A Conjoint Analysis of Deer Hunters' Preferences on Hunting Leases in Alabama

by

Anwar Hussain, Daowei Zhang and James B Armstrong*

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* Respectively Research Associate, Professor, and Associate Professor at School of Forestry and Wildlife Sciences, Auburn University, AL 36849. This research is funded in part by Alabama Department of Conservation and Natural Resources and Alabama Forestry Commission. Acknowledgements are due to Amy Grilliot for helpful comments. Zhang is the corresponding author and can be reached at (334) 844-1067; fax (334) 844-1084; email: zhangdw@auburn.edu

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Abstract

Understanding hunters' preferences on attributes of hunting lease is the first step to successfully marketing hunting lands. Using conjoint analysis (CJA), this study analyzes hunters' preferences for hunting lease attributes based on a survey of hunters in Alabama. The results show that while congestion and site quality are important attributes, it is harvest success followed by lease rate and accessibility attributes that influences the ordering of hunters' preference for hunting leases the most. The study has implications for wildlife management and marketing.

Key words**:** Conjoint analysis (CJA), part-worth, hunter preferences, hunting lease (JEL classification Q26)

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Introduction

The contribution of deer hunting leases to forest landowners' income is largely determined by how well they manage and market their hunting lands. A critical input in this regard is an understanding of hunters' preferences. Previous studies have focused on the determinants of hunters' participation and willingness to pay (WTP) for hunting leases (e.g., Stewart 1969; Pope and Stoll 1985; Rossi 1998; Wallace 1989; and Hussain, Zhang and Armstrong 2002). A limitation of these studies, however, is that hunting leases were treated as a whole, and the various attributes and the contribution of each attribute to the overall utility and hence WTP for a hunting lease were not considered. How increments or decrements in various attributes affect total utility (and hence WTP) is important as it guides prospective lessors to make the needed adjustments in their management and marketing plans and thus maximize their income from a hunting lease.

Conjoint Analysis (CJA), a multi-attribute analysis technique, allows one to obtain the contribution of various attributes to hunters' WTP. CJA postulates that by decomposing the overall judgment of an individual into its basic elements, inferences can be made about the importance of each attribute and the psychological tradeoffs performed during the decision making process. The underlying premise of CJA is that by providing respondents with a set of stimuli to choose from, it is possible to make inferences about their preference ordering based upon behavior rather than upon self-reports. Zinkhan et al. (1997) found that for some forestry applications, CJA could improve financial projections and that in other cases where financial criteria are inadequate for evaluating alternative forest management scenarios, CJA could be used to quantify non-market forest benefits when complemented with professional judgment regarding forest management alternatives.

Researchers have expressed skepticism over the open-ended contingent valuation (CVM)[1] as a tool to evaluate non-market goods. In addition, there are limitations to the dichotomous choice contingent valuation (DCCV) since it values only a single attribute. These concerns have caused attention to be focused on modifications of DCCV and alternatives such as CJA which asks respondents to rate or rank, rather than to price alternatives (Stevens et al. 1997). Developed by Luce and Tukey (1964), CJA involves decomposing a composite good into its constituent attributes, surveying respondents regarding their relative preferences for alternative attribute bundles, and quantifying marginal rates of substitution between attributes. As regards its theoretical basis in economics, CJA is consistent with Lancaster's (1966) consumer theory which postulates that consumers derive utility not from goods themselves but rather from the attributes or characteristics that the goods possess.[2]

The objective of this research is to measure and evaluate the relative importance of individual characteristics of deer hunting leases in Alabama and determine the preferred combinations of those characteristics using conjoint analysis. The study complements the study by Mackenzie (1990) who used CJA to analyze attributes of deer hunting trips where data on preference ordering are rankings and lease rate is one of the attributes. The next section provides literature review, followed by methodology. Hypotheses and data, empirical results, and conclusions are presented in the remaining sections.

Literature Review

While applications of CJA in other disciplines have become a routine practice, its use in agriculture (e.g., livestock, horticulture, and fisheries), forestry and wildlife-related fields is gaining momentum.[3] Characterizing deer hunting trips as a multi-attribute recreation good, Mackenzie (1990) used CJA to derive willingness to pay for various attributes associated with deer hunting trips and estimated that implied marginal valuation for a 1% increase in the probability of harvesting a deer was $6.84 and the marginal valuation of a one hour reduction in travel time was $24.72. Likewise, Haefele and Loomis (2001a) estimated passive use values of US forest health and found that a household would be willing to pay $0.54 an acre to reduce forest pest infestation by one acre. Reddy and Bush (1996) used CJA to examine buyers' perceptions of softwood lumber value for preservation treatment and to determine tradeoffs between lumber attributes and price. Zinkhan et al. (1997) used a variation of CJA to measure users' utility for alternative nature and recreational park designs within a southern pine forest and found that estimated total utility levels for the park designs were quite sensitive to selection decisions for each of the four attributes included in the experiment.

While Gegas and Stanely (1997) indicated that CJA are valid,[4] an increasing number of researchers (e.g., Roe et al. 1996; Stevens et al.1997; Stevens et al. 2000; Boyle et al. 2001) did not find it as the panacea for non-market valuation and have turned their attention to test the validity and reliability of CJA for valuing non-market commodities with multiple attributes. Boyle et al. (2001) used various response formats including ratings, ranks, choosing one, and DCCV to generate preferences for various timber harvesting practices and examined the implied compensating variation of moving from the status quo forest practices to more environmentally benign timber harvesting based on a survey of residents in Maine. Their results indicated that convergent validity of ratings, ranks, and choosing one of the forest practices could not be established. Using CJA, Stevens et al. (2000) estimated non-industrial private forest landowners' willingness to pay for activities that are compatible with ecosystem management. Employing four different econometric models, including a DCCV logit model, two CJA models, and a ratings difference CJA model, they found that while the CJA approach offered several conceptual advantages relative to open-ended contingent valuation, CJA was sensitive to model specification. While they could draw no comprehensive conclusions about landowners' attitudes towards ecosystem management, they concluded that many respondents would pay some amount for wood turtle habitat protection downstream off their own property and that landowner affluence and likelihood of participation in ecosystem management were related.

Conceptual Framework

To apply the CJA, consumer preferences for a product are assessed by estimating the importance of product attributes to consumers. Respondents are presented stimuli comprised of alternative profiles of attribute levels and asked to rank or rate these profiles.[5] The attributes used in CJA must be chosen carefully in order to encompass only those attributes that are most likely to influence a consumer's preference. In the case of deer hunting, attributes influencing hunters' preferences would include site accessibility, lease rate, probability of success, site congestion and quality, type of deer harvested (doe or buck), type of a company, hunting experience, investment in hunting equipment, and hunters' socioeconomic characteristics (Hussain, Zhang, and Armstrong 2002). However, while all the factors enunciated above are important, given the complexity such analysis would entail, we consider only 5 major attributes in this study (Table 1).

Given the selected 5 attributes with 3 each at 3 levels, and 2 each at 2 levels, our experimental design yields 18 hunting land lease profiles to be rank ordered by survey respondents (Table 2). Comparing our attribute specification with that of Mackenzie (1990), there are three distinctions. First, he differentiated levels of congestion as none, slight, moderate and severe, but we differentiate levels of congestion in terms of probability of encountering unexpected hunters. Second, while he defined accessibility in terms of hours taken to access a hunting site, we specify accessibility in terms of mileage from residence to hunting site. Lastly, while he used trip cost per day to serve as a numeraire for the valuation of other attributes, we include lease rate per acre.

While Green and Srinivasan (1978) reviewed a wide variety of estimation approaches and concluded that the estimation procedures did not differ much in their predictive validity, Haefelle and Loomis (2001b) recommended random effects ordered probit model with variables expressed as ratings differences that are derived as the difference between status quo as one of the product profile and other alternative product characterizations. Haefele and Loomis (2001b) claimed that non-panel estimators commonly used in CJA, such as OLS, ordered probit, and tobit models, would produce inefficient and inconsistent estimates of the standard errors in the presence of heteroskedesticity, calling into question any conclusions made about the significance of coefficients and model goodness of fit. Likewise, Mackenzie (1990) pointed out that estimating ratings as functions of the various attribute levels via ordinary least squares yields asymmetrically truncated residuals and biased coefficients. Thus he suggested that rank-order logistic regression be used. The use of OLS would be acceptable, however, if the dependent variable is measured as rankings rather than ratings (Manalo 1990).

Using one of several estimation methods discussed, the relative importance of each attribute is estimated given the ranking or rating data. The estimation technique assigns to each attribute level a value called part-worth that indicates the relative importance of that level to the respondent. The measure of the importance of an attribute is then derived from the range of the part-worths over the levels of that attribute. By summing the part-worths for various combinations of attribute levels, one can find the total worth or value of a product to the consumer.

As data on the dependent variable in this study is measured as rankings, ordinary least squares (OLS) is used to estimate part-worths consistent with the following conjoint model

$$Y_{in} = \beta_0 + \beta_1 X_{1in} + \beta_2 X_{2in} + \beta_3 X_{3in} + \beta_4 X_{4in} + \beta_5 X_{5in} + \beta_6 X_{6in} + \beta_7 X_{7in} + \beta_8 X_{8in} + e_{in}$$

where i = 1, 2, . .18 represent hunting land profiles, n = 1, … N are survey respondents, Y_{in} is the rank assigned by the nth respondent to the *i*th hunting lease profile in the orthogonal array, and e_{in} is the error term. Expressed as dummy variables, X_{1in}, and X_{2in} denote level of the attribute accessibility in the *i*th combination; X_{3in} and X_{4in} denote level of the attribute lease rate/acre. Similarly, X_{5in} and X_{6in} denote level of the attribute success—deer harvested as % of the daily bag limit; X_{7in} denotes level of the attribute congestion specified as the probability of encountering unexpected hunters while X_{8in} represents level of the attribute site quality. βs are parameters to be estimated. For estimation purposes, effects coding approach (Hardy 1993) is used to appropriately model all the Xs (see Table 3).

To quantify the relative importance of various attributes, as the first step we establish the utility range for each attribute by taking the difference between the maximum and minimum estimated part-worth of that attribute. Next, take the sum of the ranges over all attributes. The relative importance RI_i of an attribute "i" is, then, defined as

$$RI_i = [\text{Utility Range}_i \div \sum \text{Utility Ranges for all attributes}] \times 100$$

Hypotheses and Data

Based on the literature reviewed and focus group discussions, we hypothesized that hunters prefer hunting leases with possibly high harvest success, low congestion, accessibility within short distance, low lease rate, and sites with better quality such as secluded environment. In order to generate data on the various hunting land attributes and associated levels of interest, we conducted a survey of 622 active hunters in Alabama which was collected from Zhang and

Armstrong (2002). A pre-tested survey questionnaire, along with cover letter and a $1 bill was mailed to these hunters in spring of 2002. Respondents were asked to rank the set of 18 deer hunting trip profiles on a scale of 1 to 18, with 1 as the least preferred alternative and 18 as the most preferred. Nineteen unopened surveys were returned due to wrong addresses, reducing the sample size to 603. A total of 335 questionnaires were returned, representing a response rate of 56 percent. However, only 48 respondents who properly ranked the hypothetical hunting scenarios were used to estimate part-worths. As each respondent was asked to rank 18 hypothetical hunting scenarios, this resulted in 864 ranking observations. While response rate to mailed surveys is always a concern in empirical research based on such surveys, it is especially so in conjoint analyses because of the demanding nature of the questions respondents have to answer. Even the simplest scenarios force respondents to think hard. But at the same time literature suggests that even researchers with very small samples have had success in terms of obtaining meaningful statistical results. Thus, it could be that, the demanding nature of conjoint questions serves as an additional factor to result in a lower response rate to mailed surveys while at the same time these questions screen respondents with distinct clarity, with favorable implications for data quality.

Empirical Results

The conjoint model parameter estimates are given in Table 4. All the estimated coefficients have the *a priori* hypothesized signs. For example, accessibility attribute level "51 or more miles away" had a negative coefficient as expected. Likewise, hunting lands promising 100% harvest success in terms of the allowable daily bag limit were ranked positively. All the coefficients, except two, are statistically significant at the 5% level of significance or better. As indicated by the value of adjusted R^2 of 27% and $F_{(8,855)}$ statistic of 39.96, the overall model fits reasonably well.

The coefficient of 2.24 for accessibility attribute level “51 or more miles” suggests that, other things being equal, a hunting lease that is “51 or more miles” away would be ranked 2.24 units lower (on a scale of 1-18) than a hunting lease that is “less than 25 miles” away. Similarly, the coefficient of 0.50 for the attribute lease rate per acre level “$5-7 per acre” suggests that, other things being equal, a hunting lease that costs $5-7 per acre would be ranked 0.50 unit lower (on a scale of 1-18 scale) than the hunting lease that costs less than 5 dollars per acre. The estimated parameter coefficient of 6.52 for the harvest success attribute level “success -100% of the bag limit” suggests that a hunting lease that promises 100% harvest success would be ranked 6.52 units higher (again on a scale of 1-18 scale) than a hunting lease that promises harvest success of 25 or less percent of the daily bag limit.

In conjoint measurement, a hunter’s total utility for a hunting lease is a function of his/her part-worth utilities. Thus, to determine a hunter’s total utility for a hunting lease, part-worth utilities for each lease attribute were estimated. Using the part-worth expressions given in Table 3, and regression coefficients shown in Table 4, the implied part-worths are provided in Table 5. As respondents were asked to rank the various trip profiles of attributes from 1 to 18, with 1 representing the least preferred trip profile, part-worths with highest value indicates the most important level of an attribute to the hunters.

An important aspect of CJA is that knowing part-worths allows the determination of the total worth to hunters even of those attribute profiles that are not included in the orthogonal array. Based on the estimated part-worths, the most preferred trip profile of attributes is represented by a hunting lease that is accessible within 25 miles, has lease rate less than $5 per acre, promised a harvest success that was 100% of the daily bag limit, has only 25% probability of encounter with unexpected hunters, and is secluded. The total worth (i.e., the sum of the attribute-level part-worths) of this trip profile is 59.92. Of the stimulus profiles shown in Table 2, trip profile 4 has the highest total worth of 58.39 while trip profile 14 has the lowest total utility of 35.28. Note that as the derived importance of attributes is dependent on the levels of each attribute, different levels will likely result in a different estimate of attribute importance. However, this is not going to change the relative importance of a given attribute relative to others.

Given estimated part-worths, the relative importance of each attribute was obtained as the quotient of its utility range—the difference between maximum and minimum estimated part-worth of an attribute, and the absolute sum of all utility ranges associated with the set of attributes. The results, presented in Table 5, show that harvest success, lease rate, and accessibility were perceived as the most important attributes by hunters. Respective scores for these attributes are given as 14.81 (or 51%), 5.36 (18.50%) and 5.07 (or 17.50%) units, given a total score of 29.02 units. Importance scores for the congestion and site quality attribute are respectively given as 1.53 and 2.25 units. Note that the greater the difference between the maximum and minimum valued level of any attribute, the greater the importance of the attribute. Conversely, if all the possible levels have the same utility, the attribute would not be important for it would have no influence on the overall attribute.

Conclusions

An understanding of hunters' preferences for various lease attributes is central to lessors' efforts to increase their income from hunting leases because such knowledge provides direction as to the specifics of managing and marketing hunting lands. This study represents an effort to advance our understanding as to how hunters rank deer hunting leases that are uniquely distinguished from each other on the basis of certain attributes. The results show that while harvest success, lease rate per acre, accessibility, congestion and site quality play an important role in influencing hunters' rank ordering of hunting leases, harvest success has the largest impact on hunters' valuation. Since accessibility is external to most landowners, landowners in Alabama and other southern states who invest in wildlife management and attract more deer to their lands could thus generate more income from deer hunting lease.

Footnotes

[1] Comparing CJA and open-ended CVM, one conceptual difference is that the former treats price of the good as simply another component attribute of the good. From an empirical standpoint, the CJA methodology offers some significant advantages over the open-ended contingent valuation methods because respondents are generally more comfortable providing qualitative rankings or ratings of attribute bundles that include prices, rather than dollar valuations of the same bundles without prices. In treating price as simply another attribute, the conjoint approach minimizes many potential biases that can arise in open ended contingent valuation studies when respondents are presented with the unfamiliar, and often unrealistic, task of putting prices on non-market goods (Mackenzie 1992, 1993).

[2] Both CJA and hedonic pricing draw on Lancaster's (1966) demand theory for theoretical justification. CJA is essentially the non-market equivalent of hedonic pricing. For a comparison of CJA and hedonic pricing, see Gegax and Stanely (1997) who show that CJA can be useful in situations where hedonic estimation fails.

[3] See for instance, Baido-Forson et al. (1997), Gineo (1990), Gan and Luzar (1993), Halbrendth et al. (1991), Harrison et al. (1998), Holland and Wessells (1998), Tano et al. (2002), Mackenzie (1990, 1992, 1993), Manalo (1990), Reddy and Bush (1996), Steven et al. (1997, 2000), Teisl et al. (1996), and Zinkhan et al. (1997).

[4] Finding lack of a significant difference between hedonic and CJA marginal valuation (MV) estimate, Gegas and Stanely claim support for convergent validity. They also suggest that theoretical validity is supported as the utility function estimated from the CJA data conforms to expectation derived from theory.

[5] Where multiple bundles are to be compared, it is efficient for respondents to rank a small number of bundles simultaneously, i.e., use a full-profile approach, rather than make sequential pair-wise comparisons. Where the number of bundles is large, fractional factorial design such as Graeco-Latin is employed to select only the set of orthogonal array. Orthogonal arrays provide an efficient way of picking the right number of combinations. In order to derive Hicksian measures of compensating variation, Roe et al. (1998) suggested including status quo as one of the product profile besides alternative product characterizations. This, however, means that respondents must have prior experience with the product.

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Table 1. Site Attributes and Levels of Deer Hunting Leases

Attribute	Unit	Levels	Hypothesized Sign
Accessibility	Miles from residence to hunting site	i) Less than 25 ii) 26-50 iii) 51 or more	Sites farther away are valued less
Lease rate	$/ acre	i) Less than 5 ii) 5-7 iii) 8 or more	As lease rate increases, site valuation falls
Success	Deer harvested as % of daily bag limit	i) 25 or less ii) 26-50 iii) 100	As the probability of success increases, site valuation increases
Congestion	Probability of encountering unexpected hunters	i) 25 or less percent ii) 26-50 percent	As the probability of congestion increases, site valuation decreases
Site quality	Relative stage of development	i) Secluded ii) Semi-modern	Secluded hunting sites are preferred to semi-modern sites

Table 2. Orthogonal array of Combinations of Deer Hunting Land Attributes

Stimulus profile	Accessibility-miles from residence to hunting site	Lease rate-$/acre	Success-deer harvested as % of the daily bag limit	Congestion-probability of encountering unexpected hunters	Site quality
1	Less than 25	Less than 5	25% or less	Less than 25%	Secluded
2	Less than 25	5-7	26-50%	Less than 25%	Semi-modern
3	Less than 25	8 or more	100%	25 – 50%	Secluded
4	Less than 25	Less than 5	100%	25 –50%	Secluded
5	Less than 25	5-7	25% or less	Less than 25%	Semi-modern
6	Less than 25	5-7	26-50%	Less than 25%	Secluded
7	25-50	Less than 5	26-50%	25-50%	Semi-modern
8	25-50	5-7	100%	Less than 25%	Secluded
9	25-50	8 or more	25% or less	Less than 25%	Secluded
10	25-50	Less than 5	25% or less	Less than 25%	Secluded
11	25-50	5-7	26-50%	25 –50%	Secluded
12	25-50	8 or more	100%	Less than 25%	Semi-modern
13	51 or more	Less than 5	100%	Less than 25%	Semi-modern
14	51 or more	5-7	25% or less	25-50%	Secluded
15	51 or more	8 or more	26-50%	Less than 25%	Secluded
16	51 or more	Less than 5	26-50%	Less than 25%	Secluded
17	51 or more	5-7	100%	Less than 25%	Secluded
18	51 or more	8 or more	100%	25-50%	Semi-modern

Table 3. Attribute Levels and Effects Coding

Attributes by level	Dummy variables		Coefficients
Accessibility(miles from residence to hunting site)	X_1	X_2	
Less than 25	-1	-1	$\beta_0 - \beta_1 - \beta_2$
25-50	1	0	$\beta_0+\beta_1$
51 or more	0	1	$\beta_0+\beta_2$
Lease rate-$/acre	X_4	X_5	
Less than 5	-1	-1	$\beta_0 - \beta_3 - \beta_4$
5-7	1	0	$\beta_0+\beta_3$
8 or more	0	1	$\beta_0+\beta_4$
Success(deer harvested as % of daily bag limit)	X_7	X_8	
25% of the bag limit	-1	-1	$\beta_0 - \beta_5 - \beta_6$
26-50% of the bag limit	1	0	$\beta_0+\beta_5$
100% of the bag limit	0	1	$\beta_0+\beta_6$
Congestion(probability of encountering unexpected hunters)	X_{10}	X_{11}	
Less 25%	-1	-1	$\beta_0 - \beta_7$
25-50%	1	0	$\beta_0+\beta_7$
Site quality	X_{13}	X_{14}	
Secluded	-1	-1	$\beta_0 - \beta_8$
Semi-modern	1	0	$\beta_0+\beta_8$

Table 4. Estimated Regression Coefficients

Variable	Estimated Coefficient	t-ratio
Constant(β_0)	9.19	21.99*
X_1: 25-50 miles(β_1)	-0.59	-1.58
X_2: 51 or more miles(β_2)	-2.24	-5.88*
X_3: \$5-7 per acre (β_3)	-0.50	-1.36
X_4: \$8 or more per acre (β_4)	-2.62	-6.52*
X_5: 26-50% of the bag limit(β_5)	1.76	4.40*
X_6: 100% of the bag limit (β_6)	6.52	16.06*
X_7: 25-50% probability of encounter(β_7)	-0.77	-2.33**
X_8: Semi-modern site quality(β_8)	-1.13	-3.42*
Adj-R^2	0.27	
F(8,855)	39.96	
Sample size	864	

* Indicates statistical significance at 1%
** Indicates statistical significance at 5%

Table 5. Estimated Part-worths and Attribute Importance

Attributes and levels	In terms of Regression Coefficients	Estimated Part-worths	Utility Range	Attribute Importance(%)
Accessibility(miles from residence to the hunting site)				
Less than 25(base)	$\beta_0 - \beta_1 - \beta_2$	12.02		
25-50	$\beta_0 + \beta_1$	8.59	5.07	17.50
51 or more	$\beta_0 + \beta_2$	6.95		
Lease rate($/acre)				
Less than 5(base)	$\beta_0 - \beta_3 - \beta_4$	11.93		
5-7	$\beta_0 + \beta_3$	8.69	5.36	18.50
8 pr more	$\beta_0 + \beta_4$	6.57		
Success(deer harvested as % of daily bag limit)				
25 or less(base)	$\beta_0 - \beta_5 - \beta_6$	0.91		
26-50	$\beta_0 + \beta_5$	10.95	14.81	51.00
100	$\beta_0 + \beta_6$	15.71		
Congestion(probability of encountering unexpected hunters)				
Less than 25%(base)	$\beta_0 - \beta_7$	9.95		
25-50%	$\beta_0 + \beta_7$	8.42	1.53	5.27
Site quality				
Secluded(base)	$\beta_0 - \beta_8$	10.31		
Semi-modern	$\beta_0 + \beta_8$	8.06	2.25	7.75
Total score			29.02	100.00