A Conjoint Analysis of Waterfowl Hunting in Louisiana

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Abstract

Conjoint analysis, widely used in marketing research, offers an alternative resource valuation approach suited to outdoor recreation activities characterized as multiattribute. Design, implementation, and interpretation of conjoint analysis are reviewed in the context of recreation applications. Conjoint analysis is used in an analysis of waterfowl hunting in Louisiana. Using primary data collected from a survey of waterfowl hunters, ordered logit is used to estimate willingness-to-pay for recreation experience attributes.

Key Words: conjoint analysis, recreation demand, waterfowl hunting, valuation

Attempts to evaluate the economic value of outdoor recreation activities such as waterfowl hunting are often complicated by the non-market characteristics of the activity which are under-represented when considered within a conventional market framework. For example, migratory birds, a fugitive resource, are not priced in a market. Additionally, most recreation activities, including waterfowl hunting, can be characterized as multiattribute. Demand for this good may be a function of a combination of social, economic, and institutional factors. As a result, the decision to hunt waterfowl may be influenced by the composition of the hunting party, constraints on bag limits, the number of days in the season, hunting site characteristics, or the annual cost of waterfowl hunting. Economic information on the characteristics that influence the decision to hunt waterfowl can provide valuable information to public and private resource managers faced with declining waterfowl populations as well as declining numbers of waterfowl hunters. By addressing this issue of method and measurement, policy makers will be better able to set and meet multiobjective resource management goals.

This research provides an economic analysis of waterfowl hunting in Louisiana, focusing on the multiattribute nature of this outdoor recreation activity. Our research employs and evaluates the appropriateness of a relatively new non-market valuation technique, conjoint analysis (CJA), for use in the valuation of attributes influencing waterfowl hunting decisions. CJA is a multivariate technique which can be used to understand consumer preferences for products or services (Hair, et al., 1990) The following section establishes the economic and cultural role of waterfowl hunting in Louisiana. The theoretical basis for conjoint analysis and recent applications are then reviewed. An empirical illustration is presented using primary data from a survey of 7,022 Louisiana waterfowl hunters.

Waterfowl Recreation in Louisiana

Migratory birds such as those found in Louisiana provide the basis for many consumptive and nonconsumptive recreational experiences, as these birds may be hunted, observed, or photographed. Almost two-thirds of the Mississippi Flyway's migratory waterfowl population winter in Louisiana's wetlands (U.S. Fish and Wildlife Service, 1990). Waterfowl hunting has, as a result, traditionally been an important use of Louisiana's extensive coastal and inland wetlands. While waterfowl related activities generate millions of dollars for Louisiana's economy annually, duck and goose hunting are the most significant sporting activities. However, recent declines in waterfowl populations have necessitated increasingly restrictive hunting regulations. As access to this resource has become further regulated through stricter

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limits on hunting days and bag limits, a decline in the number of Louisiana waterfowl hunters from 99,109 in 1986 to 65,000 in 1990 has occurred (Louisiana Department of Wildlife and Fisheries, 1991).

Conjoint Analysis: A Multiattribute Decision-Making Process

One perspective on the decision-making process of waterfowl hunters suggests that waterfowl hunters evaluate each available hunting alternative in terms of its attributes, assessing the relative importance of the attributes and ultimately choosing the hunting alternative with the greatest weighted aggregate score. Waterfowl hunters are assumed to maximize their underlying utility functions, based on the attributes and characteristics of the hunting trips as well as their individual socio-economic attributes. Although hunting trip attributes will differ among available alternatives, an individual hunter's attributes would remain constant. The decision to rate or rank different hunting trips reflects the multiple choice combination of hunters' socio-economic attributes, hunting trip attributes and characteristics that yields the greatest utility to the hunters. Viewed within this decision framework, evaluation of a recreationist's choices can be improved by development and use of a conceptual and empirical framework which explicitly recognizes the multiattribute nature of the good as well as the consumer's process of ranking these characteristics.

Conjoint analysis has become an increasingly popular approach to modeling consumer preferences for multiattribute choices. For example, over a decade ago, Cattin and Wittink (1982) estimated that more than 1,000 CJA applications had been reported. CJA has been employed extensively in the marketing literature where it has proven especially useful in analysis of new products, market segmentation, or product differentiation (Green, 1974; Green and Srinivasan, 1978; Green et al., 1981; Wittink and Cattin, 1989; Hair, et al., 1990; Halbrendt, Wirth, and Vaughn, 1991). CJA measures the joint effect of two or more independent variables on the ordering of a dependent variable (Green and Rao, 1971; Green and Srinivisan, 1978; Cattin and Wittink, 1982). Hair, et al. (1990) suggest that CJA is especially suited for understanding consumers' reactions to predetermined attribute combinations as CJA relates an individual's preferences to a set of prespecified attributes. The objective of conjoint analysis is to decompose a set of responses to factorially designed stimuli in which the utility of each stimuli attribute can be inferred from the respondents' evaluations of the stimuli (Green, 1974; Green et al., 1988; Halbrendt, et al., 1991). CJA models are decomposition models as the technique involves surveying respondents regarding their relative preferences for alternative bundles of goods when multiple attributes are varied simultaneously. Empirical estimates of an indirect utility index from which the marginal rate of substitution between attributes and marginal willingness-to-pay estimates for attributes can then be derived.

CJA involves measuring consumer utilities associated with various combinations of products or service offerings (Sands and Warwick, 1981). The approach is based on the economic theory of consumer choice in which consumer preferences can be measured in terms of utilities for individual attributes or components of the product offering. When added together, the utility values for the components of the product offering can then measure the total preference for various combinations of the product or service. The conceptual and empirical strength of CJA lies in information gained from analysis of the trade-offs made among product attributes that can be used to establish the perceived preference or utility of various product offerings.

CJA, sometimes known as factorial survey, can be characterized as an extension of the referendum closed-end contingent valuation method (CVM) in which large numbers of attributes and levels can be included in the analysis without overwhelming the respondents. This technique can for example be employed to construct hypothetical hunting trip choice sets, estimate the form of an indirect utility index for a single hunting trip, and derive willingness-to-pay (WTP) measurements for individual hunting trip attributes. Respondents are often more comfortable providing qualitative rankings and ratings of a given set of attributes which include prices rather than offer dollar valuations of the same bundle of goods without prices.

For example, let Z represent a composite good with N attributes in which $Z = (z_1, ..., z_N)$ where z_i ($i = 1.....N$) refers to the quantity of the i^{th} constituent attribute. Assuming utility $U[Z(z_1, ..., z_N); D]$ is additively separable in Z and other goods D, the marginal rate of substitution between any pair of attributes is independent of the level of any other goods, D. Now consider a consumer comparing two bundles of good $Z^0(....z_i^0, \; z_j^0....)$ and $Z^1(....z_i^1, \; z_j^1....)$ in which the consumer is left indifferent between bundles Z^0 and Z^1, and the attributes between z_i and z_j can be varied in proportion across the two bundles Z^0 and Z^1. Holding all other attributes constant, the implied marginal rate of substitution between attributes z_i and z_j is the ratio of the marginal utilities, $-U_{zi}/U_{zj}$ (Mackenzie, 1990; Goodman, 1989).

Marketing applications of CJA have typically employed an indirect utility function approach (Mackenzie, 1990; 1991). If for example, Z is a marketed composite good with a defined price P_z, then the utility function can be expressed as an indirect utility function $U(z_1, ..., z_N, P_z, Y)$, where Y represents income. The consumer will be comparing between bundles with $Z^0(....z_i^0, ... P_z^0)$ and $Z^1(....z_i^1, ... P_z^1)$. If only z_i and P_z are varied and consumers are otherwise indifferent between bundles Z^0 and Z^1, the marginal WTP for attribute z_i is given by the ratio $- U_{zi}/U_{pz}$, a compensated measurement with utility held constant.

The indirect utility function U(Z) has a systematic component u(Z) which is assumed to be the same for all consumers and a random unobservable component ε that is unique to all consumers, the utility from any bundle Z^i is given as

$$U(Z^i) = u(Z^i) + \varepsilon^i \qquad (1)$$

where u(Z) represents a specified functional form and ε^i represents a random disturbance term. If a consumer preferred Z^1 to Z^0, it implies $u(Z^1) > u(Z^0)$. Therefore, the probability that the consumer will choose Z^1 over Z^0 is given as:

$$\text{Prob}\ [u(Z^1) > u(Z^0)] = \text{Prob}\ [(\varepsilon^0 - \varepsilon^1) < \{u(Z^1) - U(Z^0)\}] \qquad (2)$$

Assuming that the ε's are independently and identically distributed, the appropriate functional form (for example normal or logistic) for the cumulative distribution of $(\varepsilon^1 - \varepsilon^0)$ defines the appropriate estimation technique (for example probit or logit) for the specification of the utility difference. From this, an indirect utility index can be estimated (Mackenzie, 1990; 1991; McFadden, 1974).

In the following section, economic and empirical models are developed using CJA to estimate Louisiana waterfowl hunters' rating preferences for hunting trips. Given the multiattribute nature of wetland-based recreation experiences such as waterfowl hunting, conjoint measurement offers an attractive technique in estimating waterfowl hunters' part-worth utilities for different hunting attributes and levels which often appear in predetermined combinations (Hair, et al., 1992).

Conjoint Analysis of Waterfowl Hunting

Conjoint analysis involves two basic design procedures. First, the attributes and attribute levels which form the design provisions must be identified. For example, in the case of waterfowl hunting, these attributes should reflect important hunting characteristics which hunters can use to assess hunting quality and site selection. Attribute levels correspond to points along these design specifications and should cover the entire range of representative levels (Cattin and Wittink, 1982).

In the application presented in this study, the selection of waterfowl hunting trip attributes and attribute levels drew upon a survey of waterfowl hunters' hunting characteristics and habits as well as input from focus groups conducted with personnel from the Waterfowl Division of the Louisiana Department of Wildlife and Fisheries. Based on input from this group, the selected attributes for this study included travel time, site congestion, type of hunting party, total cost, duck bag limit, type of hunting area, and length of season. Once the attributes and attribute levels were identified, they were combined into hypothetical waterfowl hunting trip vignettes similar to stimuli or treatments. A preference rating scale of 1 to 10 was assigned by survey respondents to each hunting trip or vignette with one as a completely unsatisfactory season and ten as the ideal season.

CJA assumes that an individual's ratings are systematic and consistent so that their ratings provide at least as much information concerning an individual's preferences for recreation attributes as ordinal rankings since they also provide some indication of the magnitude of the preference. The utility function of the hypothetical waterfowl hunting trip can, as a result, be estimated by means of traditional binary choice techniques such as logit, probit or tobit, using n*(n-1)/2 pairwise choice observations per respondent, or using n rank observations per respondent via the rank-order logit estimation technique (Harrell, 1980). If rankings are used in the binary choice model, the conventional intercept term is then replaced by n-1 separate dummy variables $a_1, a_2..., a_{n-1}$, accounting for n-1 rank intervals, where $a_j = 1$ for an observation rating j and $a_j = 0$ otherwise. If a k level rating scale is employed, the intercept term is substituted by k-1 separate dummy variables. This ordinal logit transformation collapses the rankings or ratings to define an indirect utility index normalized to a one unit rank or rating interval (Mackenzie, 1990).

A substantial amount of literature has been developed addressing the efficient design of CJA questions using fractional factorial designs (Green, 1974; Addelman, 1962). In this application, the hypothetical waterfowl hunting trip vignettes are described according to seven different attributes, with each attribute varying across three levels. The set of all possible waterfowl hunting trip vignette attributes therefore includes 3^7 or 2,187 different trip combinations or profiles. If preferences are assumed to be transitive and do not reflect significant jointness between attributes from the perspective of information content, most of these trip vignettes then become redundant (Mackenzie, 1990). For this analysis, a design algorithm, fractional factorial, was used to identify 20 parsimonious sets of vignettes which permitted development of marginal valuations of each level of each attribute (Saxton, Frederick, and Wright, 1991; Green and Wind, 1975; Green, 1974). Informational efficiency could also be improved by eliciting simultaneous rankings of multiple vignettes rather than pairwise comparisons. A respondent's rankings of n bundles in that case implies n*(n-1)/2 non-redundant pairwise comparisons.

Further informational efficiency gains are conceivable through the use of a rating scale 1,...,k (k > n). Assuming each respondent's ratings are consistent, the ratings provide at least as much information about the respondent's preferences for attributes as ordinal rankings. Indifference between bundles can be indicated by equal ratings, while rating intervals between different vignettes can provide some information on the intensity of preferences which is not revealed in rankings or binary choice techniques (Mackenzie, 1990).

Conjoint designs are orthogonal in that the variation of each attribute is completely independent of the variation of all other attributes. Orthogonality therefore implies that specifications of the utility function in which the attributes are entered in linear form on the right-hand side yields unbiased estimates of the "main effects" (i.e. obtaining marginal estimation of each level of each attribute without separate "joint effects" of the attribute) of those attributes on the utility. The estimation results from such models imply constant marginal rates of substitution between attributes, or constant WTP measurement. For example, let

$$\text{RATING} = F(ZB), \qquad (3)$$

where Z is defined by N attributes with each attribute i (i = 1,....,N) varying across discrete level j (j = 1,..., M), F is a transformation function such as the logistic, and ZB is the linear combination of attributes given by

$$ZB = \ldots + b_i z_i + b_j z_j + \ldots \qquad (4)$$

Setting the total differential of equation (4) equal to zero (i.e. no change in the rating) yields the following:

$$dZB = \ldots + b_i dz_i + b_j dz_j + \ldots = 0 \qquad (5)$$

Holding all other attributes constant except z_i and z_j, the marginal rate of substitution dz_i/dz_j, i.e. a given change in z_i to off-set a given change in z_j, would change by $-b_j/b_i$ so as to leave ZB and the rating unchanged. If the price P_z is included as an attribute, the compensated marginal WTP for z_i is $dP_z/dz_i = -b_i/b_{pz}$, which will be valid over the mid-ranges of the attribute levels offered in the conjoint design (Mackenzie, 1990, 1991).

The Empirical Application

In this application, each vignette used a ten level rating scale with the ordinal logit procedure estimating a separate constant to account for each rating level (ALPHA_1, ..., APLHA_{w-1} as specified below). The specification for the general rating model using APLHA ratings is then given as:

$$\text{RATING} = 1 / [1 + \exp^{-(ZB)}] \qquad (6)$$

where

$$\begin{aligned} ZB = \; & \text{ALPHA}_1 + \ldots + \text{ALPHA}_{w-1} + \beta_1(\text{TRAVELTIME}) + \beta_2(\text{LENGTH}) + \\ & \beta_3(\text{COST}) + \beta_4(\text{DUCKBAG}) + \beta_5(\text{ALONE}) + \beta_6(\text{FRIENDS}) + \beta_7(\text{STRANGERS}) \\ & + \beta_8(\text{CONGEST1}) + \beta_9(\text{CONGEST2}) + \beta_{10}(\text{CONGEST3}) + \beta_{11}(\text{LEASE}) + \\ & \beta_{12}(\text{PUBLIC}) + \beta_{13}(\text{COMMERCIAL}) + \varepsilon \qquad (7) \end{aligned}$$

and

ALPHA_w	= rating interval dummies (w = 10)
ALPHA_i	= 1 if the rating is i, and = 0 otherwise
TRAVELTIME	= travel time (1.5, 3, 5 hours one way)
LENGTH	= length of hunting season (20, 30, 40 days)
COST	= total cost of duck hunting per season
DUCKBAG	= daily duck bag limit (2, 3, 7 ducks)
ALONE	= 1 if waterfowl hunter hunted alone; 0 otherwise
FRIENDS	= 1 if waterfowl hunter hunted with friends; 0 otherwise
STRANGERS	= 1 if waterfowl hunter hunted with strangers; 0 otherwise
CONGEST1	= 1 if no reported congestion at hunting site; 0 otherwise
CONGEST2	= 1 if low reported congestion at hunting site; 0 otherwise
CONGEST3	= 1 if high reported congestion at hunting site; 0 otherwise
LEASE	= 1 if waterfowl hunter belongs to a lease or hunting club; 0 otherwise
PUBLIC	= 1 if waterfowl hunter hunted on a public hunting site; 0 otherwise
COMMERCIAL	= 1 if waterfowl hunter hunted on a commercial hunting site; 0 otherwise
ε	= error term

The vignette ratings were fitted to a logit transformation of a linear combination of right-hand side variables ZB. Letting Q represent a respondent rating n vignettes on a rating scale of k levels, then q_{tj} represents the number of respondents giving hunting trip vignette i a rating of j or higher. The indirect utility function can be estimated directly, with nQ original rating observations collapsed into n*(k-1) cell observations. A further adjustment suggested by Cox (1970) and Pindyck and Rubinfeld (1976), adding 0.5 to q_{ij}, was employed to improve the model efficiency as an adjustment for data that were sparse for some cells. The dependent variable, ZB in equation (6), then takes the form:

$$\text{Log}_e[(q_{ij}+0.5)/(Q_i-q_{ij}+0.5)] =$$

$$\text{ALPHA}_1 + \ldots + \text{ALPHA}_{w-1} + \beta_1(\text{TRAVELTIME}) + \beta_2(\text{LENGTH}) + \beta 3(\text{COST}) + \beta_4(\text{DUCKBAG}) + \beta_5(\text{ALONE}) + \beta_6(\text{FRIENDS}) + \beta_7(\text{STRANGERS}) + \beta_8(\text{CONGEST1}) + \beta_9(\text{CONGEST2}) + \beta_{10}(\text{CONGEST3}) + \beta_{11}(\text{LEASE}) + \beta_{12}(\text{PUBLIC}) + \beta_{13}(\text{COMMERCIAL}) + \varepsilon \quad (8)$$

where q_{ij} = cumulative number of respondents giving trip vignette i a rating of j or higher, and Q_i = total number of rating observations for trip vignette i. The rating model was estimated in linearized logistic form with the intercept term decomposed into ALPHA-1 separate intercept dummies to account for the intervals between APLHA rating levels (Mackenzie, 1990; Maddala, 1983; Chapman and Staelin, 1982).

Data and Hypotheses

Primary data for this analysis were obtained through a mail survey of 7,022 waterfowl hunters who purchased waterfowl stamps in Louisiana for the 1990-91 waterfowl hunting season. Dillman's Total Design Method (TDM) was employed in designing and conducting the mail survey (Dillman, 1978). The overall response rate for the survey was 47.26 percent, yielding a final total of 3,319 usable surveys.

Travel time (1.5, 3, or 5 hours one way) was included in the questionnaire to obtain valuations of travel time. The need for including time in recreation demand analysis is well documented in the recreation demand literature (Knetsch, 1963; Clawson and Knetsch, 1966; Cesario and Knetsch, 1970). Neglecting to account for the cost of time in estimating a recreation framework will result in a demand curve that will be biased from the true demand curve. In this survey, lower ratings were expected from trips requiring longer travel time.

Trip cost per season ($500, $1,000 or $1,500) was included to capture the valuation of the other attributes. Theoretically, a hypothetical site fee would have been preferred to an overall total cost per season, since respondents might identify more costly hunting trips with omitted attributes such as more guide services, meals, or lodging. This effect would reduce the variance of the trip ratings with respect to the total trip cost, thereby biasing the regression coefficient on trip cost downward and increasing the valuation estimates for other trip attributes.

Focus group input suggested that an important determinant of trip enjoyment includes the composition of the hunting party, here represented as hunting with close friends or with family members, hunting alone, or hunting with strangers. In Louisiana it is generally perceived that there is a strong preference for hunting with close friends or family members who reflect friendship and safe hunting partners. A lower rating would be expected if hunting were with strangers.

Site congestion (none, low, or high) was hypothesized to influence trip ratings. A heavily congested site could reduce trip ratings due to the nature of waterfowl hunting. Waterfowl hunters can be sensitive to the number of hunters present on a site because the larger the number of hunters hunting on a given site, the greater the distraction and noise. In addition, congestion could decrease the number of ducks present on a site, and increase competition for those on a site.

Waterfowl hunters in Louisiana (and throughout the nation) are facing restrictive hunting seasons and reduced duck bag limits. The hunting season is the number of hunting days that may occur within the total season and the daily bag limit is the number of birds of a specie or group that may be taken in one day. A lower rating was hypothesized for more restrictive hunting regulations. Based on possible management scenarios offered by the Waterfowl Division personnel participating in the focus group, a length of hunting season of 20, 30, or 40 days and bag limits of two, three, or seven ducks were specified.

Three types of hunting areas (lease, public lands, and commercial hunting sites) are generally available to waterfowl hunters in Louisiana who do not hunt on their own land. Commercial sites can provide extensive packages of services including room, board, a guide, and a blind. Leased acreage typically has few owner-provided services. Public land, including Wildlife Management Areas or Federal Refuges, typically offers limited services specifically to waterfowl hunters.

Empirical Results

Table 1 presents the coefficient estimates resulting from the conjoint analysis of the rating model of

Table 1. Coefficient Estimates Resulting from the Rating Model for the 1992 Sample of Louisiana Waterfowl Hunters

Variable	Parameter	Standard Error	t-statistic	Coeff/(COST)
$Alpha_0$	-33.044	4.42277	-7.4630	
$Alpha_2$	-0.69833	0.059101	-11.816	
$Alpha_3$	-0.52807	0.040818	-12.937	
$Alpha_4$	-0.37150	0.037661	-9.864	
$Alpha_5$	-0.23282	0.034636	-6.721	
$Alpha_6$	-0.92791	0.053981	-17.190	
$Alpha_7$	0.13486	0.027735	4.862	
$Alpha_8$	0.34046	0.026643	12.779	
$Alpha_9$	0.61084	0.027002	22.622	
$Alpha_{10}$	5.6487	0.40087	14.091	
TRAVELTIME	-0.14454	0.0064259	-12.493	($687.47)
LENGTH	0.0064478	0.00085520	7.539	$30.67
COST	-0.00021025	0.00001931	-10.887	$1.00
DUCKBAG	0.083211	0.0041993	19.815	$395.77
FRIENDS	0.14420	0.019651	7.338	$685.85
STRANGERS	-0.10601	0.025030	-4.235	($504.09)
CONGEST2	-0.0035773	0.020796	-0.172	($17.01)
CONGEST3	-0.20816	0.021784	-9.556	($990.06)
LEASE	0.15452	0.021220	7.281	$734.93
PUBLIC	-0.066875	0.020720	-3.227	($318.07)
n	3,283			
df	199			
R^2	0.92			
F-value	112.242			

the sample of waterfowl hunters who hunted in Louisiana during the 1990-91 waterfowl hunting season. The rating model was estimated by means of weighted least squares in SHAZAM to correct for problems of heteroscedasticity (White, et al., 1986). Of the 3,319 usable survey responses, 3,283 provided usable hunting trip vignette ratings of the conjoint question. Thirty-six (1.096 percent) of the 3,319 respondents did not rate any of the presented 20 waterfowl hunting trip vignettes. The total number of rating observations of hunting trip vignettes is thus slightly lower than the number of usable surveys.

The marginal WTP for attributes is given by the negative of the ratios of the coefficient on each attribute divided by the coefficient for COST. Negative ratio values represent attributes that reduce utility (for example, travel time and hunting with strangers). Positive ratio values represent attributes that increase utility (for example, length of hunting season, hunting with friends, and duck bag limit per day).

Confidence intervals for the WTP estimates can be derived using Fieller's (1932) method as the assumption of normality holds for the Weibull distribution underlying the logit model. Expressing $WTP_i = -b_i/b_{COST}$ as the hypothesis $b_i - b_{COST}WTP_i = 0$, the confidence limits for each WTP_i can be estimated from the quadratic roots of the inequality

$$[b_i - b_{COST}WTP_i] \; / \; [S_i^2 - 2S_iS_{COST}WTP_i + S_{COST}^2WTP_i^2]^{0.5} > t, \qquad (9)$$

where S_i^2, S_{COST}^2, S_iS_{COST}, represent the coefficient variances and covariance respectively, for the t-value corresponding to any desired confidence level (Finney, 1971). The 95 percent confidence intervals (for t = 1.96) for each of the estimated coefficients are shown in Table 2.

The slope coefficient of TRAVELTIME (-0.14454) gives the change in the log ratio of a waterfowl hunter giving trip vignette i a rating of j or higher per total decrease in TRAVELTIME for a particular hunting season. Likewise, the slope of LENGTH (0.0064478) and DUCKBAG (0.083211) gives the change in the log ratio of a waterfowl hunter giving trip vignette i a rating of j or higher per total increase in LENGTH and DUCKBAG for a particular season.

The estimated coefficients of LENGTH (0.0064478) and DUCKBAG (0.083211) are positive and significant, implying that as the length of the hunting season and the daily duck bag limit increase, a waterfowl hunter would give a higher rating to a trip vignette reflecting these characteristics. It also suggests the increasing marginal utility of hunting success. The estimated PUBLIC (-0.066875) and CONGEST3 (-0.20816) coefficients were negative and significant, implying that hunters in general do not prefer to hunt on public lands. The estimated coefficient for CONGEST2 (-0.0035773) with a t-ratio (-0.17202) is not significant at the five percent level of significance, implying that the effect of low site congestion on trip ratings is negligible. The estimated coefficient on COST (-0.00021025) suggests an increasing marginal disutility of rating trip vignettes with a high COST, consistent with diminishing marginal utility theory. Hunters in this sample appeared, as hypothesized, reluctant to continue hunting waterfowl if the total cost of waterfowl hunting increased.

Marginal valuations of the various trip attributes can be derived from the rating model in equation (6). For example, the marginal valuation of TRAVELTIME, the responsiveness of the respondent's marginal willingness to incur a higher total cost to have travel time decreased, is the constant

$$WTP_{Time} = -b_1/b_3 = -(-0.14454) /(-0.00021025) = -\$687.47 \text{ per season hour of travel time} \quad (10)$$

as derived from the linearized logistic rating model with a 95 percent confidence interval of -\$567.41 to -\$854.28 per season hour. Since TRAVELTIME is measured in hours, b_1 represents logistically-transformed ratings points per season hour, and COST is in dollars, b_3, represents logistically-transformed rating points per season dollar. Therefore, the ratio $-b_1/b_3$ expresses the time valuation in dollars per season hour. The value of \$687.47 per season hour of travel time is the mid-range value for COST (\$1,000), LENGTH (30 days), DUCKBAG (four ducks), and TRAVELTIME (three hours) from the CJA design.

This valuation of travel time is higher than the hourly wage rate which is often employed in traditional travel cost model studies (Cesario, 1976; Farber, 1985). In addition, this valuation reflects the implicit cost of displaced time at the hunting site rather than the opportunity cost of work time (Mackenzie, 1990). These high valuations of travel time also reflect the brevity of waterfowl hunting seasons which include substantial hunting expenses as reported by many respondents in the survey.

The marginal valuations of LENGTH and DUCKBAG are similarly derived as a constant from the linearized logistic rating model:

$$WTP_{Length} = -b_2/b_3 = -(0.0064478) /(-0.00021025) = \$30.67 \quad (11)$$

$$WTP_{Duck} = -b_4/b_3 = -(0.083211) /(-0.00021025) = \$395.77 \quad (12)$$

with a 95 percent confidence interval of \$22.87 to \$39.63 and \$326.67 to \$490.72 respectively. This valuation implies that the hunters are willing to pay \$426.44 to have the number of hunting days extended and the daily duck bag limit increased from the currently mandated three ducks per day.

Similarly, the implied WTP for type of hunting party and degree of site congestion can be derived by the constant of

$$WTP_{Friends} = -b_5/b_3 = -(0.14420) /(-0.00021025) = \$685.85 \quad (13)$$

$$WTP_{Strangers} = -b_6/b_3 = -(-0.10601) /(-0.00021025) = -\$504.09 \quad (14)$$

as derived from the linearized logistic rating model. The average hunter implicitly is willing to pay \$1,189.94 per season to hunt with close friends rather than with strangers. The hunter is also willing to pay \$990.06 [-(-0.20816)/(-0.00021025)] per season to have site congestion reduced from high to low. These results suggest that hunters implicitly are willing to spend \$318.07 more [-(-0.066875)/(-0.00021025)] to lease land for hunting rather than hunt on a public site.

Table 2. Confidence Intervals for Marginal Willingness to Pay Attribute Estimates from the Rating Model[1]

Variable	Covariance (with b_{COST})	Willingness to Pay Estimates	Upper $Bound_2$	Lower $Bound_3$
TRAVELTIME	-0.39701E-08	($687.47)	($854.28)	($567.41)
LENGTH	-0.49526E-08	$30.67	$39.63	$22.87
DUCKBAG	-0.37638E-08	$395.77	$490.72	$326.66
FRIENDS	-0.79668E-07	$685.85	$903.83	$499.50
STRANGERS	0.11112E-06	($504.09)	($745.12)	($277.09)
CONGEST2	-0.77019E-07	($17.01)	($222.35)	$173.34
CONGEST3	-0.52046E-08	($990.06)	($1302.08)	($745.29)
LEASE	-0.12356E-06	$734.93	$954.37	$542.53
PUBLIC	-0.50866E-07	($318.07)	($545.63)	($120.96)

Note:

1: The WTP confidence intervals for each WTP_i are the quadratic roots of the inequality $[b_i - b_{COST}WTP_i] / [S_i^2 - 2S_iS_{COST}WTP_i + S_{COST}^2WTP_i^2]^{0.5} > t$, where S_i^2, S_{COST}^2, S_iS_{COST}, represent the coefficient variances and covariance respectively, for the t-value corresponding to any desired confidence level (Fieller, 1932).

Source: E.C. Fieller, "The Distribution of the Index in a Normal Bivariate Population," *Biometrika*, 24(1932): 428-440.

Summary and Conclusion

Efforts to value many resource based recreation activities are complicated by the non-market characteristics inherent in these goods as well as variation in the bundling of these goods for consumers. In the case of waterfowl hunting, in addition to valuing a fugitive resource, demand may be influenced by the attributes of the experience, including party composition, site characteristics, cost considerations, and institutional restrictions. Conjoint analysis appears to offer a valuable theoretical and empirical perspective for this form of multiattribute decision-making process.

The ability to decompose consumer recreation choices into relevant components and assign values to these components offers valuable information to public as well as private resource managers. Private landowners seeking to package or bundle a product offering such as a waterfowl hunting weekend at a commercial site can benefit from additional information on preferred bundles. Likewise, landowners hoping to offer land for lease to waterfowl hunters can benefit from this level and form of new product information. Public land managers are often cast as managers of the most convenient recreation site, not necessarily the most preferred site. Information obtained through conjoint analysis offers some insight to public land managers on factors such as site congestion, hunting party composition, demand for services, and location of public lands which may influence future managerial decisions.

Although well established in field of marketing, conjoint analysis appears to offer new information to recreation analysts seeking to understand increasingly sophisticated consumer decisions. However, conjoint analysis is especially sensitive to design, implementation, and interpretation. Component attributes or factors selected for inclusion in a treatment or vignette must be reasonably representative of the composite good and be clearly defined. The number of attributes varying across plausible levels (or ranges) must also be well defined. Focus groups knowledgeable of the good prove invaluable at this point of the design process. The conjoint design questions should be pre-tested extensively and revised as necessary to resolve any doubts or ambiguity that respondents might face in the survey process. Finally, the practical application of the conjoint method should be clearly identified. More extensive use of this technique by resource and environmental economists will undoubtedly refine and define its applicability to non-market valuation.

References

Addelman, Sidney. "Orthogonal Main-Effect Plans for Asymmetrical Factorial Experiments." *Technometrics.* 4:2(1962): 21-46.

Cattin, Philippe and Dick R. Wittink. "Commercial Use of Conjoint Analysis: A Survey." *Journal of Marketing.* 46(1982): 44-53.

Cesario, Frank J. and Jack L. Knetsch. "Time Bias in Recreation Benefit Estimate." *Water Resource Research.* 6(1970): 700-704.

Chapman, Randall G. and Richard Staelin. "Exploiting Rank Ordered Choice Set Data within the Stochastic Utility Model." *Journal of Marketing.* 15:8(1982): 288-301.

Clawson, Marion and J. L. Knetsch. *Economics of Outdoor Recreation.* Baltimore, Maryland: Johns Hopkins University, 1966.

Cox, D. R. *The Analysis of Binary Data.* London: Chapman and Hall, 1970.

Dillman, D.A. *Mail and Telephone Survey.* New York: John Wiley and Sons, 1978.

Farber, Stephen. "The Value of Coastal Wetlands for Recreation: An Application of Travel Cost and Contingent Valuation Methodologies." *Journal of Environmental Management.* 26:4(1988): 299-312.

Fieller, E.C. "The Distribution of the Index in a Normal Bivariate Population," *Biometrika,* 24(1932): 428-440.

Green, Paul E. and Yoram Wind. "New Way to Measure Consumers' Judgments." *Harvard Business Review.* 53:7(1975): 107-17.

Green, Paul E. "On the Design of Choice Experiments Involving Multifactor Alternatives." *Journal of Consumer Research.* 1:9(1974): 61-68.

Green, Paul E. and V. Srinivasan. "Conjoint Analysis in Consumer Research: Issues and Outlook." *Journal of Consumer Research.* 5:9(1978): 103-123.

Green, Paul E., and Vithala. R. Rao. "Conjoint Measurement for Quantifying Judgmental Data." *Journal of Marketing Research.* 8:8(1971): 355-363.

Green, Paul E., and Yoram Wind. *Multiattribute Decisions In Marketing: A Measurement Approach.* Hinsdale, Illinois: The Dryden Press, 1973.

Goodman, Allen C. "Identifying Willingness-to-Pay for Heterogeneous Goods with Factorial Survey Methods." *Journal of Environmental Economics and Management.* 16(1989): 58-79.

Hair, J.F., R.E. Anderson, R.L. Tatham, and W.C. Black. *Multivariate Data Analysis with Readings.* New York, New York: Macmillan Publishing Company, 1991.

Halbrendt, C.K., F.F. Wirth, and G.F. Vaughn. "Conjoint Analysis of the Mid-Atlantic Food-Fish Market for Farm-Raised Hybrid Striped Bass." *Southern Journal of Agricultural Economics.* 23:1(1991):155-164.

Harrell Jr., Frank E. "The Logist Procedure." SUGI Manual SAS Institute, Cary, NC, 1980.

Judge, George G, R. Cater Hill, William E. Griffiths, Helmut Lutkepohl, and Tsoung-Chao Lee. *Introduction to the Theory and Practice of Econometrics.* New York: John Wiley and Sons, 1988.

Knetsch, J. L. "Outdoor Recreation Demands and Benefits." *Land Economics.* 39(1963): 387-396.

Louisiana Department of Wildlife and Fisheries. *Wildlife Resources of Louisiana.* Baton Rouge, Louisiana, 1987.

McFadden, Daniel. "Conditional Logit Analysis of Qualitative Choice Behavior." In P. Zarembka (ed.), *Frontiers in Econometrics.* New York: Academic Press, 1974, pp. 105-142.

Mackenzie, John. "Valuation of Open Space as a Composite Environmental Good via Conjoint Analysis." Paper Presented at the Annual American Agricultural Economics Association Meeting, Manhattan, Kansas, August 1991.

Mackenzie, John. "Conjoint Analysis of Waterfowl Hunting As A Composite Recreation Good." Paper Presented at the Annual American Economics Association Meeting, Vancouver, Canada, August 1990.

Maddala, G. S. *Limited Dependent and Qualitative Variables in Econometrics.* Cambridge, MA: Cambridge University Press, 1983.

Miller, Jon R. and Michael J. Hay. "Determinants of Hunter Participation: Duck Hunting in the Mississippi Flyway." *American Journal of Agricultural Economics.* 63:4(1981): 677-684.

Pindyck, Robert S. and Daniel L. Rubinfeld. *Econometric Models and Economic Forecasts.* New York: McGraw-Hill Book Company, 1976.

Saxton, Arnold, Rebecca Frederick, and Vernon Wright. Department of Experimental Statistics, Louisiana State University, Baton Rouge, Louisiana, 1990. Personal Communication.

White, K.E, S.A. Haun, N.G. Horsman, and S.D. Wong. *SHAZAM Econometrics Computer Program.* New York: McGraw-Hill Book Company, 1988.