THE NET ECONOMIC VALUE OF DEER HUNTING IN MONTANA

Montana Department of Fish, Wildlife & Parks

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by

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EXECUTIVE SUMMARY

The objective of this study was to estimate the net economic value (net willingness to pay) for deer hunting in Montana. A regional Travel Cost Model (TCM) was used to statistically derive a demand equation from survey data collected from hunters during the spring of 1986.

The regional TCM approach is recommended by the Water Resources Council (1979, 1983) as one of the two preferred techniques for estimating recreational benefits. In addition, a number of Federal agencies are required by the Water Resource Council Principles and Guidelines (1983) to use the concept of net economic value when evaluating Federal agency actions.

The TCM method uses the distance traveled as a measure of price and the number of trips taken from a given origin to a particular site as a measure of quantity. The resulting "demand equation" is used to calculate the additional amount deer hunters would be willing to pay, over and above their travel costs, to have the opportunity to hunt at the site being investigated.

The conversion of distance traveled to a dollar value is accomplished by multiplying travel distance by a cost per mile figure. Two cost per mile values were calculated and used in this study. The cost per mile figure calculated from the angler survey (i.e., reported cost basis) more closely represents the actual cost associated with recreational vehicles used during

hunting season and the driving conditions during that time. The net economic values, estimated using the reported cost basis, reflect the value of deer hunting in Montana.

The state average net economic value for deer hunting is $108 per trip. As mentioned above, this means hunters would be willing to pay $108 more per trip than they actually do to be able to hunt at a given site. The net willingness to pay per hunter day is $55. Converting this value to a Forest Service WFUD (Wildlife-fish User Day) yields $102. These benefit estimates are based on a double log regression model, using the actual number of trips from the sample.

Expenditure data from the survey shows that, in 1985, resident deer hunters spent $55 per trip or $31 per day. Nonresidents, in contrast, spent $542 per trip or $86 per day.

The net economic values presented in this paper are the appropriate values to use in benefit/cost analysis or economic efficiency decisions (i.e., forest or range planning). If the annual values of stream and lake fishing are converted into net present value, they can be used in trade-off analysis with marketed resources, such as timber, coal or grazing. The net economic values presented here are limited to the direct use values associated with Montana deer hunting resources. Accordingly, these net economic values underestimate the total value associated with this resource, since indirect values (existence, bequest and option uses) have not been estimated.

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ACKNOWLEDGEMENTS

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INTRODUCTION

Purpose and Scope of Research

The objective of this research is to statistically estimate the net economic value (net willingness to pay) for deer hunting in Montana, using a survey of Montana hunters. The hunting benefit estimates are derived from a regional (multi-site) travel cost model (TCM) demand equation. These estimates should prove useful in U.S. Forest Service and Bureau of Land Management multiple-use planning decisions. These values are also suitable for evaluation of the benefits of habitat improvements (as performed by BLM using SAGERAM) or making trade-offs between wildlife and livestock land use. While the values reported here represent the direct contribution of deer hunting to society: there is 1) value in knowing that the opportunity exists to hunt deer (option value); 2) value in simply knowing that deer exist, regardless of one's use of them (existence value); and 3) a willingness to pay to provide deer for future generations' use or enjoyment (bequest value). Although option, existence, and bequest values are important when determining large-scale impacts to resources, these values are not the most appropriate for determining the economic impact of small management changes on resources.

Definition of Benefits

Many federal agencies are required by the U.S. Water Resources Council Principles and Guidelines (1983) to use the net willingness to pay (net economic value) as a measure of value in benefit cost analysis or evaluation of Federal actions. When performing natural resource damage assessments, U.S. Department of the Interior regulations require that the calculation of economic values lost to society be measured in terms of net willingness to pay (U.S. Department of the Interior, 1986). Use of net willingness to pay is also recommended in textbooks on benefit cost analysis (Sassone and Schaffer, 1978; Just, Hueth, and Schmitz 1982).

Introduction

The method employed in this study is a Regional Travel Cost Model (TCM). This approach is recommended by the U.S. Water Resources Council (1979, 1983) as one of the two preferred techniques for estimating recreation benefits. The method is one of the most widely applied demand estimating techniques. TCM uses observations of travel distance (as a measure of price) and trips taken (as a measure of quantity) to statistically trace out a demand equation. The resulting first stage or per capita demand equation allows the analyst to calculate the additional amount recreationists would pay, over and above their travel costs, to have the opportunity to hunt at a particular site. This calculation can be done using a second stage, or site, demand curve that relates added distance or added travel cost to visitation. The method used here is direct integration of the first stage demand curve, which is an equivalent approach (Menz and Wilton, 1983). See Clawson and Knetsch (1966), Dwyer, Kelly and Bowes (1977), or Sorg and Loomis (1985) for a discussion of the basic TCM approach.

Estimating the First Stage or Per Capita Demand Equation

The traditional TCM demand equation has, as its dependent variable, trips per capita from a given zone (i.e., a county or state) of origin to a particular site. An alternative approach is the individual observations model (Brown and Nawas, 1973). In the latter, the dependent variable is the sum of trips that a given individual makes to a site over the course of a recreation season. This method will generally lead to overestimates of consumer surplus (Brown, et al, 1983).

This study uses a modified approach that combines features of both the zonal and the individual observations models. This modified approach, first suggested by Brown, Shalloof and Hsiao (1984), is the individual per capita model. The dependent variable is the sum of trips taken by a given individual divided by some fraction of the population of that individual's origin zone. The zonal population is equally allocated among all individuals observed to participate from a given zone. The advantage of this approach is that the equation is estimated on the most disaggregated data possible (individual level observations), while avoiding the overestimation associated with the pure individual observation model.

The basic specification of the per capita or first stage TCM demand equation estimated for deer hunting is given in Equation 1 as:

1) $TRIPCAP_{ij} = B0 + B1\ (RDTRDIS_{ij}) + B2\ (SUCCESS_j) + B3\ (DEMOG_i) + B4\ (SUBST_{ij})$

where:

$TRIPCAP_{ij}$ = trips taken by individual i to site j over the individual's share of origin population.

$RDTRDIS_{ij}$ = round trip distance from the hunter's residence to hunting area j.

$SUCCESS_j$ = hunter success at site j.

$DEMOG_i$ = socioeconomic variables such as income, age, sex, preferences that describe individual i.

$SUBST_i$ = a measure of the price and availability of substitutes to area j for individual i.

The general specification shown is the linear functional form. However, all results discussed below are for a double log model, where dependent and independent variables are transformed to natural log values. Generally, the linear model provides a poor fit to travel cost data, as was the case with this study's data. The double log model is used here because it provides a good fit to the data, may correct for heteroscedasticity, and has an obvious interpretation for differences in net economic values across sites.

Assumptions of the Travel Cost Model

As for any economic model, there are a number of assumptions involved in estimating the Travel Cost Model. These assumptions fall into three groups: the specific assumptions of the TCM, the assumptions related to the basic economic theory of demand, and the statistical assumptions invoked in estimating the demand function.

The basic assumption of the TCM is that, in a site-based model of recreation demand, travel cost is equivalent to price. Aside from this special assumption, the general problem of modeling recreation demand is similar at the theoretical level to modeling demand for any commodity. Two very general requirements of an economic demand model are that 1) the variables are correctly specified, and 2) the commodity being modeled is sufficiently homogeneous to constitute a unique market. Both of these requirements have proved to be problematic for modeling nonmarket recreation.

In TCM variable definition, a major problem is that price is not directly observed and must be inferred from survey data. In most cases, distance is taken as the price variable for estimation purposes and converted to travel costs by a fixed, cents-per-mile travel cost parameter. In addition to direct monetary transportation costs, the real cost of travel includes the opportunity cost of time. There are several methods that have been developed for estimating both of these components of travel cost. With respect to transportation cost, the standard approach recommended by the U.S. Water Resources Council is to use the variable cost of vehicle operation, as defined by the U.S. Department of Transportation (1984) publications on the costs of owning and operating vehicles to determine transportation costs. However, because the latter does not necessarily reflect the actual costs associated with operating recreational vehicles, an estimate is also derived using the survey data on reported trip expenditures by our sample of deer hunters. Both the standard and reported cost estimates are described in a later section of this report.

To determine the opportunity cost of travel time, the Water Resources Council relies on Cesario's (1976) review of the value of travel time to urban commuters. Cesario's work suggests using a value between one-fourth and one-half of the wage rate as a proxy for the opportunity cost of travel time. The approach taken in the present study is to use one-third the wage rate for the opportunity cost of travel time.

A TCM demand model also needs to include variables reflecting income, preferences, and price and availability of substitutes. For all of these terms, demand theory provides some guidance as to the expected sign (direction) of the estimated relationship to quantity demanded. These hypotheses are used below to evaluate the estimated model.

In order to use trip expenditures as a price variable, it is necessary that travel cost be associated exclusively with the opportunity to hunt a given site. To ensure this aspect of trip homogeneity, the standard practice is to include only sample trips that are mainly for purposes of hunting a specific site (main purpose, single destination trips). As will be described below, approximately 15% of our sample were excluded as either multi-destination or multi-purpose trips.

A final assumption necessary for the TCM model is that there are no constraints on recreational use. In fact, only 19,550 nonresident deer tags (17,000 combination licenses and 2,550 deer permits through special drawings) are sold each year. There is currently excess demand for these nonresident licenses.

In addition, the distribution of hunting pressure by area for nonresidents is influenced by the system of special permits. For example, in many hunting districts, deer can only be taken if the nonresident hunter has drawn a special permit for that area. On the other hand, there is no limit on the number of resident deer tags. If all deer hunting in Montana were lottery rationed, it would be possible to estimate the TCM model on application data (Loomis, 1982).

A model that combines application and license data may be appropriate for the complex licensing system in Montana. However, development of such a model is beyond the scope of this project.

It is important to note that licensing constraints mean that the conventional TCM net economic values presented in this study are conservative. In addition, because the special permit system influences the distribution of hunting pressure across sites, the difference in net economic values across sites reflect both the influence of the permit distribution system and the underlying site values.

An additional complication in modeling the demand for Montana deer hunting is the substantial difference in license fees between residents ($9 for deer tag or $35 for a combination license) and nonresidents (combination license $300 or $102 for special permit).

The basic method used for estimating the first stage demand curve (Equation 1) is ordinary least squares (OLS) regression analysis. The statistical assumptions include correct specification, inference, and variable measurement.

The main specification issues from a statistical standpoint are the choice of regressors and the choice of functional form. If the estimated model is incomplete, there is a danger of omitted variable bias. Since the underlying model for OLS is linear, it is necessary that the variable transformations (implicit in the choice of functional form) result in a linear relationship. There is a considerable literature on functional form for travel cost models. The analysis reported below is based on the standard double log model.

The statistical inference assumptions relate to the test statistics (such as the t-statistic and F-statistic) used to evaluate the "fit," or appropriateness, of the model. These include homoscedasticity, independence of error terms (autocorrelation), normal properties of the dependent variable , and the assumption that no linear relationship exists between any two or more of the independent variables (multicollinearity). Generally, the major problem with estimating a travel cost model using cross-sectional data has been heteroscedasticity.

A final assumption of ordinary least squares regression is that the variables are correctly measured in the survey data. In the TCM model, measurement error is a potential problem, especially with respect to reported travel costs and/or distances.

A related problem is that the TCM model requires zonal aggregation. The costs of defining population zones on other than political boundaries (county, state) are prohibitive. This aggregation will inevitably result in some survey distances (even if the latter are correct) that do not represent population-weighted averages. The methods used to define zones and validate distances are described later.

Calculation of Benefits From the Per Capita Demand Equation

Once the per capita demand equation of the form in Equation 1 is estimated using OLS regression, benefits can be calculated in several ways. First, the per capita curve can be integrated for each zone of origin (or individual observation) between the current distance and the maximum distance assumed to be relevant for the model. Net economic value for each site is then the population-weighted sum of each zone's net willingness to pay.

The alternative approach is to calculate a second stage, or site, demand curve from Equation 1. This second stage demand curve relates total trips made to a given site to increases in distance (or travel cost), over and above existing distance (or cost). The area under this curve is also an estimate of net willingness to pay.

The approach used in this study is direct integration of the first stage demand curve, which is an exact method. The second stage approach involves either an approximation in estimating area (generally a numerical methods approach, such as the trapezoidal approximation, is used) or an approximation in deriving the second stage demand function (through regression analysis, for example). The general equivalence of these two approaches has been demonstrated in the literature (Burt and Brewer, 1971; Menz and Wilton, 1983).

The major assumption involved in benefit estimation is the choice of the appropriate upper limit of integration. With the double log model, trips per capita asymptotically approach zero as distance approaches infinity. The distance where trips fall close to zero may exceed a site's likely market area, and, in any case, the definition of a limit based on trips (one, "close to zero", etc.) is arbitrary. We have chosen to truncate the second stage demand curve at the highest observed distance in the sample. The equivalent limit for direct integration of the first stage equation is to integrate to the highest observed distance in the sample, plus the observed distance form origin i to site j.

Another methodological option with respect to benefit estimation is the use of the actual intercept rather than the model estimated intercept. Gum and Martin (1975) were the first to utilize an actual intercept in estimating consumer surplus from a recreational demand function. The intercept is the number of trips (quantity demanded) that would be taken at zero price. The reason for using actual instead of predicted trips is that use of the former eliminates the error associated with estimating the intercept. It can be shown that with direct integration of the first stage demand function, only the parameter estimate on distance (travel cost) needs to be utilized from the model; this helps eliminate specification bias.

In the benefit estimates reported later, net economic values are reported for actual trips, using a modified Gum and Martin Approach. The benefit estimates using predicted intercepts are shown in Appendix C.

DATA SOURCES

The information about hunters' origins and site destinations was obtained from a telephone survey of licensed hunters performed by the Montana Department of Fish, Wildlife and Parks (DFWP). This survey was undertaken in January and February, 1986. The survey involved mailing a one-page questionnaire and hunting map to sampled hunters. Each hunter was asked to answer as many of the hunting-related trip questions as possible. The hunter was also told to expect a telephone call from DFWP.

In the telephone interview, hunters read back their answers to the questions already asked, and were then asked to respond to a few additional questions. The two-page survey was more or less a diary of the previous hunting season. Hunters were asked to list the sites visited, species hunted, distance traveled, etc., for each big game hunting trip during the fall season. This survey instrument is provided in Appendix A. This survey also asked information about trip expenditures, vehicle driven, and hunter demographics.

The data was coded and entered into data files under the direction of the author. A total of 1,131 observations were related to deer hunting. Each respondent was asked if the primary purpose of the trip was to hunt big game, if the area hunted was the primary place hunted, and deer was the species for which the hunter selected the given hunting area. The total number of main purpose (deer hunting only) single destination trip observations was 1,123. Deleting observations that had missing origin information and problems with measurement with the distance variable reduced the final sample to 1,031.

In order to estimate the TCM model, it was necesary to identify an origin zone for each individual hunter. Separate maps were developed for each hunting site, and counties and states were aggregated in roughly concentric zones around the site. The basic criteria used in zonal aggregation was to have at least one observation per zone, to have the observation in a given zone be in an approximate population-weighted average location, and to have contiguous zones (no unaggregated areas) out to the limits of the observed spatial market. Typically, zones nearest a site were single counties, with aggregates of counties defining the origin zone around more distant observations. Nonresident origins were states or aggregates of states.

The 40 specific deer hunting areas originally defined for this study were based on aggregations of the 129 hunting districts shown in DFWP hunting regulations. These areas are shown on the "Elk and Deer Hunting Areas" map in Appendix B. Because of the sample size, a number of the aggregated hunting areas only had a few observations. Hence, a number of hunting areas were combined. The net result was that the original 40 areas were reduced to 21 aggregated hunting sites.

In addition to the survey, two additional data sources were used in developing the deer hunting data base. DFWP personnel in each region were surveyed by John Cada, Assistant Research Bureau Chief, to identify the predominant management, topographic, roading, and timber characteristics of each site. The management characteristics were based on the general type of hunting regulation. The extent of timber cover on each site was characterized on a scale of 1 to 4, from "heavy timber" to "open." Topography was characterized as "steep," "general mountains," or "rolling hills." Roading was on a scale of 1 to 4, from "unroaded" to "heavily roaded."

The other data source was the 1985 Deer Harvest Survey administered by John Cada. This data was aggregated to develop measures of hunting success by site and to determine total deer hunting pressure by site.

STATISTICAL ESTIMATION OF THE DEER HUNTING DEMAND EQUATION

The basic variables used in the deer hunting (first stage) demand equation are shown in Equation 1. The specific variables used in preliminary regression estimates included demographic variables such as age, income, education, years of hunting experience, and success variables. Two substitute variables were defined from the survey data. One was a dummy variable based on the yes/no response to whether there was a substitute elk hunting site available to the hunter. A second substitute variable was based on the telephone survey response to (if yes, a substitute exists) the named substitute area and the distance to that substitute area. Substitute distance was calculated from the sample using actual trips from a given origin to the named substitute. Distance to a substitute was used as a measure of substitute price.

The results of the estimation of Equation 1 (double log specification) are as follows:

2) LTRIPCAP = -.825 - 1.2179LRDTRDIS - .1376 LYRSHUNT

(t-statistics): (-.88) (32.38) (-2.647)

- .4657 LSUCS

(-1.917)

Adjusted R^2 = .56, Observations = 994, F-statistic = 422.65

where:

LTRIPCAP = log of trips by individual i to site j over fractional zonal population (trips per capita).

LRDTRDIS = log of round trip distance from origin i to site j.

LYRSHUNT = log of number of years individual i has hunted site j.

LSUCS = log of deer success ratio at site j.

The adjusted R^2 statistic and F-statistc are quite high for a TCM model, indicating that the model provides a good fit to the data. All of the estimated coefficients except success are significant at the 95% level and have the expected sign. Success is significant at the 90% level. The key parameter, for purposes of consumer surplus estimation, is the slope coefficient on distance. The very high t-statistic for this parameter indicates that it is precisely estimated.

None of the site characteristic variables other than success were significant, and most of the demographic variables (such as income) were also not significantly correlated to per capita trips. The sample with substitute information was limited almost entirely to residents and was too small to use for the general model.

In addition to statistical significance and consistency with the theoretical model, the TCM model estimate can be evaluated on how well it predicts. As the model is estimated on per capita trips, accurate prediction of total trips is critical for the consumer surplus estimate. The model badly overestimates total trips for the sample: 7,180 predicted trips versus 2,010 actual trips. Examination of trip prediction at the observation level revealed that most of the overprediction is for origins either very close to or very far from the hunting sites.

Because of the prediction problems, the model was tested for heteroscedasticity using the Glejser (1969) Test. It was found that residuals were significantly correlated to distance. These results indicate that the double log transformation was not entirely successful at producing a model that was linear in the transformed variables.

As noted previously, the total number of nonresident hunters was also constrained by an absolute limit on the number of nonresident deer combination licenses and special permits. The limit in 1985 was 19,550. Unfortunately, information on the total number of nonresident permits that could be sold is not readily available. The net effect of constraints on nonresident licenses was to make the estimated demand curve more elastic at higher distances. This imparted a conservative bias to the estimated net economic values.

Opportunity Cost of Travel Time

The opportunity cost of travel time reflects the deterrent effect that longer drives have on visiting more distant sites, independent of vehicle operating costs. For example, many higher income people could afford the extra $8.00 or so of gasoline cost incurred if they drove an additional two hours to hunt, but many could not "afford" the additional time cost in terms of other activities foregone.

As noted previously, some fraction of the hourly wage is generally used as a proxy for this opportunity cost of time. This is due, in part, to the work of Cesario (1976), which showed the opportunity cost of time in commuting studies equaled between one-fourth and one-half of the wage rate. Based on this work, the Water Resources Council recommends using the opportunity cost of time in recreational travel at one-third the wage rate.

For our study, this estimate of the opportunity cost of travel time is 7.0 cents per mile, based on an estimated wage rate for our sample of deer hunters of $9.43 per hour and 45 miles per hour speed of travel. The hourly wage is derived from average household income for the deer hunter sample (25,380, based on 994 observations) and the ratio of U.S. median household income to average hourly earnings (Statistical Abstract, 1986). The latter implies an average of 2,691 hours of work per household for Montana.

Other empirical evidence on the cost of travel time is provided by a study of Rhode Island saltwater sport anglers

(McConnell and Strand, 1981). A comparison of the deterrent effect of travel time and monetary travel cost indicated that the anglers valued the time spent traveling at about 60% of the wage rate. The McConnell and Strand Model was estimated on the deer hunting database. The estimated parameters on trip costs and time were not significant at the 90% level. Accordingly, the Water Resources method estimate of 7.0 cents per mile for the opportunity cost of time was used for both the standard and reported travel cost parameters.

Variable Transportation Costs

Variable out-of-pocket travel expenses for Montana deer hunters were also calculated by two different methods. The "standard" approach recommended by the Water Resources Council is based on the variable cost of operating a motor vehicle. This cost was obtained from the U.S. Department of Transportation's Cost of Owning and Operating Vehicles and Vans - 1984 and is 15.2 cents per mile. This figure is based on the variable cost of operating a large-size vehicle, which most closely approximates engine efficiencies and size of typical vehicles utilized by hunters. Only 6% of our sample utilized compact- or intermediate-sized vehicles. The "standard" cost per passenger mile is, then, 5.8 cents, based on our sample average of 2.62 hunters per vehicle.

The reported variable travel cost is derived by regressing reported trip expenditures on distance traveled. The estimated slope coefficient on distance can then be interpreted as the variable monetary cost of travel (Burt and Brewer, 1971). The reported estimate differs from the standard, in that all trip costs (not just vehicle operating costs) are included. In addition, the estimate is derived from hunter survey data. The estimated equation is as follows:

3) TOTLCST =	17.86	+	.30 RDTRDIS
(t-statistics):	(2.09)		(30.90)

Adjusted R-square = .62, Observations = 583,F-statistic = 954.93

where:

TOTLCST = sum of reported hunter expenditures on transportation, lodging, food, guide fees, and other purchases.

RDTRDIS = round trip distance from hunter's residence to area hunted.

This model shows that total trip expenditures (defined to include transportation costs plus food, lodging, guide fees, and other purchases) are a function of distance traveled to the area hunted. The R-square statistic shows that the model has high explanatory power. The coefficient on distance (.30) is precisely estimated, as indicated by the high t-statistic value for this parameter. The coefficient on distance can be interpreted as the variable cost per mile traveled, or 30 cents per mile.

It should be noted that the estimate reported above is based on the assumption that all missing values for hunter expenditures are equal to zero. Some assumption on missing values was necessary, since the total number of observations with complete trip expenditure data was low. This occurred because many guiding fees. The assumption that all missing values are zero is the most conservative possible.

Table 1 provides a summary of the travel cost parameter values used in this study. The standard cost estimate (following the Water Resources Council method) is 13 cents per mile, while the reported cost estimate is 37.0 cents per mile.

Table 1. Travel cost parameters

	Transportation Cost (cents per mile)	Opportunity Cost of Time (cents per mile)	Sum
Water Resource Council Method	5.8	7.0	13
Reported Cost	30.0	7.0	37

Expenditure Data

Deer hunter expenditure data are provided in Table 2. Resident deer hunters spent an average of $55.00 per trip for transportation, food and beverages bought in stores and restaurants, lodging, guiding fees, and other purchases. This amounted to $31.11 per day. Not surprisingly, nonresident deer hunters spent an average of $542 per trip, or $85.83 per day, almost ten times as much as residents did. The average expenditure per trip for the sample was (residents and nonresidents) $146.00, or $73.00 per hunter day. Based on the 875,010 estimated hunter days, total expenditures by deer hunters in 1985 amounted to $63,875,730. Residents, on average, took two hunting trips during the hunting season and traveled an average of 61 miles, while nonresidents took one trip and traveled 800 miles.

Table 2. Per trip expenditures -- resident and nonresident deer hunters

Category	Average Resident Expenditures	Average Nonresident Expenditures	Sample Average
Transportation	$ 31.31	$ 253.06	$ 72.70
Lodging	2.19	62.51	13.45
Food bought in stores	13.35	78.78	25.56
Food bought in restaurants	4.32	72.90	17.12
Guiding Fees	0.00	45.41	8.48
Miscellaneous	3.89	29.77	8.72
TOTAL	55.06	542.43	146.03
Per Day Expenditures:			
Total	31.11 [1]	85.83 [2]	73.00 [3]

[1] Resident average days per trip = 1.77
[2] Nonresident average days per trip = 6.32
[3] Sample average days per trip = 1.98

Net economic values for Montana deer hunting were derived from the first stage demand functions shown in Equation 2. The following section presents these estimates.

Net Economic Values for Montana Deer Hunting

As explained above, net economic values were derived from the first stage demand curves by direct integration. The upper limit of integration in the following tables for any given observation is the furthest observed distance traveled in the sample, plus the observed distance. This corresponds to facing each hunter with a hypothetical site fee no higher than the maximum travel cost observed for the opportunity to hunt a particular area.

Consumer surplus per trip, based on Equation 2, is shown in Tables 3 and 4. The site average per trip, based on the standard cost parameter (13 cents per mile), and using the actual intercept term (Gum and Martin Method), is $38.22, or $108.00 based on the reported trip costs (37 cents per mile). The range across sites for the latter is considerable. The average values per day, are $20.88 and $54.94, for the standard and reported cost estimates, respectively.

The conventional method, used to derive the tables in Appendix C, uses a predicted intercept (or predicted trips) as the starting point for integrating the area under the demand curve. As may be recalled, trips are overpredicted, compared to actual, for most sites. It can be shown that site benefits are closely related to the trip-weighted average distance of hunting trips to a given site. The effect of poor trip prediction is that trip-weighted average distance may be incorrect. For Equation 2, a specific problem is that trips from far distances tend to be overpredicted; this has the effect of overstating average distance and site value.

Table 5 is a summary of the per trip and per day values, using both the standard and reported costs. In addition, the value of a Forest Service wildlife-fish user day (WFUD) is shown.

Table 3. Montana deer hunting -- net economic values per trip and per day (standard cost) -- Gum and Martin method

Area No.	Average Days per Trip	Value per Trip	Value per Day
101	2.35	23.56	10.03
102	2.23	27.75	12.44
201	1.87	21.93	11.73
202	2.47	25.58	10.36
301	2.40	25.40	10.58
302	2.10	21.84	10.40
303	2.28	19.03	8.35
344	1.68	28.96	17.24
401	1.68	25.63	15.26
402	1.90	41.22	21.69
422	1.92	33.46	17.43
433	1.82	38.76	21.30
466	2.00	44.63	22.32
501	2.07	41.17	19.89
511	2.32	27.11	11.69
522	2.28	22.61	9.92
611	1.85	55.01	29.74
622	1.72	55.16	32.07
633	1.53	56.27	36.78
701	1.65	81.09	49.15
702	1.43	86.53	60.51
	$\bar{x}$ = 1.98	$\bar{x}$ = 38.22	

Table 4. Montana deer hunting -- net economic values per trip and per day (reported cost) -- Gum and Martin method

Area No.	Average Days per Trip	Value per Trip	Value per Day
101	2.35	67.06	28.54
102	2.23	78.99	35.42
201	1.87	62.41	33.37
202	2.47	72.80	29.47
301	2.40	72.27	30.11
302	2.10	62.15	29.60
303	2.28	54.15	23.75
344	1.68	82.43	49.07
401	1.68	72.94	43.42
402	1.90	117.33	61.75
422	1.92	95.24	49.60
433	1.82	110.31	60.61
466	2.00	127.00	63.50
501	2.07	117.18	56.61
511	2.32	77.17	33.26
522	2.28	64.34	28.22
611	1.85	156.58	84.64
622	1.72	156.99	91.27
633	1.53	160.16	104.68
701	1.65	230.80	139.88
702	1.43	246.28	172.22
	$\bar{x}$ = 1.98	$\bar{x}$ = 108.79	

Table 5. Summary of net economic values -- per trip, per day, and per WFUD

	Net Economic Value	
	Standard Cost	Reported Cost
Per Trip	38.22	108.00
Per Day [1]	20.88	54.94
Per WFUD [2]	38.79	102.06

[1] Based on sample average of 1.98 days per trip.
[2] Based on sample average of 6.46 hours hunted per day.

Site Recreational Values

The total recreational value of Montana hunting areas can be estimated by multiplying hunting pressure (estimated total days of deer hunting per year) times the values per day, shown in Tables 6 and 7. This method implies that multiple destination and multiple purpose trips are at least as valuable as the trips that satisfy the TCM model requirements described in Section II C) above. Independent evidence from Contingent Valuation Method (CVM) studies suggest that this is so. Based on the benefit estimates using the Gum and Martin Approach and standard cost values, the total recreational value of Montana deer hunting is $18 million per year (Table 5). The corresponding estimate based on reported cost is $36.6 million (Table 6). The hunting pressure estimates are from the DFWP's 1985 Deer Harvest Survey.

Table 6. Montana deer hunting -- total recreational value of sites -- Gum and Martin method (standard cost)

Area No.	Value Per Day	Hunting Pressure	Site Value
101	10.03	49,481	$ 496,294.43
102	12.44	89,623	1,114,910.12
201	11.73	83,475	979,161.75
202	10.36	67,876	703,195.36
301	10.58	85,678	906,473.24
302	10.40	46,758	486,283.20
303	8.35	43,529	363,467.15
344	17.24	17,265	297,648.60
401	15.26	21,316	325,282.16
402	21.69	37,434	811,943.46
422	17.43	7,904	137,766.72
433	21.30	33,570	715,041.00
466	22.32	27,643	616,991.76
501	19.89	18,081	359,631.09
511	11.69	24,807	289,993.83
522	9.92	21,423	212,516.16
611	29.74	16,627	494,486.98
622	32.07	26,207	840,458.49
633	36.78	40,229	1,479,622.62
701	49.15	65,587	3,223,601.05
702	60.51	50,497	3,055,573.47
Total:		**875,010**	**$ 17,910,340.00**

Table 7. Montana deer hunting -- total recreational value of sites -- Gum and Martin method (reported cost)

Area No.	Value per Day	Hunting Pressure	Site Value
101	28.54	49,481	$ 1,011,391.64
102	35.42	89,623	2,273,735.51
201	33.37	83,475	1,995,052.50
202	29.47	67,876	1,432,862.36
301	30.11	85,678	1,848,074.46
302	29.60	46,758	991,269.60
303	23.75	43,529	740,428.29
344	49.07	17,265	606,692.10
401	43.42	21,316	662,927.60
402	61.75	37,434	1,655,705.82
422	49.60	7,904	280,829.12
433	60.61	33,570	1,457,273.70
466	63.50	27,643	1,257,480.07
501	56.61	18,081	733,003.74
511	33.26	24,807	590,902.74
522	28.22	21,423	432,958.83
611	84.64	16,627	1,007,928.74
622	91.27	26,207	1,713,151.59
633	104.68	40,229	3,015,968.13
701	139.88	65,587	6,570,505.66
702	172.22	50,497	6,228,804.95
Total:		875,010	$ 36,506,948.00

CONCLUSIONS

A modified Travel Cost Model suggested by Brown, Shalloof and Ksiao (1984) was used to calculate the net economic value of deer hunting in Montana. The demand equation estimated from survey data collected after the 1985 hunting season included variables on distance, years hunted, and success. Although a number of demographic and substitute site variables were tested, none were found to be statistically significant.

The TCM values presented in this report were calculated using both reported and standard transportation costs. The reported transportation costs are probably more accurate since they represent the driving conditions and vehicle types used when deer hunting.

The average net economic value of $108 per trip or $55 per hunter day equals the marginal net economic value of deer hunting. Therefore, the values presented in this report can be used in Benefit/Cost Analysis or economic efficiency analyses. By putting the annual value of deer hunting into present value terms, trade-off analyses with marketed resources (i.e., coal, livestock, etc.) can be performed.

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APPENDIX A

INTERVIEW DATE ____________

INTERVIEWER ____________

Did not hunt this past season ________

HUNTING SURVEY

For random trip# (1 die) ____.
if >6, roll again and add to 1st as needed

		HUNTING TRIP							
		1st	2nd	3rd	4th	5th	6th	7th	8th
1. Primary hunting area? (From Map)									
2. Was the primary purpose of your trip to hunt big game?	YES NO								
3. Primary species you selected the area for?	ELK DEER ANTELOPE								
4. Number of game you killed?	ELK DEER ANTELOPE								
5. Type of weapon used?	FIREARM ARCHERY								
6. Total number of days away from home	DAYS								
7. Total number of hours hunted.	(HOURS)								
8. One way distance to hunting area	(MILES)								
9. Was this area the primary place you hunted? (If yes go to next question) If no, how may areas did you hunt in? (Terminate and start next hunting trip)	YES NO								
10. How many years have you visited this area to hunt big game?	YEARS								
11. If you were unable to hunt in this area (due to emergency closure) would you have hunted this species at another area? If yes which one?	YES AREA NO								
12. About how long did it take to travel from your home to ______? (This should start when they left home and end when they arrived at the hunting area)	DAYS HRS. MIN								
13. Did you travel entirely by vehicle? YES ______ (If yes, fill in only 1st Mode section) NO ______ (If no, fill in as many Modes as necessary) Would you estimate the miles you traveled and what your transportation costs were? MODE TYPE 1. Compact (4 cyl) 2. Intermediate (6 cyl) 3. Full size (8 cyl) 4. 4 wheel drive 5. Recreational 6. Bus 7. Plane 8. Train 9. Motorcycle 10. Horseback 11. Walk	1st MODE TYPE MILES $SPENT								
	2nd MODE TYPE MILES $SPENT								
	3rd MODE TYPE MILES $SPENT								
14. If you had not gone hunting, would you have been working?	YES NO								
15. If yes, did this trip result in lost income?	YES NO								
16. If yes, could you estimate about how much you lost by going hunting? (Ask only once.)									

1. "First, about how many years have you been hunting?"
YEARS HUNTED ________

2. "What percentage of your hunting time was spent on foot or on horse back?"
TIME ________

3. "For hunting purposes, do you feel that the number of open roads in THIS AREA is: (Check One)
___ TOO FEW
___ ABOUT RIGHT
___ TOO MANY

4. "On average, how crowded did you feel this area was when you were hunting?" (Check One)
___ NOT AT ALL CROWDED
___ SOMEWHAT CROWDED
___ VERY CROWDED

5. "What do you perceive your chances of bagging a 4 point or better buck or 6 point or better bull elk are in this hunting area?"
Bull: ___ Poor ___ Fair ___ Good ___ Excellent
Buck: ___ Poor ___ Fair ___ Good ___ Excellent

6. "How many licensed hunters were in your vehicle?"
LICENSED HUNTERS ________

7. The next questions will help us to determine how much people spend on their Montana hunting trips. I'm going to list several things you may have spent money on specifically for this trip to ________________. Could you tell me how much you spent, if anything, on each item during the trip?

NOTE - Read each item, then record a dollar value next to it

Total transportation costs (gas,oil,wear & tear) $________
% at home ________
% spent in route ________
% near or at site ________

Lodging, such as hotels or campground fees? $________
% spent in route ________
% near or at site ________

Food and beverages bought in stores? $________
% spent in route ________
% near or at site ________
% at home ________

Food and beverages bought in resturants? $________
% spent in route ________
% near or at site ________

Fees for guides or outfitters? $________

Any other on site purchases such as hunting equipment, film, auto repairs, etc. $________

8. "Was the trip to this area worth more than you paid?"
___ YES
___ NO

If yes, what is the maximum amount you would have been willing to spend to visit this hunting area rather than some other?
$ ________

9. "How does hunting compare to other types of outdoor recreation you do?" (Check One)
___ FAVORITE
___ ONE OF FAVORITE
___ ONE OF MANY

10. "Could you estimate the current market value of the equipment you have purchased over the years primarily for hunting such as guns, wall tents, campers, etc.?
CURRENT VALUE IN HUNTING EQUIP. $________

11. "How many children under 15 live in your household?"
CHILDREN ________

12. "How many years of education have you had?"
YEARS ________

NOTE: Elementary = 6 yrs.
High School = 12 yrs
College Degree = 16 yrs
Master's Degree = 18 yrs
Ph D or MD. = 20 yrs

13. "During this last fall, about how many hours a week did you normally work?" (Include time such as housew^rk, volunteer work etc.) (Check One)
___ 01 - 10 HOURS
___ 11 - 20 HOURS
___ 21 - 30 HOURS
___ 31 - 40 HOURS
___ 41 - 50 HOURS
___ 51 - 60 HOURS
___ MORE THAN 60 HOURS.

14. "As I read the following age catagories, please indicate which one you are in." (Check One)
___ a. 12 - 15 ___ d. 30 - 39 ___ f. 50 - 61
___ b. 16 - 20 ___ e. 40 - 49 ___ g. 62 or older
___ c. 21 - 29

15. "I'm going to read a list of income categories. Could you please tell me which catagory your total household income before taxes in 1985 is in?"
___ a. 0 - 5,000 ___ f. 25,000 - 30,000
___ b. 5,000 - 10,000 ___ g. 30,000 - 40,000
___ c. 10,000 - 15,000 ___ h. 40,000 - 50,000
___ d. 15,000 - 20,000 ___ i. 50,000 - 75,000
___ e. 20,000 - 25,000 ___ j. MORE THAN 75,000
(please specify to nearest $10,000 dollar)

16. "This is the last question. Is there anything you would like to tell us about hunting in Montana?"

____

____

____

____

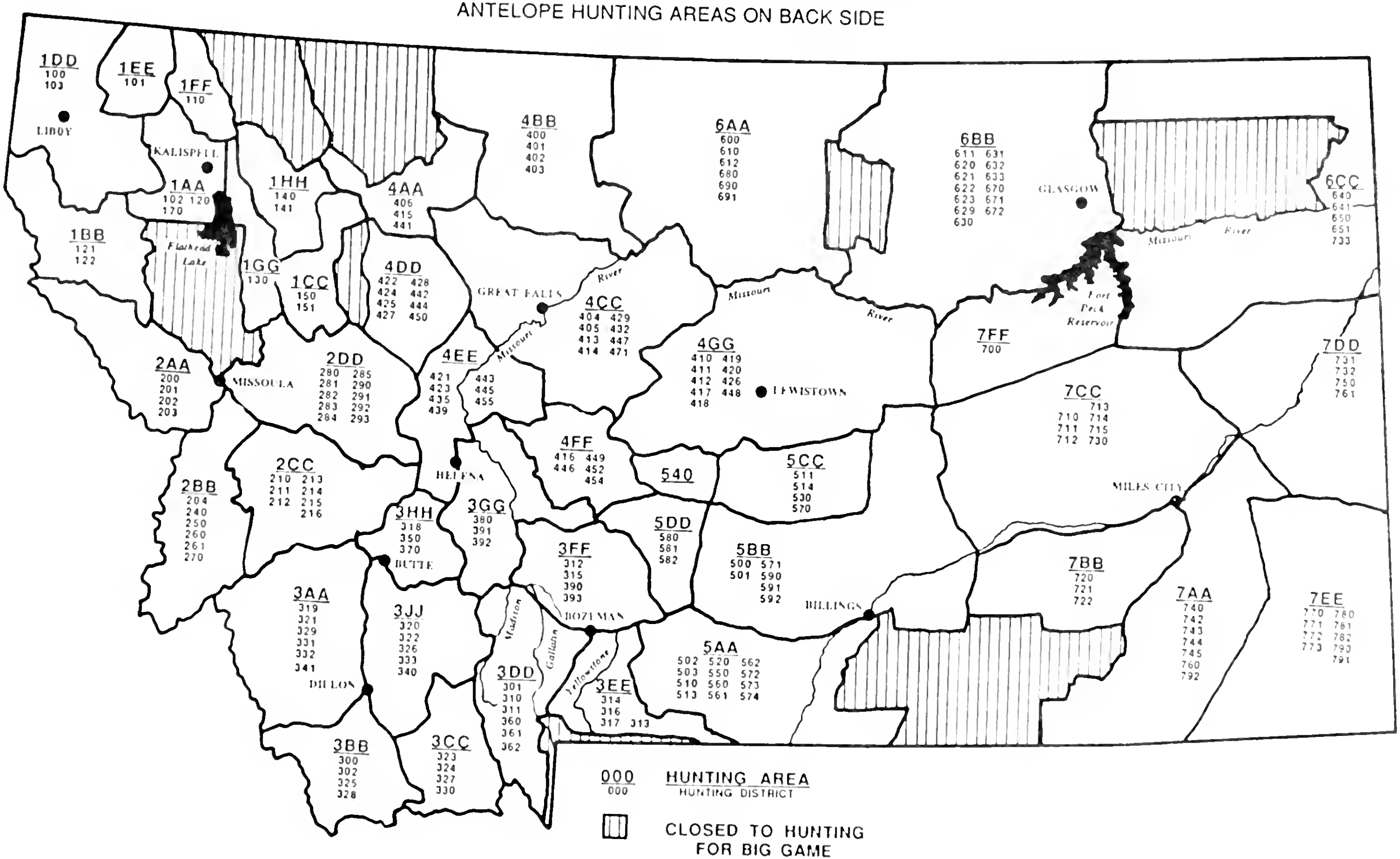
APPENDIX B

A number of Hunting Areas were combined into sites to provide a sufficient number of observations for the Travel Cost Method analysis.

Site No.	Hunting Area(s)
101	1AA, 1CC, 1GG, 1HH
102	1BB, 1DD, 1EE, 1FF
201	2AA, 2BB
202	2CC, 2DD
301	3AA, 3BB, 3JJ, 3CC
302	3EE, 3FF
303	3HH, 3GG
344	3DD
401	4AA, 4DD
402	4EE, 4FF
422	4BB
433	4CC
477	4GG
511	5AA
522	5BB
501	5CC, 5DD, 540
611	6AA
622	6BB
633	6CC
701	7AA, 7DD, 7EE
702	7BB, 7CC, 7EE

ELK AND DEER HUNTING AREAS

ANTELOPE HUNTING AREAS ON BACK SIDE



APPENDIX C

Table C-1. Montana deer hunting -- net economic value per trip (standard cost)

Area No.	Average Days Per Trip	Value Per Trip	Value Per Day
101	2.35	130.33	55.46
102	2.23	74.41	33.37
201	1.87	24.10	12.88
202	2.47	19.30	7.81
301	2.4	36.02	15.00
302	2.1	26.39	12.57
303	2.28	62.89	27.58
344	1.68	112.20	66.79
401	1.68	18.35	10.92
402	1.90	49.47	26.04
422	1.92	142.56	74.25
433	1.82	99.90	54.89
466	2.0	39.18	19.59
501	2.07	170.21	82.23
511	2.32	45.15	19.46
522	2.28	11.68	5.12
611	1.85	70.60	38.16
622	1.85	70.60	38.16
623	1.53	189.48	123.84
701	1.65	225.46	136.64
702	1.43	253.22	177.07
	$\bar{x}$ = 1.98	$\bar{x}$ = 96.53	

Table C-2. Montana deer hunting -- net economic value per trip and per day (reported cost)

Area No.	Average Days Per Trip	Value Per Trip	Value Per Day
101	2.35	370.94	113.05
102	2.23	211.78	68.02
201	1.87	68.61	26.27
202	2.47	54.93	15.93
301	2.40	102.53	30.60
302	2.10	75.12	25.62
303	2.28	179.00	78.51
344	2.28	319.33	56.22
401	1.68	52.23	22.2
402	1.90	140.81	53.08
422	1.92	405.75	151.36
433	1.82	284.33	111.89
466	2.00	111.50	39.93
501	2.07	484.44	167.61
511	2.32	128.51	39.67
522	2.28	33.28	10.44
611	1.85	200.95	77.80
622	1.72	643.94	268.13
633	1.53	539.30	252.45
701	1.65	641.69	278.54
702	1.43	720.69	360.96
	$\bar{x} = 1.98$	$\bar{x} = 274.74$	

Table C-3. Montana deer hunting -- total recreational value of sites (standard cost)

Area No.	Value Per Day	Hunting Pressure	Site Value
101	55.46	49,481	$ 2,774,216.00
102	33.37	89,623	2,990,719.00
201	12.88	83,475	1,075,158.00
202	7.81	67,876	530,111.00
301	15.00	85,678	1,285,170.00
302	12.57	46.758	587,748.00
303	27.58	43,529	1,200,529.00
344	66.79	17,265	1,153,129.00
401	10.92	21,316	232,770.00
402	26.04	37,434	974,781.00
422	74.25	7,904	586,872.00
433	54.89	33,570	1,842,657.00
466	19.59	27,643	541,526.00
501	82.23	18,081	1,486,800.00
511	19.46	24,807	482,744.00
522	5.12	21,423	109,685.00
611	38.16	16,627	634,486.00
622	131.54	26,207	3,447,268.00
633	123.84	40,229	4,981,959.00
701	136.64	65,587	8,961,807.00
702	177.07	50,497	8,941,503.00
Total		875,010	$ 44,791,638.00

Table C-4. Montana deer hunting -- total recreational value of sites (reported costs)

Area No.	Value Per Day	Hunting Pressure	Site Value
101	113.05	49,481	$ 5,593,827.05
102	68.02	89,623	6,096,156.46
201	26.27	83,475	2,192,888.25
202	15.93	67,876	1,081,264.68
301	30.60	85,678	2,621,746.80
302	25.62	46,758	1,197,939.96
303	56.22	43,529	2,447,200.38
344	136.14	17,265	2,350,457.10
401	22.27	21,316	474,707.32
402	53.08	37,434	1,986,996.72
422	151.36	7,904	1,196,349.44
433	111.89	33,570	3,756,147.30
466	39.93	27,643	1,103,784.99
501	167,61	18,081	3,030,556.41
511	39.67	24,807	984,093.69
522	10.44	21,423	223,656.12
611	77.80	16,627	1,293,580.60
622	268.13	26,207	7,026,882.91
633	252.45	40,229	10,155,811.05
701	278.54	65,587	18,268,602.98
702	360.96	50,497	18,227,397.12
Total:		875,070	$ 91,310,037.00