

Stated Preference Methods for Environmental Valuation

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Stated Preference Methods Environmental Valuation

Introduction

Contingent valuation (CV) has been employed by economists for approximately 30 years to value changes in natural resources and environments. Estimating the value of resource improvements or damages is analogous to the problem in marketing research of estimating the demand for new products or services. There are two basic approaches to this problem which have evolved during the past two decades, although there are minor variations within each (See, e.g., Urban and Hauser 1993). The first approach involves the development of a detailed concept description of the product for which the demand forecast is to be made. This description need not be limited to verbiage, but may require the development of renderings, models, mockups, prototypes, multimedia presentations, etc. In any case, the essential elements are that the most accurate description possible of one (or at most a very few) potential products are used as the basis for determining the potential demand or share. In the second approach, the product of interest is viewed as one of many possible products which differ in the values or positions they occupy on key product characteristics or features. In this approach, carefully designed arrays of product characteristics are used to develop a number of product concept descriptions to which consumers react. This approach differs in terms of whether the product descriptions are shown "one-at-a-time", which represents some variant of traditional conjoint analysis (Green, et al. 1972; Green and Srinivasan 1978, 1990; Louviere 1988, 1994); or presented as sets of competing options, which represents some variant of experimental choice analysis (Louviere and Woodworth 1983; Louviere 1988a,b, 1994; Batsell and Louviere 1991; Carson, et al. 1994).

The first approach shares many similarities with traditional applications of CV, in which as accurate as possible a description of a resource improvement or damage is created, and samples of individuals are asked to respond to that improvement using open- or closed-ended valuation questions. The problem with this approach is that it relies very heavily on the accuracy of a particular description, and any errors in the description discovered after the fact cannot be changed. Thus, in the case of product concepts, if consumers are told the selling price is \$5.48, but the actual selling price upon and after introduction is \$7.24, there is no way to "adjust" the forecast to take this into account. Similarly, in the case of a resource damage scenario, if later

research indicates that instead of 250 dead ducks, the number was closer to 375, there is no way to take that into account. Similarly, this approach cannot actually value the various and separate components of the description; hence, the value of each duck cannot be determined. Likewise, in marketing research applications, the values of individual product features that comprise the product bundle cannot be ascertained.

In contrast, the second approach relies less on the accuracy and completeness of any particular product bundle description, but rather more on the accuracy and completeness of the product characteristics and features used to describe all the bundles. In this approach, a stream pollution "event" is viewed as one of many possible such events, and the onus is on the researcher to determine as exhaustive a set of variables as possible to describe either stream pollution events in general, or events that fall within a particular mutually exclusive category that includes the event in question. Statistical design techniques are used to sample from the universe of all possible "events" that are spanned by the variables and the values that the variables can take on in the type(s) of problem of interest. Rather than being questioned about a single event in detail, therefore, consumers are questioned about a sample of events drawn from the universe of possible events of that type. We refer to this latter method as the stated preference (SP) approach.

While CV methods have attracted environmental and natural resource economists' attention for nearly three decades, SP approaches to eliciting consumer preferences have not. SP methods have remained in the domain of human decision research, marketing and transportation research, even though support for their use in economic analysis was formalized some time ago (McFadden, 1986). In this paper, we outline the stated preference approach and describe how it can be used to value environmental amenities. We also discuss the advantages of SP techniques both in relation to CV methods and revealed preference (RP) techniques.

The Stated Preference Approach

Stated preference analysis, or the experimental analysis of choice, has its roots in conjoint analysis. Conjoint analysis is a form of analysis used to represent individual judgements of multiattribute stimuli (Batsell and Louviere, 1991). Conjoint analysis is a well known technique and has been applied in marketing for over 20 years. However, conjoint techniques have more

recently been applied in geography, transportation, and economics (see Louviere, 1991). The particular type of conjoint analysis that we examine here is the experimental analysis of choice. We focus on this particular approach because it parallels the Random Utility Model (RUM) structure (see McFadden, 1974; Ben-Akiva and Lerman, 1985) that is common in referendum CV models (Mitchell and Carson, 1989) and in discrete choice travel cost models (Bockstael et al, 1991).

Steps in an SP Experiment

There is a considerable literature that describes the steps to be taken in designing a CV experiment (Mitchell and Carson, 1989). Similarly, there is a substantial literature on designing SP experiments (Louviere, 1988a; Hensher, 1994). A summary of the steps is provided here with some elaboration of the components presented below. These steps are based on Hensher (1994):

1. Identification of the set of attributes.
2. Selecting the measurement unit for each attribute.
3. Specification of the number and magnitude of attribute levels.
4. Experimental design.
5. Survey instrument design.
6. Model estimation.
7. Use of parameters to simulate choice.

Most of these steps are well known to CV researchers. Tasks 1-3 can be considered the preparation of the information phase of CV. CV researchers are concerned with accurate presentation of information in a clear, concise fashion. Steps 1-3 in SP experiments attempt to describe the choice context in the form of attributes. This is, in many ways, the most important element of a SP study. This stage of research typically involves information collection from secondary sources, focus group research, and pre-testing in order to identify the attributes of a situation as perceived by the respondent and to determine the levels of the attributes in a manner that can be understood by the respondent. In both CV and SP the concern is with presenting the respondent with information that they can understand and respond to. Step 4 is unique to SP and is one of the advantages of the approach. It is discussed in detail below. Step 5 is again

comparable with a CV task. Survey design is important in any stated preference approach. In SP tasks the fact that respondents may be asked to consider several choice sets and/or multiple alternatives within each choice set, raises a set of survey design issues that are different from CV concerns. These are also discussed in more detail below.

In referendum CV models, econometric modelling is necessary and these models are then used to calculate welfare measures. Thus, steps 6 and 7 are common to SP and CV. However, recent advances in the analysis of SP tasks has led to the finding that these data sets can be combined with CV and/or RP data to enrich the data sources. We discuss these findings under the heading *Joint Estimation of SP, RP, and CV Models*. Also, since SP employs a RUM formulation, welfare analysis applied to these models in the economics' literature can be employed to yield measures of compensating variation from the SP models. We discuss this aspect under the heading *Welfare Measures*.

Experimental Designs

One of the fundamental aspects of SP methods is their use of experimental designs to array attributes and levels into choice sets. There is a large literature on this topic and a general consensus that the issues are well understood (Carson, et al, 1994; Batsell and Louviere, 1991). Given a set of attributes and levels, design methods can be used to structure paired comparisons or choice sets with more than two alternatives.

The experimental choice approach pioneered by Louviere and his associates (previous references) requires one to design both the "product" descriptions and the choice sets into which these descriptions are placed to satisfy the statistical assumptions and properties of various probabilistic discrete choice models. Unfortunately, as discussed by Louviere and Woodworth (1983), Batsell and Louviere (1991) and Bunch, Louviere and Anderson (1994), probabilistic discrete choice models are non-linear, and research into the construction of designs with desirable statistical efficiency properties for such models has barely begun (See Bunch, Louviere and Anderson 1994 for a review of this literature and a discussion of the issues). Thus, the current state-of-the-art in design construction for discrete dependent variable models is such that there are a large number of construction techniques now known to produce designs that satisfy the

properties of the models and permit the identification of a wide range of model forms and utility specifications (See, e.g., Batsell and Louviere 1991; Louviere 1994; Bunch, Louviere and Anderson 1994). Choosing among any of the candidate designs on the basis of statistical efficiency, however, remains elusive because one must know the true vector of probabilities a priori to optimize any particular design for efficiency, an obvious design impediment¹. The most recent statement of the state-of-the-art in this area based on the discussions and conclusions of the Workshop On Experimental Choice Analysis at the Duke Invitational Conference On Consumer Decision Making And Choice Behavior (Carson, et al. 1994), concluded that a number of design construction approaches are probably quite statistically efficient, but that formal proofs of this property are unavailable.

In the research described below, we employ a design construction technique first proposed by Louviere and Woodworth (1983) and since applied in many empirical research efforts (e.g., see Adamowicz, et al. 1994; Swait, Louviere and Williams 1994). This approach treats the attributes of all competing alternatives (known as "factors" in the design literature in marketing and statistics) and their associated levels as one large factorial design. The design problem consists of selecting samples of choice sets from the space spanned by the attributes and levels such that various identification properties can be realized. In the present case, we eventually wish to test for violations of the IIA property of certain probabilistic choice models like the conditional logit model (McFadden 1974), and explore more general stochastic choice model forms if necessary. Hence, the choice sets and the descriptions (called "profiles" in the marketing literature) are designed to permit us to estimate the most general model possible, which in our case is McFadden's (1975) Mother Logit model (See also McFadden, Train and Tye 1977).

The statistical design aspect of SP can be considered an advantage, however, care must be taken to ensure that the design is capturing the salient elements of the choice process. In cases with many attributes and/or levels, the potential number of combinations is very large. Experimental design can provide a structure that allows the estimation of parameters, however,

¹ It is noteworthy that CV research has focused on optimal statistical bid designs (Cooper, 1993) in order to efficiently estimate this important parameter. SP research, on the other hand, has concentrated on estimating the parameters of various attributes of the choice situation in a relatively (although not optimally) efficient fashion.

this design requires assumptions of zero coefficients on higher order interactions. For example, most SP research employs main effects plans that preclude the analysis of interaction effects between attributes. This suggests that a well designed SP study, just as a well designed CV study, requires a significant amount of pre-test work to identify attributes, levels and important interactions (Louviere, 1988).

An important aspect of the design process is that alternatives can be constructed to maintain orthogonality in the attributes. In contrast to revealed preference (or actual choice) data, which are often correlated, this property allows the researcher to identify the contribution of each attribute to the choice process. The use of orthogonal experimental designs in SP approaches also allows the SP data to be used as a form of "external information" to alleviate colinearity in RP models. SP information can be used in a type of mixed estimation process to address this issue. However, in order to be used in such a fashion, the models must be estimated jointly. We examine that aspect of SP models below.

Survey Design Considerations

An aspect of SP experimental procedures that is different from CV approaches is the determination of the number and size of the choice set. For example, in Adamowicz, et al, 1994, respondents were presented with 16 choice sets and were asked to choose 1 of the 3 options available. The experimental design process generated 64 choice sets but this was deemed to be too large a task for any respondent. Thus, the 64 sets were blocked into 4 sets of 16. Clearly, one must consider how many choice sets a respondent can accurately assess and how many alternatives within each choice set can be examined. Referendum CV models essentially provide 1 choice set with two alternatives. Research in the marketing literature suggests that a respondent can assess fairly large numbers of choice sets but that providing more than 6 alternatives within each choice set is difficult (Batsell and Louviere, 1991)². However, in most environmental analysis cases, one is concerned with the attributes before a change versus after a change. Thus, structuring experiments with 2 or 3 alternatives should represent reality quite well. For example,

² Providing more than 6 alternatives is possible in cases with few attributes or relatively simple choice situations.

2 designed alternatives could be presented along with the status quo.

Model Estimation

In the SP approach the respondent is asked to select the preferred "object" (described by attributes at various levels) from a choice set. Each alternative (i) in the choice set has an associated utility level represented by

$$U_i = V_i + \epsilon_i \quad (1)$$

This utility is comprised of an objective component (V_i) and an error component (ϵ_i). In the economics literature this function is also known as a conditional indirect utility function since it is conditional on the choice of the object (i). Selection of one object (package of attributes) over another implies that the utility (U_i) of that object is greater than the utility of another, say j (U_j). Since overall utility is random one can only analyze the probability of choice of one package over another, or

$$Pr \{i \text{ chosen}\} = Pr \{V_i + \epsilon_i > V_j + \epsilon_j; \forall j \in C\} \quad (2)$$

where C is the choice set. Specific choices of error distributions lead to methods for the estimation of the parameters of this utility function and quantitative representations of tradeoffs between attributes. An assumption of Type I extreme value distributed errors produces the conditional logit specification of the probability of choice, or

$$Pr \{i\} = \frac{e^{V_i}}{\sum_{j \in C} e^{V_j}} \quad (3)$$

The Random Utility Model described above provides the basis for the experimental choice process. However, this model is also the basis for the referendum model of CV. Thus, both techniques arise from the same theoretical background. SP, however, typically entails repeated

measure responses from the individual while CV does not.³

Revealed preference (RP) models also employ random utility theory. Typically these are models of recreational site choice or some other form of qualitative choice. These models are very popular in measuring economic values of environmental quality change (Bockstael, et al , 1991). In this case the objective component of the utility function is comprised of measures of attributes of the "real" alternatives. SP techniques directly parallel these qualitative choice models, however, SP approaches avoid measurement error and colinearity effects common in RP methods.

Joint Estimation of SP, RP, and CV Models

Since SP, RP, and CV models are all Random Utility Models they can be estimated jointly, exploiting the information available in each source. For example, Adamowicz et al. (1994) jointly estimate a SP and RP model of recreational site choice. In this case the SP and RP utility models can be specified as:

$$\begin{aligned} U_{RP} &= V_{RP} + \epsilon_{RP} \\ U_{SP} &= V_{SP} + \epsilon_{SP} \end{aligned} \tag{4}$$

where RP indexes the revealed preference utility function and SP indexes the stated preference function. Given a similar set of attributes (one set based on the experimental design and the other based on actual conditions) the data can be "stacked" to estimate a joint model. However, the variances in the two data sets may be different. In multinomial logit models it is common to assume that the scale parameters equal 1⁴. Swait and Louviere (1993) have developed an approach that estimates the relative scale parameter (the ratio of the scale parameters from each data set). This approach also facilitates the testing of the similarity of the models (equality of parameters) conditional on the possibility of different scale effects. In principle, SP, RP, and CV

³ There has been some movement toward a type of repeated measures responses in CV via the double bounded or triple bounded referendum CV models (eg. Hanemann, et al., 1991).

⁴ In Multinomial Logit Models, the scale parameter cannot be identified. Therefore, it is commonly assumed to be unity.

models can all be combined to efficiently utilize the information contained within each data form.

Welfare Measures

SP models provide estimates of conditional indirect utility function parameters. Therefore, determination of theoretically correct measures of welfare (compensating variation) is possible. Welfare measures arising from Multinomial Logit Models are well known (Hanemann, 1984; Bockstael et al, 1991). If one is interested in the value of an improvement at one of several available alternatives (eg. recreation sites) then the comparison of the expected maximum utility before and after the change becomes the foundation of the welfare analysis.

It is also possible to structure SP welfare analysis along the lines of referendum CV measures. In referendum CV models, the expected value of willingness to pay can be calculated as the area under the distribution of the probability of accepting the bid (Hanemann, 1984). The median welfare measure can be described as the payment level that makes the individual indifferent between the improvement and the status quo. Since the SP models are random utility models they can be rearranged to describe the probability of choice of the status quo attributes versus the "improved" attributes.

SP utility function parameters can be used to describe the marginal value of a change in an attribute. As shown by Lareau and Rae (1988) and McKenzie (1993), in a simple linear model, the ratio of the attribute coefficient to the "price" coefficient provides a marginal welfare effect. This welfare value, however, is not entirely consistent with the Random Utility Model if the welfare effect being examined is a change in one of several possible alternatives (e.g. quality changes at one of many recreation sites). In such a case information on the probability of choice of that alternative is also required (see Bockstael, et al, 1991).

Potential Advantages of SP Methods

Stated preference methods can reveal the value of attributes as well as the value of more complex changes in several attributes. In terms of eliciting preferences, stated preference methods, since they are structured as choices, have the same survey design advantages as referendum CV methods. That is, there will likely be fewer refusals and the choice approach is

more familiar to the respondent than a "payment" approach. However, the repeated sampling method employed in SP can alleviate some of the concerns regarding lower informational efficiency that affect the referendum CV model (Carson, 1991). Strategic behaviour should be minimal in SP tasks since the choices are made from descriptions of attributes and it will not be clear which choice will over- or under- represent a valuation. The phenomenon of "yea-saying" often arises in CV tasks as the respondents appear to be voting for an environmental "good cause." This phenomenon should not arise in SP tasks because the respondents will be choosing from a number of descriptions of situations rather than a single base case - improved case situation. Embedding is a significant concern in the CV literature (Kahneman and Knetsch, 1992). SP exercises address embedding directly having respondents implicitly value components. Alternately, embedding effects can be tested as part of a SP design.

Stated preference methods can be used as complements to CV and RP methods or as substitutes. They can be complements in that the information from these approaches can be combined to yield a richer overall result (Adamowicz et al, 1994; Swait and Louviere, 1993; Swiat, Louviere and Williams, 1994). They can be substitutes since stated preference methods on their own are representations of individual choice consistent with Random Utility Theory. Furthermore, SP can examine situations (attributes, levels) that do not exist in currently available options. In such cases, RP is limited in scope since it relies on currently available attributes in generating behavioural representations of choice.

Examples of Stated Preference Methods in Environmental Valuation

While the use of SP techniques in environmental valuation is relatively recent, there have been a few noteworthy examples. Lareau and Rae (1988) studied the value of odour reductions using a type of SP model. They asked individuals to rank alternative combinations of odour contact numbers and increased household costs. Rae (1983) employed SP type techniques in the analysis of benefits from air quality improvements. Mackenzie (1993) has employed SP type techniques to examine tradeoffs between attributes of recreational hunting experiences. Mackenzie compares a variety of SP methods and illustrates how many of these techniques can be designed to correspond with the Random Utility Model. Opaluch et al., (1993) employed

pairwise choices in an SP framework to analyze hazardous waste siting decisions. Viscusi et al., (1991) employed SP type techniques in analyzing health risk trade offs. Goodman (1989) examines housing attributes in a SP framework (see also Freeman, 1991).

Adamowicz et al., (1994) employed a choice experiment design to value the impact of a water resource development. This model was constructed to examine recreational site choice. They also examined a revealed preference model of site choice, and combined the two approaches. Among the interesting findings from this study was the fact that the RP and SP models were not significantly different (once the differences in the scale factors were accounted for).

While there are relatively few examples of stated preference studies in the environmental valuation field, we suspect this area of research will increase rapidly. We now present another example of SP and CV based on research in Alberta.

Recreational Quality Improvements: An Application of Stated Preference and Contingent Valuation

As a test of stated preference and contingent valuation techniques a research project involving the valuation of recreational hunting quality improvements was undertaken. This particular activity provides an excellent opportunity for the testing of these procedures because; (a) there is a substantial literature on valuing quality changes in recreational activities, (b) the activity is well defined and the quality attributes are typically well understood by the respondents, (c) the fact that individuals travel to recreation sites provides a realistic payment vehicle, and (d) one can construct a corresponding revealed preference model of recreational hunting behaviour.

We seek to estimate the value of moose habitat improvements in general, rather than the value of a single habitat improvement. Conceptually, to the extent that we understand the fundamental variables that influence moose hunters' or other observers' valuations of habitat changes, we should be able to not only estimate the value of a particular habitat change, but also to value the components of habitat changes in general, regardless of location and extent. To this end, therefore, we undertook exploratory research with samples of moose hunters in areas likely to be affected by the proposed habitat change(s) to determine how hunters think and talk about

moose hunting in general and improvements in habitat as it impacts on the quality of the moose population that they hunt in particular. From this exploratory research we were able to determine the kinds of variables, and ranges of values of those variables, that would be likely to influence moose hunters' valuations of habitat changes. We could then relate such variables to specific wildlife management actions and measurements that could be taken to improve habitat conditions.

We were specifically interested in changes proposed for a particular Wildlife Management Unit (WMU) in West Central Alberta, Canada. This situation provided an excellent opportunity to compare traditional, event-specific CV valuation with the SP approach. Thus, we conceptualized the problem as one of hunters choosing among alternative WMUs which compete for their time and effort. Not surprisingly, because our research deals with a real, existing region of WMUs, it is also possible to ascertain where hunters went last and estimate the value of each WMU, and possibly its characteristics (depending on the statistical properties of the particular sample of WMUs in the region under study) using travel cost approaches. We wanted the SP study to resemble a travel cost exercise in as many essential details as possible; hence, we deliberately designed the SP study to resemble the problem faced by hunters that is measured in the travel cost approach.

Hunters face the problem of choosing one WMU in which to hunt on a particular trip from a set of available WMUs. Based on their choices, associated characteristics of chosen and rejected WMUs and measured differences in hunters, one can estimate a travel cost model using well-established techniques for estimating probabilistic discrete choice models (McFadden 1974; Ben-Akiva and Lerman 1985; Bockstael et al. 1991). In the case of the SP survey, the research problem involves not only the *a priori* identification of relevant variables that influence hunter choices and relevant ranges of these variables, but also the development of an appropriate choice experiment that mimics the actual choices faced by the hunters in the real environment. To do this, we relied heavily on theory and methods described above (Louviere and Woodworth 1983; Louviere 1988a,b; Batsell and Louviere 1991; Louviere 1994; Carson, et al. 1994) to design and administer discrete choice experiments.

The particular design strategy employed in our research involves initially determining a set of decision attributes and levels to represent their variation in the real situation (in this case, the

WMUs in our study region). The attributes and levels used in our study were determined from focus group discussions with hunters and from our knowledge of hunting based on over 10 years of research. These attributes are displayed in Table 1. We conceptualized the hunters' decision problem as one in which we would offer them a choice between pairs of competing WMU descriptions, and give them the option of choosing to hunt in one of the described WMUs or to choose not to go moose hunting at all. The design was based on the attributes and levels described in Table 1. The design problem involves selecting a sample of WMU profile pairs from the universe of pairs given by a $(2^2 \times 4^4) \times (2^2 \times 4^4) \times (2 \text{ versions})$ factorial, i.e., treating left- and right-hand pairs as a composite set of attributes and levels. As discussed by Louviere and Woodworth (1983), the necessary and sufficient conditions to estimate the parameters of McFadden's (1975) Mother Logit model can be satisfied by selecting the smallest, orthogonal main effects design from this larger factorial to create the WMU profiles and pairs simultaneously. The smallest orthogonal main effects design consists of 32 pairs, which were blocked into two sets of 16 pairs each using a two-level blocking factor added to the design for that purpose.

This design strategy produces a survey in which samples of hunters in the areas potentially affected by the proposed WMU habitat improvement are shown 16 pairs of WMU profiles and asked what they would most likely do if their choices were restricted to only the left- and right-hand WMUs and the choice of not moose hunting in the region at all (see Figure 1 for an example of the choice question). Logical reasons why such choice restrictions might occur were suggested, such as floods, wildlife management decisions to close areas to hunting, blocking of access by timber companies and the like. Such occurrences were realistic and had occasionally happened in the past; hence, they provide hunters with rational reasons why choices might be restricted. Thus, the data for analysis consists of the single choice from a trinary set of options observed in each of the 16 sets for each hunter in the sample. As described by Louviere and Woodworth (1983), these choices can be aggregated for analysis if one can assume homogeneity of preferences, or the sample can be categorized into mutually exclusive groups (segments) of hunters with similar tastes and preferences. The latter hypothesis can be tested, and is the subject of on-going research by our team. Indeed, a key advantage of the design strategy we employed is that the design permits tests of violations of the IID error component assumption of stochastic choice models.

One such violation is preference heterogeneity, which we are presently investigating. It is worth noting, however, that such investigations are non-trivial undertakings due to the magnitude of the data set(s) involved, and the number of tests required to pinpoint the source of the IID violations should they occur (See Louviere 1988a,b, 1994; Batsell and Louviere 1991; Carson, et al. 1994).

As previously mentioned, a major advantage of the experimental choice approach we selected is that it is possible to separately value the attributes (and levels) of WMU profiles. Thus, we can not only estimate the value of the particular WMU habitat improvement of immediate interest, but we can also determine the value of the attributes that comprise it. In this way, we can generalize our valuation of a habitat improvement to any WMU that can be described by the attributes and associated levels varied in this study. Theoretically, therefore, we can use the estimated model(s) to value habitat improvements in any WMU in West Central Alberta without having to repeat the study for each WMU of interest. This latter property of the particular SP approach we selected strikes us as being of significant potential value to agencies faced with assessment problems involving multiple sites and/or events of similar types, but lacking budgets and resources to conduct separate studies for each.

Hunters were also asked a CV type question regarding an improvement in one particular WMU. The CV question was structured as a moose population improvement in WMU 344. This WMU is near the center of the study area and has a very low moose density. The CV question included a description of the WMU and its moose population level and a description of the population improvement. The quality levels were described using the same terminology as the choice experiment. Moose populations would increase from seeing evidence of 1 moose per day of hunting to seeing evidence of 2 moose per day. The payment vehicle was a willingness to incur additional travel costs. This was considered to be a realistic payment vehicle since closing access routes is a common form of policy to lessen pressure on moose populations. Closing access routes requires hunters to travel further to reach another access point. The CV experiment was a referendum model with ranges of additional distance travelled varied using draws from a random uniform distribution (for more details, see McLeod, et al, 1993).

Sampling and Data Collection

Samples of hunters were selected from Alberta Fish and Wildlife records. These hunters were mailed a letter indicating that the study was being conducted and that they would be telephoned regarding their participation. The hunters were then telephoned and asked to attend a meeting in their town (alternative dates were provided). Incentives were used to attract the hunters to the meetings. Of the 422 hunters who were telephoned, 312 confirmed that they would attend the sessions. Of these 312, 271 (87%) actually attended the sessions. There were 8 sessions with group sizes ranging from 20 to 55.

Each hunter was asked to complete five survey components: 1. Demographics, 2. Choice Experiment, 3. Record of Moose Hunting Activity (revealed preference), 4. Contingent Valuation, and 5. Perceptions of Moose Hunting Site Quality. Sections 2-5 of the survey were randomized to allow testing of section ordering bias. Further details of the sampling process and descriptive statistics can be found in McLeod et al. (1993).

Model Results

The CV responses were analyzed using standard binary logit techniques (dependent variable = the probability that the individual is willing to accept the higher travel costs and the improved hunting quality). While analysis that includes demographic characteristics and alternative functional forms has been performed, in this paper we concentrate on a simple analysis of the CV model with "bid" as the only independent variable. The results are presented in Table 2. The coefficient on bid (additional distance that the hunter is willing to travel) is negative and significant as expected. The median willingness to pay (per trip) for the improvement is \$69.93 and the expected value is \$85.59⁵. Note that the ρ^2 for the CV model is quite low (.05).

The results of the stated preference experiment are also provided in Table 2. The

⁵ The calculation of median and mean willingness to pay is based on the measures provided by Hanemann (1984). However, the "payment" is elicited in additional distance travelled. Therefore, we use \$0.27 per kilometre to convert the distance into costs. This same measure of costs per kilometre is used in the stated preference welfare analysis.

qualitative attributes are described using effects coding.⁶ As expected, distance is negative and significant. Moose population effects codes show rising utility as populations rise. Seeing no other hunters has a positive contribution to utility relative to seeing other hunters on ATVs which is negative. The ρ^2 for this model is .22.

Since the attribute levels for all of the 15 hunting sites (WMUs) are known⁷, the improvement of site 344 can be examined using the expression derived by Hanemann (1984);

$$W = \frac{1}{\mu} \left[\ln \sum_{i \in C} e^{v_{i0}} - \ln \sum_{i \in C} e^{v_{i1}} \right] \quad (5)$$

Where W is compensating variation, V_{i0} and V_{i1} represent the utility before and after the change, μ is the marginal utility of income (the coefficient of the travel cost or price attribute), and C is the choice set of the individual (WMUs). As a comparison to the CV model, we calculated the value of the improvement of WMU 344. Averaged over the individuals in the sample, it is valued at \$3.46 per trip.

Combining SP and CV Data

The CV question essentially asks the hunter if he/she prefers site 344 as it is currently or if they prefer the site with higher access costs and better moose populations. This comparison can be described in the same framework as the SP model if one considers the CV question as a choice between two sites. The two data sets can be combined by simply defining the CV data as a 2

⁶ Effects codes are an alternative to dummy variables for qualitative attributes. If an attribute has 4 levels, the first three levels are coded as dummy variables (3 columns in the design matrix) and the 4th is coded as -1 for each column. The result is that the coefficient on the 4th level is the negative sum of the coefficients on the 3 other levels. The coefficients can be interpreted directly as the impact of that level of the attribute on utility.

⁷ Information on the perceptions of attributes of the sites was also collected, allowing the examination of welfare results from "objective" versus "perceived" levels of quality. However, preliminary analysis (McLeod, et al, 1993) suggests a reasonable degree of correlation between objective and perceived measures.

element choice set in which only moose population and distance are different⁸. The results are provided in Table 2. Two interesting findings arise. First, the SP and CV data appear to have significantly different scale factors (significant at a 95% level). Second, the null hypothesis of parameter equality, after adjusting for differences in scale, cannot be rejected. Therefore, the CV and SP responses can be considered as arising from the same preferences. However, the coefficients of the joint model (Table 2) are almost exactly the same as those of the SP model. This suggests that the CV model has a high variance and that combining it with the SP data has little impact on the SP coefficients. In other words, the CV model contributes little to the SP estimates. The welfare measures from the joint models can also be determined. However, since the joint and SP model parameters are almost identical, there is little difference in the welfare measures.

Discussion

The particular case examined here was designed to provide an example of SP techniques and a comparison of environmental valuation techniques. The "goods" are well known to the respondents and the quality change should be well understood. The town meeting format was used to aid in information provision and randomization of the task ordering. In general, respondents had no difficulty with the stated preference questions. There were only a few respondents who did not complete the entire set of replications. The majority of respondents also completed the CV question.

The fact that the CV welfare measure is considerably higher than the SP measure raises questions about the "correct" estimate. In further research, we will compare these results with RP measures as well as joint model estimates. At this point it is worth noting that the CV welfare measure is remarkably similar to the marginal welfare effect that can be derived using the ratios of

⁸ The base situation can be represented as utility with current travel distance and current moose populations. The improved situation is represented as utility with current+additional travel distance and improved moose populations. Let moose populations be represented by a dummy variable where 1=improved and 0=base. The two utility functions are: $U(\text{Base}) = b_{00} + b_1(\text{Current Distance}) + b_2(0)$ and $U(\text{Improved}) = b_{01} + b_1(\text{Current Distance} + \text{Additional Distance}) + b_2(1)$. The utility difference expression (improved - base) becomes $dU = (b_{01}-b_{00}) + b_1(\text{Additional Distance}) + b_2(1)$. The coefficients $(b_{01}-b_{00})$ and b_2 are not uniquely identified. In our empirical example we do not include the intercept terms and thus estimate only the parameter on moose populations.

coefficients from the SP model.⁹ However, as mentioned earlier, this ratio of coefficients approach assumes that the change occurs at all "sites". Perhaps the CV measure is capturing the welfare change given that the hunter has already chosen site 344 (ie. ignoring substitutes). The SP measure we employ considers the fact that the hunter can choose one of the substitutes instead of site 344. In any event, these issues will be investigated in our continuing research.

One advantage of the SP approach in this case is that the external validity of the technique can be determined. It is also possible to externally validate the CV model, although this would probably be more difficult. While there have been some positive findings regarding external validity of SP models (Batsell and Louviere, 1991) this is an area in which there will undoubtedly be further research.

The findings reported in this study should be considered preliminary in nature. However, given that the data collected includes SP, CV, and RP responses and includes responses to quality perceptions questions, there is considerable scope for further testing and refinement of our models. We have only reported the preliminary comparisons of habitat improvement values estimated from fitting conditional logit models to the choice data we collect. SP studies of this type produce very large quantities of data, and we are gradually analyzing these data, adding complexity and testing for the significance of same as our research expands.

Conclusions

In this paper we have outlined the stated preference approach to valuing environmental amenities. The flexibility of stated preference and its compatibility with Contingent Valuation and Revealed Preference methods of valuation suggests that it will become a popular method of eliciting environmental preferences. However, in this paper we have only presented a basic form of stated preference model. Recent advances in this field include incorporating uncertainty in the choice models, including dynamic elements (state dependence and serial correlation), incorporating non-choice alternatives and a variety of experimental design and model validation

⁹ In discrete choice models the travel cost term is modeled as (Income-Travel Cost). The marginal utility of income is the parameter on the distance (travel cost) term. The marginal utility of a quality change can be computed using the change in coefficients from one level to the next. The ratio of these two marginal utilities provides a welfare measure for a quality change.

issues (see Hensher, 1994; Batsell and Louviere, 1991).

Stated preference models seem to be well suited to addressing questions that have troubled economists for some time. For example, the question of the value of travel time can be addressed using stated preference (eg. Hensher and Truong, 1985). Stated preference techniques are likely to be useful for benefit transfer exercises as well. If an activity can be broken down into its attribute components, and if models can be appropriately "segmented" to account for different types of users, the stated preference approach may provide a broad enough response surface to allow for accurate benefit transfer calculations.

Stated preference models have a long history in the marketing and transport literature. They are generally well accepted as methods for eliciting consumer responses to multi-attribute stimuli. These techniques will undoubtedly become more widely used in the valuation of environmental amenities and in the economics literature in general.

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Table 1. Attributes used in the stated preference experiment

Attribute	Level
Moose Populations	Evidence of < 1 moose per day
	Evidence of 1-2 moose per day
	Evidence of 3-4 moose per day
	Evidence of more than 4 moose per day
Hunter Congestion	Encounters with no other hunters
	Encounters with other hunters on foot
	Encounters with other hunters on ATVs
	Encounters with other hunters in trucks
Hunter Access	No trails, cutlines or seismic lines
	Old trails, passable with ATV
	Newer trails, passable with 4 wheel drive vehicle
	Newer trails, passable with 2 wheel drive vehicle
Forestry Activity	Evidence of recent forestry activity
	No evidence of recent forestry activity
Road Quality	Mostly paved, some gravel or dirt
	Mostly gravel or dirt, some paved
Distance to site	50 Km
	150 Km
	250 Km
	350 Km

Table 2. Results of stated preference, referendum CV and joint estimation

Variable (Attribute)	Stated Preference Model	Referendum CV	Joint Model (Stated Preference and CV)
Distance	-.0056 (.0002)	-.0092 (.0023)	-.0056 (.0002)
Road Quality Level 1	.0185* (.0260)		.0185* (.0260)
Access Level 1	-.3210 (.0466)		-.3210 (.0466)
Access Level 2	.4006 (.0499)		.4006 (.0499)
Access Level 3	.1702 (.0426)		.1702 (.0426)
Congestion Level 1	.6030 (.0442)		.6030 (.0442)
Congestion Level 2	.0687* (.0484)		.0688* (.0488)
Congestion Level 3	-.2784 (.0464)		-.2786 (.0464)
Forestry Level 1	-.0452* (.0259)		-.0453* (.0259)
Moose Population 1	-1.238 (.0508)		-1.240 (.0494)
Moose Population 2	-.0622* (.0446)	1.188 (.2750)	-.0601* (.0429)
Moose Population 3	.4440 (.0440)		.4439 (.0440)
Relative Scale Parameter			1.5838 (.4829)
Observations	266	271	537
Log Likelihood (max)	-3418.67	-177.70	-3596.38
Log Likelihood (0)	-4675.69	-187.84	-4863.54
ρ^2	.2688	.0540	.2605

Standard Error in Parentheses.

* indicates not significant at 95% level.

CHOICE OF MOOSE HUNTING SITE

In this section you will examine 16 different scenarios which offer you the choice of hunting moose at two different sites or not hunting, Please assume that the two sites presented in each scenario are the only sites that you can choose from for your next hunting trip. We want you to indicate for each scenario which site you would choose, if either.

The enclosed information sheet entitled "Glossary of Terms" provides detailed information about the terms used in this section of the survey.

1. Assuming that the following areas were the **ONLY** areas available, which one would you choose on your next hunting trip, if either?

Features of Hunting Area	Site A	Site B	
Distance from home to hunting area	50 kilometres	50 kilometres	Neither Site A or Site B I will NOT go moose hunting
Quality of road from home to hunting area	Mostly gravel or dirt, some paved	Mostly paved, some gravel or dirt	
Access within hunting area	Newer trails, cutlines or seismic lines, passable with a 2WD vehicle	Newer trails, cutlines or seismic lines passable with a 4WD truck	
Encounters with other hunters	No hunters, other than those in my hunting party, are encountered	Other hunters, on ATVs, are encountered	
Forestry activity	Some evidence of recent logging found in the area	No evidence of logging	
Moose population	Evidence of less than 1 moose per day	Evidence of less than 1 moose per day	

Check ONE and only one box

Please complete all 16 of the scenarios that follow. Missing any of these questions will not allow us to properly analyze your choices!

Figure 1. Example of the instrument used to gather stated preference data

