rate	Point estimate ($)	Std. deviation ($)	Aggregate Range ($ billions)
Reduced	Quarter	215.23	23.57	44.5 - 55.4
Reduced	Half	251.95	27.66	52.0 - 64.9
Full	Quarter	732.33	59.07	156.2 - 183.6
Full	Half	739.07	58.69	157.8 - 185.1

Discussion

As in previous studies, consumer surplus estimates were highly sensitive to assumptions related to categories to include in the trip costs variables as well as wage rate specification. Comparing to previous studies, consumer surplus estimates obtained by this research were fairly similar and moderately higher. Aggregate consumer surplus estimates obtained for the year 2006 ranged from $44.5 to $185.1 billion based on modeling assumptions involving costs and wage rate specifications. Adjusting for inflation and reflecting its findings in 2006 dollars, Zawacki et al. (2000) found aggregate consumer surplus estimates to range from $8.5 to $97.7 billion. In addition, Rockel and Kealy (1991) found aggregate consumer surplus estimates to range from $18.9 to $400 billion while Boyle et al. (1994) calculated an aggregate consumer surplus estimate of $19.6 billion.

Overall, since the value of wildlife viewing access seems to be increasing, policymakers potentially have an impetus to introduce legislation aimed at increasing funding and access for wildlife viewing on public lands. The examples of previously enacted aid programs such as the Pittman-Robertson Act, Dingell-Johnson Act, and Migratory Bird Conservation Act can be useful in implementing a federal program that specifically targets wildlife viewers and the preservation and restoration of wildlife viewing habitat (McKinney et al. 2005). Since wildlife viewing equipment expenditures totaled $9.9 billion in 2006, policymakers could consider placing federal excise taxes on equipment such as binoculars, cameras, and bird feed that can be used to fund wildlife viewing habitat preservation and restoration efforts (USDI 2006). In addition, policymakers could also consider the sale of wildlife viewing or non-consumptive stamps that can give buyers free admission to federal refuges and national parks.

Determinants of participation and trip frequency have potential implications for policymakers as well. Even though one should be cautious of applying national results to specific local areas, results from this research highlight some potential important trends. In an effort to promote recreational wildlife viewing, policymakers could consider incentives as well as educational programs aimed at increasing wildlife viewing awareness among young people in particular. Also, considering nationwide demographic trends involving rising minority and, in particular, Hispanic populations and a general increased movement of individuals from rural to urban areas, policymakers may consider the use of incentives as well as outreach programs aimed at increasing wildlife viewing awareness among those in the Hispanic population and those living in urban areas. Regarding demand, household income was found to be negative and significant. Though not intuitive, this result is similar to findings from Zawacki et al. (2000) and Rockel and Kealy (1991) who found negative or insignificant income coefficients.

Even though this research did not find significance involving the hunting price variable, land managers in particular may be interested in exploring increasing either hunting or wildlife viewing opportunities found on their land. If hunting and wildlife viewing are indeed complementary activities, increasing opportunities for one of the recreational activities would likely increase both the number of hunting and wildlife viewing trips a participant takes. In contrast to both Zawacki et al. (2000) and Rockel and Kealy (1991), this study found fishing costs to be positive but insignificant for the demand equation. If, however, wildlife viewing and fishing were substitutes, managers attempting to promote wildlife viewing could emphasize the potential low cost nature of wildlife viewing trips in attracting wildlife viewing trip takers.

The current research provides greater insight concerning aspects of wildlife viewing participation and demand. By using a sample selection estimation technique, possible concerns involving selection bias were alleviated. Even though the research possessed methodological concerns such as the specification of the costs variables, the study identified determinants of wildlife viewing participation and demand and identified also the possibility of the increasing value of wildlife viewing access.

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