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UNIVERSITY OF ALBERTA

An Economic Evaluation of Woodland Caribou in Northwestern Saskatchewan

By

MARK RICHARD TANGUAY

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

IN

FOREST ECONOMICS

DEPARTMENT OF RURAL ECONOMY

EDMONTON, ALBERTA

Spring 1994

ISBN 0-612-11384-1

UNIVERSITY OF ALBERTA

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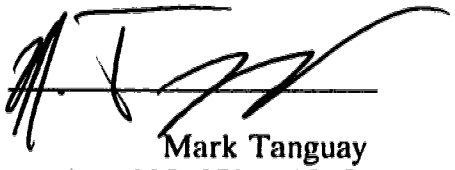

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ABSTRACT

The purpose of this study was to identify some of the values Saskatchewan residents place on their provincial wildlife. Using contingent valuation methods, individual values for maintaining caribou numbers within Millar Western-NorSask Forest Management Licence agreement area were estimated. Using these value estimates, societal benefits were estimated for the implementation of a woodland caribou maintenance program within the licence agreement.

This study also examined two potential problems, the ordering and whole-part effects, in value estimation when using the contingent valuation format. These two effects have been found, in past contingent valuation studies, to influence value estimates. Although the influence of these two effects are difficult to measure, the possible presence of them make contingent valuation measures suspect.

The data used in this study was collected using a mailout survey to Saskatchewan residents. Two contingent valuation formats were used, the opened ended willingness to pay and the dichotomous choice. Two questions were designed, using both formats and placed in random series, for a total of 9 different versions. This was done so that the data could be examined for the presences of the ordering and whole-part effects.

The resulting welfare measures for the implementation of the caribou maintenance program were high, but variable. The open ended format produced the lowest estimates, while the dichotomous choice estimates were higher they also showed a higher degree of variability. This variability may be due to the presence of the ordering or whole-part effects.

ACKNOWLEDGEMENTS

I suppose in most cases this exercise of thanking everyone is considered the fun part of writing a thesis. This case is no exception. There are a lot of people that I have to thank, because without them this thesis my never have been completed.

I would like to start by thanking my committee members, Jim Beck, Bill Phillips, Bill White, and my supervisors, Wiktor Adamowicz and Marty Luckert. Thank you all for your guidance, patience, understanding and most of all your signatures.

Special thanks goes to the support staff in Rural Economy. This group of people, Wendy, Liz, Kim, Judy, Dawn, Barb and Jim, were always willing to lend me a hand, from solving computer problems to locating that certain missing book, Thanks.

In an environment like graduate studies it is always important to have friends that you can count to be there, other wise this graduate thing can be a tough row to hoe. I want to start by thanking the high elevation club, this infamous group includes, Tracy (say it with your hands) Hanson, Earl (I'm enlightened) Munro, Karen (None of the crunchy stuff) Munro, and Glen (I don't want to look down) Armstrong. Our trip was really one for the books and most certainly will always be a fond memory - can't wait 'til the next one.

To get over the weekly trials and tribulations, it is essential that one expands their horizons to include some favourite watering holes, but there's no point in going alone. To Dave and Crystal Fullerton, and Kim and Rob Horton, thanks for hanging out. A special thanks goes out to the Commercial crew, especially to my friends Marian Weber and Ken Mackenzie - we just go there cause we got the blues, from our heads right down to our shoes.

I also want to thank Karen Morton - were would I be if you weren't around to bug!

It's very important that I also thank the Condon Family, your support and encouragement seemed to make things go a little easier, most importantly I want to thank Barbara for being my friend when I really needed one. You are always missed.

Last, I want to thank my family, Dad and Anna for there continued support and encouragement, my brother Gary for his all to infrequent inspirational phone calls, and to my sister Jeannette, who managed to listen to all my gripes and complaints, yes Jeannette, you were right, there really is an end.

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An Economic Evaluation of Woodland Caribou in Northwestern Saskatchewan

CHAPTER 1 Introduction

1.1 Valuation

Value is a term used to describe the worth of a good or service that is desired by individuals or society. The elements of value have perplexed scholars for generations. In economics, value is central to the concept of rational choice. Under the rigors of economic analysis, values are generally measured in dollar terms. These dollar values may be defined for a given good through the actions of competitive market systems, which result in a market price.

In a natural resource setting, many goods and services are not traded in markets and their associated value cannot be measured by using market prices. Because of the lack of market pricing, information to reflect the value, in monetary terms, of these goods or services is consequently more difficult to obtain. In Canada, most of the natural resources are owned by the public. Because of the nature of non-market goods, the price demand signals from private consumers are often not communicated to the public supply side (Asafu-Adjaye *et al.*, 1989).

Historically, economists had few methods to determine values for these goods and services. Many economists acknowledged the existence of these goods and services and that they were valuable. The general rule was to lump these goods into a group of "intangibles" or "unmeasurables", and exclude them from the analysis (Gittinger, 1972).

This lack of pricing information makes typical policy tools ineffective in the policy decision process. An example would be the use of Benefit Cost (BC) analysis[1]. This policy tool is used to measure what the social benefits and costs are for a given program or policy. If the final result of the analysis is a net gain to society, then the policy is deemed "good" under a potential Pareto efficient criteria (Mitchell and Carson, 1989).

One problem in BC analysis is that the process assumes complete information on the value of the resources involved. Because of the frequent exclusion of non-market goods in a natural resource setting, this assumption may be incorrect. Consequently, the potential for the misallocation of resources and an inequitable distribution of benefits increases (Adamowicz, 1991).

1.2 The Situation

In Saskatchewan, most natural resources are publicly owned and managed by the provincial government. Many of the goods and services provided by these natural resources are non-market[2] in nature, such as recreational hunting and fishing, non-consumptive outdoor activities like birdwatching, and the existence of wildlife and wildlands. Due to increased extraction of some marketable resources in Saskatchewan (eg. timber), the supply of many of these non-market goods and services which depend on old growth or mature forest is decreasing. If these goods

---

[1] See Sugden and Williams (1990) for a more detailed description of benefit-cost analysis.

[2] In a forest environment non-market goods are frequently referred to as non-timber benefits.

and services are valued by society then this decrease would be considered a loss to society which should be weighed against the benefits of timber harvesting[3]. In the 1991 Statistics Canada survey "Importance of Wildlife to Canadians" over 80% of Saskatchewan respondents stated that maintaining the abundance of wildlife and the preservation of endangered species are important. This same survey found that over 40 000 Saskatchewan residents were involved in maintaining natural areas. Clearly, wildlife and natural area preservation is valued by the citizens of this province.

Recently, a Forest Management Licence Agreement (FMLA) was issued in Northwestern Saskatchewan, to Norsask Forest Products Inc. (Figure 1.1), allowing this company to harvest timber on public lands. Part of the requirements of this agreement was that the company was to utilize the aspen or find another company to join them in the FMLA that would. In accordance with this provision the company formed a partnership with Millar Western Pulp (Meadow Lake) Ltd, who would utilize the aspen. The Saskatchewan Government placed several additional requirements into the terms of the agreement in the granting of the FMLA. The firms must provide a Twenty Year Forest Management Plan and an Environmental Impact Assessment of their forest operations. Within the Twenty Year Management Plan, as stipulated by Saskatchewan Environment and Public Safety, the firms must consider both fibre and non-fibre values within the FMLA. These non-fibre values

---

[3] This thesis is concerned with the measurement of gross societal benefits of one type of non-timber value and some associated problems with using contingent valuation methods. To determine the net gains or losses to society maintaining a non-timber resource the cost in relation to the estimated benefits must be examined. The trade-offs between benefits and costs determine the net gains or losses that will be incurred by society.

include non-timber resource supply benefits such as wildlife habitat, forest biodiversity, recreational/tourism opportunities and vegetation non-wood products (Mistik Management Ltd. 1992). To meet the requirements of this holistic or integrated resource management approach, the partnership created Mistik Management to manage and develop the Twenty Year Management Plan for the FMLA. To include non-timber goods into the management plan their values must be estimated.

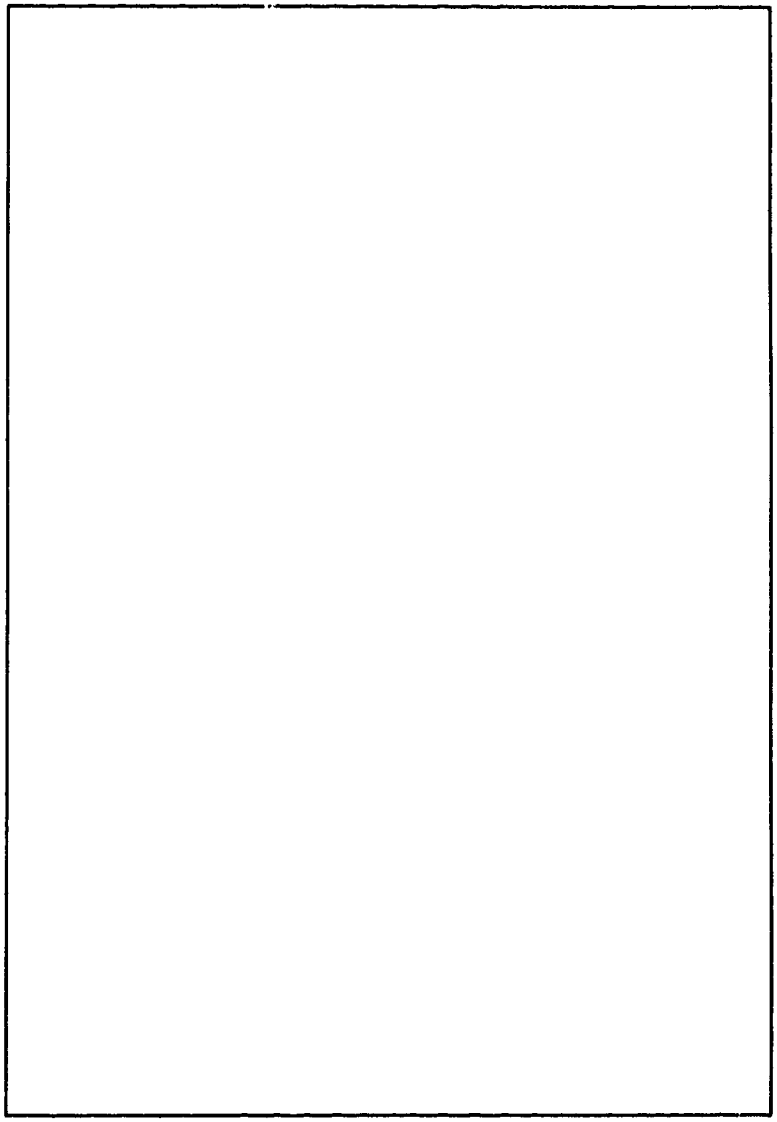

Figure 1.1 Map of Forest Management License Agreement Area

1.3 Problem Statement

Woodland caribou (*Rangifer tarandus caribou*) are considered to be vulnerable to the effects of timber harvesting (Cumming, 1992). In the Northwestern region of Saskatchewan, increased forest industry activity could place local populations of this species in jeopardy. Given the degree of public interest in maintaining wildlife populations, and the requirements of the Twenty Year Management Plan, a study was initiated in 1992 to examine the socioeconomic significance of this species.

A survey was developed to collect information on the social and economic elements that would influence the valuation of wildlife. Contingent valuation methods (CVM) were incorporated, into the survey, to estimate the value of a woodland caribou maintenance program. These benefit estimates will be examined to determine the benefits to society that would be derived from the implementation of a caribou maintenance program within the FMLA.

1.4 Thesis Plan

The plan of this thesis is as follows. Chapter 2 provides a review of non-market goods evaluation methods. The development of theoretical models and the derived empirical models is also discussed. A discussion of welfare measures is provided so that potential benefits can be identified. The data collection methods used to gather the required information necessary for contingent valuation are presented in Chapter 3. In Chapter 4, a number of benefit estimation models are developed and the results are presented and discussed. Implications of the results, conclusions and future research recommendations are provided in Chapter 5.

CHAPTER 2 Non-Market Goods and Benefit Measures

2.1 Identification and Definition of Non-market Goods

Many goods and services derived from natural resource settings are classified as public goods. These goods are characterized as being non-rival and non-excludable. Non-rivalry is the condition where one individual's use of a good does not take away from the satisfaction of another individual's use of the good. Nonexcludability is the condition where the right of exclusive use does not exist. In economics, an evaluation of public goods is difficult due to the lack of a competitive market pricing mechanism[4]. Without the explicit values derived from competitive markets, inclusion of these goods and services into an economic analysis is difficult (Mitchell and Carson,1989). Within the last 25 years, methods have been developed so that many values of public goods can be measured. By being able to place a monetary value on these non-market goods and services, economists can now include these values in economic analyses. This may result in a more efficient allocation of resources (Phillips and Adamowicz, 1983).

Using a taxonomy of value measures developed by Asafu-Adjaye *et al.* (1989) the hierarchy and description of these non-market goods' values can be presented. Values can be divided into two groups, use and non-use values. Use values can be sub-divided into indirect and direct uses. With indirect use there is no first person interaction with the resource. Indirect uses can be placed into two categories: Type

---

[4] Property rights must be complete for a given good for a competitive market to function. The lack of property rights for public goods can lead to market failures.

1, is viewing on television or reading about a resource, while Type 2, is research dissemination.

With direct use there exists interaction with the resource by the individual. Direct Use can be broken down into consumptive and non-consumptive uses. Consumptive use involves a depletion of the resource being used. Non-consumptive uses, like birdwatching, are on site uses that do not cause a depletion of the resource with use.

Non-use values are composed of two elements, preservation and bequest values. Preservation values can be divided into pure existence values and vicarious consumption values. Existence values or "passive values" (National Oceanic and Atmospheric Administration, 1993), relate to the degree of uniqueness and attributes of the resource, but the resource does not have to be irreplaceable (Walsh, *et al.*, 1984). Existence value, simply stated, is the value associated having wildlife or wildlands preserved, regardless of other uses or values (Asafu-Adjaye *et al.*, 1989). Vicarious consumption values can be described as the value one derives from the satisfaction that others will use the resource. The second element of non-use values is bequest value. Bequest value is the value of endowing future generations with wilderness resources.

Option value, not described in the above taxonomy, is also included within the non-use category. Option value can be described as the value or benefits an individual receives as identified from the consumer surplus minus the option price of the good being valued. Option price is the amount an individual will pay to take

account of uncertainty with respect to the availability of some environmental good in the future. Related to option value, is quasi-option value. Quasi-option value deals with the concepts of irreversibility, uncertainty and forthcoming additional decision making information. Therefore, quasi-option value is the value of information conditional on no development of a given project (Mitchell and Carson, 1989).

2.2 Measurement of Non-market Goods: Direct and Indirect Approaches

The methods for evaluation of these non-market goods can be divided into two approaches, direct and indirect.

The indirect approach relies on the assumption of weak complementarity (WC) and the most frequently used models are the travel cost (TC) model and a variant of the implicit price (IP) approach (Hoehn and Randall, 1987). Travel cost models use the difference in travel, and possibly other, costs recreationists incur to infer how a recreationist would behave if a price higher than the actual admission fee was charged[5] (Bishop and Herbelein, 1979). Implicit price or hedonic techniques are similar to the TC model but use total activity expenditures. These techniques assume that goods can be broken down into characteristics which can be valued (Phillips and Adamowicz, 1983). For example, water quality would be a characteristic of a fishing experience. These methods allow the economist to determine the increase in benefits an angler would gain with a positive change in water quality.

---

[5] This procedure relies on the assumption of weak complementarity. The weak complementarity assumption relies on the premise that associated expenditures relate to the receiving of benefits from some non-market good and that these expenditures can be used to estimate a value for the non-market good.

An indirect approach, may be suitable for measuring the value of many natural resource consumptive uses (eg. hunting or camping). However, this study is concerned with the measurement of non-use values and therefore relies on the direct approach, described in the next section.

The most common direct approach is called the Contingent Valuation Method (CVM) which is a procedure using questions to directly elicit values from the recreationist (Randall and Hoehn, 1983; Adamowicz, 1991). The main objective of CVM is to determine an "ex ante" valuation of policy impacts (Hoehn and Randall, 1987). The basic premise is that the value given is contingent on there being a market created by interviews or questionnaires (Adamowicz, 1991). The procedure can cover broad approaches and very specific behavioral preferences (Hoehn and Randall, 1987). CVM compared to TC, is free of many of the restrictive assumptions associated with TC (Phillips and Adamowicz, 1983).

2.3 Contingent Valuation Technique

CVM studies use surveys or questionnaires to elicit values from respondents. These values are obtained by asking the respondent, "how much would you be willing to pay? (WTP)" for some environmental good. An alternative form is to ask "what is the minimum amount you would be willing to accept in compensation? (WTA)" for a decrease in the supply of an environmental good (Phillips and Adamowicz, 1983).

CVM's are more adaptable for measuring the value of non-market goods than indirect methods because of the lack of restrictive assumptions on an individual's

preferences. CVM relies on two basic assumptions. First, the respondent can accurately evaluate the non-market good or service of concern. Second, the elicited value is the maximum an individual is willing to pay or the minimum amount an individual is willing to accept for compensation (i.e. it is not just a "fair" price).

In situations where market transactions data are available over a full range of policy issues, both indirect and direct methods can be used (Hoehn and Randall, 1987). If both types of approaches are available, results from the indirect approach can be used to validate CVM results.

The validation of CVM is important because in many cases CVM is the only method available for natural resource change valuation. The cases in which CVM is the only approach for valuation are:

1) Policy considerations that lie outside the range of available data;

2) Past market transactions fail to reflect recent information regarding environmental quality, substitutes or hazards (Hoehn and Randall, 1987; NOAA, 1993).

Since the inception of CVM, several empirical studies have been done to help establish confidence in this valuation procedure (Phillips and Adamowicz, 1983). The justification in using CVM is given by the following 4 reasons. First, results have been shown to be consistent with revealed preferences (Hoehn and Randall, 1987). Second, CVM value estimates are consistent in relation to other applied valuation methods. Third, where economic theory is sufficiently developed to imply a qualitative relationship between CVM and other approaches, empirical results have

shown the expected outcome. Fourth, CVM results are systematically related to individual demographic characteristics and to the availability of substitutes and complements (Hoehn and Randall, 1987). Despite this justification, empirical work done by Kahneman and Knetsch (1992) seems to provide some evidence questioning the validity of CVM. This evidence will be presented later in the text.

Because CVM elicits a value, respondents must go through a valuation process to determine a value response. This valuation process can be broken down into two parts, a valuation stage and a value statement stage. The valuation stage is the period where the respondent decides on the true value for a change in supply of an environmental good (Hanley and Munro, 1991; Hoehn and Randall, 1987). If the good is increasing in supply then the value given is a Hicksian compensating measure of money for the welfare change. For a decreasing supply of a good, Willingness to Pay (WTP) can be viewed as an equivalent surplus measure (Randall *et al*, 1983).

The second stage is the value statement stage where the respondent reveals a figure to the researcher. Because of some actual or perceived gain to the respondent, the revealed value may not be the same value as determined in the valuation stage. This behaviour of false value presentation is known as "strategic behaviour".

CVM is dependent on surveys, most of which are similar in design, for the gathering of data. A particular situation is described to the respondent in which a commodity is changed or a service is offered. The main difference between the techniques is in how the valuation question is structured. With the iterative bidding

process, values are presented to the respondent and are either accepted or rejected. Once the upper and lower bounds of bids are defined, the incremental changes in bids are narrowed until a final bid is determined. Open ended willingness to pay (OE WTP) questions elicit a single amount from the respondent by asking "what is the maximum amount you would be willing to pay" for the described situation. Dichotomous choice willingness to pay (DC WTP) questions are designed to mimic a real market situation. A hypothetical situation is described and a bid is offered. The respondent can either accept or refuse the bid amount. The bid offered is randomized for each respondent questioned. The hypothetical situation is couched in a referendum style proposal, where the respondents may be told "the majority must accept the bid amount for the prescribed action to occur." The theoretical models for the OE WTP and the DC WTP methods are presented below.

2.4 Theory of Open Ended Willingness to Pay Model

The OE WTP for an environmental quality change can be described by using an indirect utility function[6] which includes environmental quality as a variable. The indirect utility function of a utility maximizer who is constrained by a budget, could be shown as:

$$V = v\ (\ P,q^{i},m\ ) \qquad (1)$$

Where: **P** = vector of prices for all goods
q^{i} = environmental quality with level **i**
m = income

In this study, the value of an environmental change is being estimated. The

---

[6] The indirect utility function is derived by solving a utility maximizing, budget constrained individual optimal solution. For a detailed description and derivation of an indirect utility function see Binger and Hoffman (1988).

value elicited is for a positive change in environmental quality. The decrease in income that maintains the individual at the same level of utility as before the change in environmental quality is a measure of welfare impact. This point of indifference can be shown as:

$$v\ (\ P,q^0,m\ ) = v\ (\ P,q^1,m-w\ ) \qquad (2)$$

Where: i = 0,1 for original and new level of environmental quality, respectively
w = maximum willingness to pay value

The OE WTP question involves eliciting the value of w from the respondent.

2.5 Theory of Discrete Choice Model (Random Utility Model)

As above, an assumption of the Random Utility Model (RUM) for this study, is that the individual derives utility from environmental quality and income. In addition, observable sociological and demographic attributes are depicted as s, and w represents the bid amount **presented** to the individual to pay for the change in environmental quality. The utility function, V_i, for a bid acceptance can be shown as:

$$V_1 = v\ (\ q^1,\ m\ -\ w;\ s\ ) \qquad (3)$$

If the individual rejects the offered bid amount for the environmental change then the utility function is:

$$V_0 = v\ (\ q^0,\ m;\ s\ ) \qquad (4)$$

An important assumption is that the individual knows his/her preferences. This utility function contains attributes that are not observable to the researcher. Therefore, to the observer, there would appear to be a certain amount of randomness to the individual's actions. If we treat these unobservable characteristics as stochastic, then it is possible to develop the stochastic structure required for a statistical binary response model. The underlying sources of the randomness of the individual's utility function are the basis for the distributional assumption to be used in the statistical models. Ben-Akiva and Lerman (1985) cite 4 sources of randomness as identified by Manski (1973):

1. unobserved attributes of the good
2. unobserved taste variation
3. measurement errors and imperfect information
4. instrumental (or proxy) variables.

If the above assumption on stochastic structure holds then the utility functions of the individual can be viewed as random variables. We can let the individual's random utility functions for bid acceptance and bid refusal be represented as $\mathbf{u}_1$ and $\mathbf{u}_0$, respectively. The utility function can then be shown as:

$$u_i = V_i + \epsilon_i \qquad (5)$$

where: ϵ_0 and ϵ_1 are independently identically distributed (i.i.d.) random variables with zero means. These random utility functions have some given parametric probability distribution with means, $\mathbf{v(q^1,m-w;s)}$ and $\mathbf{v(q^0,m;s)}$, respectively. It is assumed that the means are dependent on the observable characteristics of the

individual given.

If an individual is asked a WTP question for some environmental quality change and the individual responds positively then:

$$v\,(q^1,\ m-w;\ s)\ +\ \epsilon_1\ \geq\ v\,(q^0,\ m;\ s)\ +\ \epsilon_0 \qquad (6)$$

If this condition does not hold, then the respondent will refuse the bid.

We assume that the individual knows the proper allocation of resources to maximize his/her utility. The probability that the individual is willing to accept the bid can be described as:

$$\begin{aligned} P_1 &= Pr\ (\ \textit{Individual WTP}\ ) \\ &= Pr\ (\ u_1\ \geq\ u_0\ ) \\ &= Pr\ [v\ (\ q^1, m-w; s\ )\ +\ \epsilon_1\ \geq\ v\ (\ q^0, m; s\ )\ +\ \epsilon_0\ ] \end{aligned} \qquad (7)$$

If the individual is not willing to pay then:

$$\begin{aligned} P_0 &= Pr\ (\ \textit{Individual NWTP}\ ) \\ &= 1\ -\ P_1 \end{aligned} \qquad (8)$$

2.6 Logit Model

Under the assumption that ϵ_0 and ϵ_1 are i.i.d., the random variables $\eta \equiv (\epsilon_0 - \epsilon_1)$ and $\eta' \equiv (\epsilon_1 - \epsilon_0)$ have the same distribution. If we assume the distribution of ϵ_1 is a Weibull density function the probability (Equation 7) takes the form of a

general logit[7] model (Sellar *et al.*, 1986).

The probabilities can be written with the standard logistic variate as:

$$p_1 = F_\eta(\Delta u) = (1 + e^{-\Delta u})^{-1} \quad (9)$$

where:

$$\Delta u \equiv u_1 - u_0 \quad (10)$$

Let the utility function for bid acceptance be represented as:

$$u_1 = \alpha_1 + B*(m-w) + \beta_1 * s \quad (11)$$

where: β_i = vector of coefficients for socioeconomic attributes[8]
B = coefficient for the bid variable

and the utility function for a bid refusal as:

$$u_0 = \alpha_0 + B * m + \beta_0 * s \quad (12)$$

The probability of accepting the bid is a function of the utility difference:

---

[7] Because of the referendum styling of the DC WTP technique, a logit or probit distribution is used within the model. The results obtained from these two distribution functions are similar and since logit models are easier to work with, they are the models of choice (Sellar et al., 1986).

[8] In Hanemann's (1984) original model all socioeconomic terms dropped out. It has since been shown that retention of some socioeconomic attributes in the model improve the model's estimation capability.

$$\Delta u \equiv (\alpha_1 - \alpha_0) - B*w+(\beta_1-\beta_0)*s \quad (13)$$

If we normalize α_0 and β_0 to equal 0, we reduce $(\alpha_1 - \alpha_0)$ to α^* and $(\beta_1 - \beta_0)$ to β^* and the utility difference function is:

$$\Delta u = \alpha^* - B*w + \beta^**s \quad (14)$$

An alternative log form described by Hanemann (1984) is:

$$u_i = \alpha_i + B*\ln m_i+\beta_i^**s \quad (15)$$

With a change in utility the final statistical model will generate:

$$\begin{aligned} \Delta u &= (\alpha_1 - \alpha_0) + B \ln(1-w/m)+(\beta_1 - \beta_0)*s \\ &\approx (\alpha_1 - \alpha_0) - B (w/m)+(\beta_1 - \beta_0)*s \\ &\approx \alpha^* + B (w/m) + \beta^**s \end{aligned} \quad (16)$$

Both statistical models described above (equations 14 and 16) were estimated in this study.

2.7 Welfare Measures

To determine the welfare impacts, one can examine either median or mean welfare measures. The median WTP value can be estimated as the bid value (w) that sets the probability of accepting the bid (equation 9) equal to 0.5:

$$0.5 = (1 + e^{-\Delta u})^{-1} \quad (17)$$

By rearranging equation 17 to:

$$e^{-\Delta\mu} = \frac{1-.5}{.5} \tag{18}$$

and then substituting in equation 14 and taking the log we get:

$$-\alpha + Bw^* = 0 \tag{19}$$

where $\alpha = (\alpha_1 - \alpha_0)$[9].

Solving for w, this simplifies to[10]:

$$w^* = \alpha/-B \tag{20}$$

The median value for the second utility model (14), using a similar procedure as shown above, simplifies to:

$$w' = \alpha \; / \; (\; - B/m \;) \tag{21}$$

To determine the mean values, where WTP is a non-negative random variable, the area under the logit distribution for Equation (7) can be described as:

$$w^{**} = \int_0^{\infty} [\; 1 - F(w) \;]\, dw \tag{22}$$

This can be simplified to:

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[9] In 1992, Loomis and Cooper showed that by assuming that α was a grand constant, other dependent variables could be used in the WTP estimates for the Hanemann model. The sum of any number of explanatory variables times their means could be placed into α.

[10] The final Beta term is negative in the final expression because bid (w) amount is negatively correlated to bid acceptance.

$$w^{**} = (1/-B) * \ln(1 + \exp^{\alpha}) \quad (23)$$

For the second model (16) the mean WTP simplifies to:

$$WTP^{II} = (1/ (-B / m)) * \ln(1 + \exp^{\alpha}) \quad (24)$$

2.8 Problems Associated With CVM

In a CVM procedure, either the respondent or the interviewer can be constrained by time, cost, or both. Two types of errors can occur as a result of these constraints. First, there is the potential for an information error due to the complexity of the policy information being conveyed and the understanding of the information, by the respondent, due to limited time. Second, a valuation error may be introduced. Once the information is understood, the valuation stage may be cut short due to a time constraint (Whittington *et al.*, 1992). This time limitation may cause the respondent to state a value which may not be equal to the individual's true value.

Although CVM's are gaining favour with researchers, several additional potential problems have been identified. These problems can be categorized as potential "biases"[11], strategic behaviour and the embedding effect. The potential biases identified in the literature are: sampling, payment vehicle, information, hypothetical and starting point. All of these biases can influence a respondent's WTP value or impair the final results of the analysis.

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[11] These "biases", as described in the literature, are not all true biases because there is no "true" value. The WTP values estimated in CV questions are sensitive to these issues.

Sample Bias

Sampling bias is a problem common to all surveys and questionnaires. The sample, used in a study, may not capture a true cross section of the population of concern. It is possible to remove this bias with proper research design and management (Hoehn and Randall, 1987).

Starting Point Bias

Starting point bias is a problem of the iterative bidding method commonly used in personal interviews. This bias is a consequence of using a constant starting point bid and the direction of incremental changes used to arrive at a final value. For example, if the method used starts with a constant low bid amount and the incremental changes in the bids work upwards the final WTP value will be biased downwards (Walsh, 1986). The bias will be reversed if bids start high and work downwards. To remove this bias, Walsh (1986) suggests the following procedure. First, randomize the starting bid for each respondent. Second, the incremental changes should initially be so large as to bound the respondents true WTP value. As the respondent nears his/her point of indifference the incremental changes should become smaller until a final bid is determined.

Vehicle Bias

The mechanism of payment (i.e. taxes, permits, donations) can influence a respondent's final WTP (vehicle bias). The mean bids and/or number of protest bids have been shown to vary significantly with the type of payment vehicle used (Cummings, *et al.*, 1988). One reason is that substitute possibilities may differ with

the payment vehicle used. If the payment vehicle allows for substitution over a wide range of commodity purchases the WTP will be higher (Cummings, *et al.*, 1988). For example, if the payment vehicle used can allocate funds to a number of causes with similar attributes as opposed to just one cause, the WTP amount will be higher.

To choose the appropriate payment vehicle Walsh (1986) recommends doing pretests with several different likely payment vehicles and then testing for statistical differences. He also recommends questioning respondents about the acceptability of the payment vehicle used. The influence of the payment vehicle is reduced if it seems appropriate to the respondents.

Hypothetical Bias

Because CVM uses a hypothetical market situation, the method can be biased by its own design. Hypothetical bias is due to the weak penalties (no true payment) for inaccurate information (Randall and Hoehn, 1983). The respondent may not take the valuation process seriously and therefore may not convey a true value for the described good. To mitigate the effects of this lack of realism it is important that the researcher provides a realistic market situation to the respondent (Mitchell and Carson, 1989).

Information Bias

Information bias can occur during the respondent's value formulation stage. It has been found that the information provided will influence WTP amounts. In a study by Berstrom *et al.* (1990), it was found that as the information concerning wetland preservation increased so did the WTP amounts. The authors did not feel

this was a problem as the information provided accuracy and completeness in defining the commodity being valued. When using CVM it is important that the respondents can make a well informed value decision. Several studies have found that small incremental changes in information have little influence on WTP amounts, while large incremental changes can have a significant effect on WTP (Hanley and Munro, 1991; Samples, *et al.*, 1986; Boyle, 1989). Hanley and Munro, in their 1991 study, observed that information also displayed diminishing marginal returns in relation to bid values. Information may also change a respondent's marginal utility for a given commodity. In a study done by Samples *et al.* (1986) there was some evidence that the marginal utility of the respondents did change with the amount of information provided. In the same study it was suggested that the respondents may refuse the market situation when inadequate information is provided. Without adequately describing the opportunity cost and pay-offs, the WTP values may be under estimated (Samples, *et al.*, 1986). There are some draw backs to providing information. If the information itself is biased or inaccurate due to policy changes, WTP values may be suspect. It is therefore important that the information be checked for such biases and inaccuracies (Samples, *et al.*, 1986).

Strategic Behaviour

It has been suggested that optimizing individuals could pursue policies of extreme misstatement; (i.e. Strategic Behaviour). Such individuals may grossly over/under estimate WTP values depending on the strategies employed for the given situation (Hoehn and Randall, 1987). For example, if an individual is prone to "free

riding" s/he may understate WTP if s/he assumes others will pay for a service that s/he will be able to use (Walsh, 1986). The process of strategic behaviour occurs during the value statement stage, where the respondent's revealed WTP is not equal to their true WTP value. Little evidence of strategic behaviour has been found (Hoehn and Randall, 1987; Walsh, 1896). In a study by Milon (1989) no strong evidence was found for free ridership and the majority of the respondents tried their best to provide truthful information about their preferences.

Embedding Effect

The embedding effect, coined by Kahneman and Knetsch (1992), encompasses the ordering effect, the whole-part effect and the purchase of moral satisfaction. The ordering effect refers to the order in which a CV question is presented within a series of CV questions. The ordering effect suggests that the fewer the questions or the higher the position of the question within a series of questions the greater the value it will be assigned. The ordering effect can be better explained with the use of a diagram (Figure 2). If the ordering effect is present, then the value stated for the same good will be different depending on the position of the question within a series of questions. For the example shown in Figure 2, the value for Sask. Program (Column 1) will not be equal to the value assigned to Sask. Program (Column 2), due to the position of the questions within the series.

The whole-part effect is a term used to describe the apparent inappropriate valuation of a subset of goods when compared to the associated complete set of goods. This phenomena can best be explained with the use of an example illustrated

in Figure 2. For this description, the Canadian Program will represent a compete set of goods offered by a national program and the Sask. Program represents the a subset of goods provided by a provincial program that is a component of the national

Figure 2 Ordering and Whole-Part Effects

Column 1	Column 2	Column 3
Sask Program	Canadian Program	
Canadian Program	Sask. Program	Sask. Program

program. The whole-part effect is the condition where the value assigned to the Sask. Program in column 3 is equal to the value assigned to the Canadian Program in column 2. It is this inconsistency in the valuation of subset goods in comparison to the more inclusive good that Kahneman and Knetsch (1992) identify as the whole-part effect.

Two issues are raised by the whole-part and ordering effects. First, embedding provides an opportunity to manipulate a good's value by placing deliberately structured questions into the survey design. Second, if a number of values are estimated using different survey structures, which is the correct one? At present, there is no economic theory or precedent to determine the correct value. This study will investigate this phenomena further.

The purchase of "Moral Satisfaction" is another potential problem identified by Kahneman and Knetsch (1992). This phenomenon suggests that the good being

valued by CVM is not the good described but rather a good embedded within it. This embedded good is described as the satisfaction in giving to a good cause. Smith, (1992) and Harrison (1992) have argued that moral satisfaction is just another name for utility and that respondents are simply maximizing their utility by paying for some change in environmental quality. At present there is still considerable debate on this issue.

Willingness to Pay (WTP) Versus Willingness to Accept (WTA)

Another problem identified in the CV literature is the difference between WTP and WTA. Economic theory suggests that WTP and WTA values should be similar (Hoehn and Randall, 1987; Knetsch, 1990). However, there is a growing body of empirical evidence that suggest this assumption is incorrect (Randall and Hoehn, 1983; Knetsch, 1990). The empirical results from numerous studies have shown a difference of between 3 to 5 times for WTA over WTP values (Adamowicz *et al.*, 1993; Knetsch, 1990). Several reasons for this disparity have been proposed: Income Effects, Substitution Effects, and Psychological Effects.

The income effect suggests WTP amounts are constrained by the respondents income, while WTA amounts are not. In the case of high valued goods this may be a relevant explanation. However, in a study by Knetsch (1990), he provided empirical evidence that when participants traded non-income constrained inexpensive private goods the disparity still existed.

The availability of substitutes for a good has been suggested as a reason for this disparity. The substitution effect theory states that the lack of available

substitutes for the commodity being valued causes the disparity. If there are a large number of perfect substitutes for the good being valued then WTA should equal WTP. If no substitutes exist then WTA should be greater than WTP (Hanemann, 1989). Adamowicz *et al.* (1993) found if a suitable substitute is available the WTA measure will decrease and converge towards the WTP measure. However a disparity between WTP and WTA persisted.

Several psychological effects have also been put forth to explain this disparity. One such effect is the endowment effect. Knetsch (1990) conducted experiments which suggested that individuals measure losses and gains from a neutral reference point and that losses have a greater impact on the individual than gains. What this suggests, is that the individual's value function is not smooth but "kinked" at this reference point. Because of this evidence, Knetsch (1990) suggests that when individuals are experiencing an increase in some commodity, WTP should be used as the welfare measure. If the individual is expecting a decrease in a commodity, then WTA would be the appropriate measure.

2.9 Willingness to Pay: Open Ended Versus Dichotomous Choice

Dichotomous Choice and Open Ended methods have advantages and disadvantages for estimating willingness to pay. The main advantage in using Open Ended Willingness to Pay (OE WTP) models is that values are directly elicited from the respondent. Since no values are presented to the respondent no value inference is provided for the good being valued. OE WTP methods are free of the restrictive

assumptions concerning distribution of the error terms and the specified utility function (Sellar *et al.*, 1986).

Dichotomous Choice Willingness to Pay (DC WTP) models have several advantages over Open Ended Willingness to Pay. First, DC WTP is less demanding mentally for the respondent to use, consequently the number of non-responses are fewer (Seller *et al.*, 1985). Second, the structure of dichotomous choice surveys can be designed so that the impact of strategic behaviour is minimized and the respondent's true preference is revealed. Third, DC WTP methods tend to have smaller variances of the estimated values (Boyle, 1989). Finally, DC WTP models are structured so as to mimic a true market situation and the respondent behaves as a price taker. It is for the above reasons that DC WTP models are generally preferred by CVM researchers.

2.10 Mean versus Median Willingness to Pay Measures

There has been some debate over which welfare measure is appropriate. Hanemann (1989) believes that the median value is the correct one, for the following reasons:

1) The mean is sensitive to parameter changes

2) The median is more robust, and for a probability function better reflects the value of the majority.

On the second point, Hanemann (1989) gives the following example. If 1000 respondents were questioned and 999 gave $1 and one individual gave $1000, the

mean would be $1.98. If this value was used there would be 999 disenfranchised individuals. However, Johansson *et al.* (1989) believe that the mean value should be used to determine the appropriate welfare measure. The reason cited is that the median value does not produce a Pareto-efficient outcome since the voter expects more or less public expenditure than is consistent with Pareto efficiency. In Benefit Cost analysis the total benefits and total costs are required, thus the mean value is the appropriate measure. Since total cost are compared to total benefits the mean willingness to pay measure times the number of individuals would be the relevant measure of total benefits for a Benefit Cost analysis.

In this study, for the referendum format of the DC WTP question both the median and mean welfare measures were calculated. For the OE WTP format only the mean values were determined. In cases where the DC WTP values are used in a true referendum, the median value would be the correct estimate. In situations where total value estimates are required (eg. cost/benefit analysis) the mean values are appropriate. To use the median value would under estimate the true value of the good to society. In this study for comparing the results between the two formats the mean values were used.

2.11 Summary

As the demand for non-market goods and services from natural resources increase the measure of these values will become more important. If policy tools like benefit cost analysis continue to be used for evaluation of proposed projects non-

market values must be included. Contingent valuation methods in many situations are the only procedure capable of measuring these values. Failure to give due consideration in the design and structure of the CVM question, as has been discussed earlier, can lead to a multitude of problems. However, CVM's have been shown, through empirical studies, to be reliable and valid measuring instruments if care is given in the design and structure of the CVM question.

CHAPTER 3 Data Collection and Response Rates

3.1 Data Collection

The data collection for welfare estimates were obtained from a mail survey conducted by the University of Alberta and The Canadian Forest Service in the winter of 1992-93. The questionnaire was composed of 3 sections. The first section contained questions concerning attitudes and opinions towards wildlife and more specifically, woodland caribou. Also included in this section were questions eliciting information about participation in wildlife and outdoor related activities. These questions were asked so that the importance of wildlife to the respondents could be determined. The second section was composed of several CV questions, which are described in the following section. The final section elicited demographic information from the respondents. The size of household, income, age, and other attributes could be important in predicting the value respondents have for woodland caribou. A final version of the questionnaire can be found in Appendix A.

3.2 The Contingent Valuation Questions

There were 9 versions of the questionnaire. These versions can be divided into two groups: DC WTP questions (versions 1 through 4 and 9) and OE WTP questions (versions 5 through 8). These two types of questions were used so that a comparative validity analysis could be done. Research by Loomis (1990) found that OE WTP and DC WTP estimates were not significantly different. However, in an earlier paper, Seller *et al.* (1985) found that OE WTP measures were significantly lower than DC WTP measures. Research by Kristrom (1993) found results similar

to Seller *et al.* (1985). The zero bids and non-responses were also found to be higher for the OE WTP format. In this CVM study an analysis was conducted to determine how OE WTP and DC WTP measures compare.

Further questionnaire versions (within the DC and OE WTP format) were designed in order to measure the impacts and the influences of the whole-part and ordering effects. Two WTP questions dealing with a woodland caribou maintenance program were designed. One question dealt with a Canadian program and a second question pertained to a Saskatchewan program. Table 3.1 shows how the presentation of the WTP questions varied in the 9 versions of the questionnaire. Versions 1, 2, 5 and 6 were composed of two-tiered questions. In versions 1 and 5 a question about the Canadian population of caribou was asked first, followed by a Saskatchewan caribou WTP question. In versions 2 and 6 the question order was reversed. A Canadian WTP question was the single question presented in versions 3 and 7 and the Saskatchewan question was presented alone in versions 4, 8 and 9. Within the versions containing two-tiered questions the respondent was informed on the final question that s/he may change their initial values if desired.

Table 3.1: Question Position

	DC WTP					OE WTP			
Version	1	2	3	4	9	5	6	7	8
Canada	2	1	*			2	1	*	
Saskatchewan	1	2		*	*	1	2		*

Note: 1 indicates question appeared first; 2, question was second; *, question presented alone.

Using guidelines set out by Smith (1992), Harrison (1992) and Boyle (1989)

the following attributes were incorporated into the WTP question. First a brief description of the good and associated tradeoffs were provided prior to the WTP question. Within the question, a base population number was given as was the expected gain contingent on the maintenance program's implementation. A map of the Canadian distribution of woodland caribou was provided with the Saskatchewan program so that respondents were aware of the inclusiveness of the provincial question and that substitute populations of caribou existed elsewhere in Canada. The duration of payments and the payment vehicle were also provided. All WTP questions used similar wording. Below is an example of the DC WTP question.

Suppose you have a choice between two options, given below. The action described will be carried out for the option that receives the majority of votes

Option A, Have No Maintenance Program to preserve Woodland Caribou. Local populations will disappear within 10 years of logging activities due to increased hunting from people and wolves, habitat loss and animals leaving the area. The end result is that Woodland Caribou populations will decrease to 1,800 in Northwestern Saskatchewan by the year 2002.

Option B, Have every household in Saskatchewan pay $_____ per year for the next ten years into a trust fund to be spent on a Caribou Maintenance Program. This maintenance program will be run by an independent foundation and will maintain the current range and numbers of approximately 3,600 Woodland Caribou within Northwestern Saskatchewan.

Given the opportunity to vote for Option A or B which one would you choose?

___ Option A ___ Option B

In version 9 the vehicle payment mechanism was changed from payment to an independently run private foundation to increased wood product expenditures[12]. This was done so that the influences of vehicle payment could be analyzed. The

[12] The respondent was informed of average annual expenditures a Saskatchewan resident spends on paper products. The respondent was then told that paper product expenditures would increase by a given amount of dollars per year if a caribou maintenance program was implemented. The respondents could accept or refuse the increase in expenditures.

conciseness of the question format was expected to mitigate many of the problems, discussed earlier, associated with CVM (eg. hypothetical and information biases). For additional information on the survey and a discussion of descriptive statistics, see Tanguay *et al.* (1993).

To determine the bid range for the DC WTP questions, empirical results from several other studies which estimated the existence value of other species were used. In a study by Samples *et al.* (1986) the mean values for humpback whales was between 40 and 60 dollars. In another study the mean value for bald eagles was estimated at $28.25 (Stevens *et al.*, 1991). From this information it was decided that the DC WTP bids would range from $1 to $100. These values were generated using a uniform random numbers generator sub-routine.

For the purpose of the survey, two samples, one provincial and one from the northwestern region of Saskatchewan were required. The regional sample was considered a critical area since any change due to the forestry development would directly effect the economy of this region. The two samples were tested to examine if regional verse provincial perspectives influenced respondents valuation of the caribou maintenance program. To obtain a representative cross section of the sample regions two sample intensities were used. A 0.75% provincial sample and a 7.5% regional sample was determined to meet the needs of the analysis.

Names and mailing addresses were purchased from Targetwest Marketing of Saskatoon, Saskatchewan. These addresses were randomly generated from telephone listings provided by Sask-Tel.

3.3 Response Rates

Table 3.2 summarizes the response rates for the completed returns for the Saskatchewan and Northwestern samples. The total mail out for the Saskatchewan sample was 2 774 (309 per questionnaire version) and the Northwestern was 1 472 (164 per questionnaire version). The questionnaire's covering letters, and reminder card were designed using guidelines set out by Dillman (1978) to maximize response rates. The total completed returns for the Saskatchewan sample were 1 374, another 113 surveys were returned unopened (eg. respondent may have died or moved). The completed returns represent a response rate of 51.6%. For the Northwestern region, 680 completed (50.4% response rate) and 123 unopened questionnaires were returned. These response rates are considered good for a general household survey. Both unopened return rates were below 10%.

The first and third mailings were examined for any response bias using the demographic variables and none was found.

Table 3.2: Sample Size, Response and Response Rates

Mailed	Number Sent	Number Returned Unopened	Percent Returned Unopened	Effective Sample Size	Number Completed	Percent of Effective Completed
Sask. Region	2 774	113	4.0	2 661	1 374	51.6
N.W. Region	1 472	123	8.4	1 349	680	50.4
Total	4 246	236	5.6	4 010	2 054	51.22

3.4 Data Entry

All responses entered were verified. The final data set was segregated into OE WTP and DC WTP subsets, which had 908 and 1 074 observations, respectively. Because of the large number of versions within the questionnaire design, cleaning of the data for missing values was done on a per variable basis during the analysis so that the largest possible number of observations could be maintained.

3.5 Data Segregation

The raw data set contained 48 potential variables for model formulation. From these 48 variables only variables that were considered relevant[13] to the analysis were used. Since two types of models were to be developed, the data set was divided into two groups. For the DC WTP models a total of 38 variables were identified for inclusion into the analysis. The OE WTP models used 36 of the 48 variables. As recommended by Train (1979) to avoid the process of "data mining" only variables that were thought to be relevant in revealing individual preferences were considered.

The data described in this chapter was used in this study to conduct analyses which are arranged into 4 major sections within chapter 4. Section 4.1 is composed of the OE WTP analysis. The mean welfare measures were determined and analyzed for the whole-part and ordering effects. Open Ended WTP Tobit[14] models were

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[13] Since the questionnaire was designed to collected data for both the different CVM formats some of the variables were only relevant for one of the models and not the other.

[14] Tobit models or censored data models are used when the analysis is using censored data. For a detailed description see Judge et al. (1988).

developed to determine socioeconomic attributes of individuals who gain utility from the implementation of a caribou maintenance program. Section 4.2 contains the DC WTP analysis. Logit models were developed from each questionnaire version to determine the socioeconomic attributes of the respondents and to estimate the median and mean welfare measures. These welfare measures were then analyzed for the whole-part and ordering effects. Aggregate DC WTP models for the two types of CVM questions were estimated and the goodness of fit of these two models was examined. In section 4.3, OE and DC WTP welfare measures from aggregated models were estimated and a comparison of these two different formats was completed. Contained in section 4.4 are the capitalized welfare measures for both of the CVM formats.

CHAPTER 4 Results And Discussion

4.1 Results of the Open Ended Willingness to Pay (OE WTP)

4.1.1 Open Ended Willingness To Pay Welfare Estimates

The means and variances for the OE WTP questions for Saskatchewan and Canada were calculated[15]. A t-test was conducted on the OE WTP Canada and Saskatchewan questions to determine if the values given were significantly different across regions. The null hypothesis is $WTP_{ij} = WTP_{kj}$, where i,k represents regions 1 (Northwestern sample) and 2 (Provincial sample); and $i \neq k$. The subscript j represents question order, 1st, 2nd, and alone (0). The null hypothesis could not be rejected at the 99% level. Therefore the mean values across regions were not significantly different. Consequently, all further discussion will deal with data not segregated by region.

The means and variances were re-estimated for the merged data. Table 4.1 presents the means and variances of the question types (C = Canada and S = Saskatchewan) and question orders (C2 = Canadian question placed second in series). All calculated mean estimates were found to be in the $10 to $20 range.

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[15] The outliers (values > 1000) were removed from the data set since they represent unrealistically high valuations for a caribou maintenance program. This procedure removed only a small number of observations from each of the questionnaire version, all over $10 000. Outliers are an artifact of the open ended WTP contingent valuation method because they are unbounded at the upper end. Outliers can significantly distort benefit estimates. Some extreme values (those that exceed respondents income) can be easily identified and eliminated. However, values that appear inconsistent with the respondent's answers for the demand of the amenity are more difficult to determine(Mitchel and Carson, 1989).

The standard deviations were found to be approximately 2.5 times the value of their means.

Table 4.1: Open Ended Willingness to Pay Questions: Means and Variances

	Canada			Saskatchewan		
Question Order	C2	C1	C0	S1	S2	S0
Mean	17.73	11.24	10.86	20.53	12.58	11.75
Std. Dev.	46.74	26.58	25.61	49.29	26.40	37.34
N	184	202	272	185	202	228

Note: 1 represents first order question; 2, second order; 0, presented alone: S represents Saskatchewan and C, Canada.

4.1.2.1 Open Ended Willingness To Pay: Test of The Ordering Effect

To test for the ordering effect, t-tests using pooled variances were conducted to determine if the values derived from the different question ordering were significantly different. Table 4.2 lists the results from the t-tests. For each of the

Table 4.2: Results of the t-Tests for The Ordering Effect

	Canada			Saskatchewan		
Question Order	C2 vs. C1	C2 vs. C0	C1 vs. C0	S1 vs. S2	S1 vs. S0	S2 vs. S0
t-stat	1.69529	1.8888	0.15699	1.9520	2.0011	0.26239
p-value	0.09202	0.06130	-0.7551	0.05126	0.0466	-0.7031

Note: 2 represents second order questions; 1, first order; S represents Saskatchewan and C, Canada.

question types the null hypothesis is $WTP_i = WTP_j$, where subscripts i and j each represent question orders 1, 2, and 0, for first and second order questions; and single question presentation, respectively and $i \neq j$. For both the Canadian and Saskatchewan questions, the t statistics were not significant at the 99% level. At this level, the null hypothesis can not be rejected and question order values (WTP's) are not significantly different. The results indicate that the Saskatchewan and Canadian program evaluations were not influenced by the question order within the survey design at a 99% significant level. P-values were also calculated to determine at what level the mean values were significantly different. These p-values were calculated by interpolating between the t values which bordered the calculated t-statistic. Some t-statistics were not bordered and consequently the corresponding p-value are only close approximations. With the exceptions of C1 vs. C0, and S2 vs. S0, the p-values indicate that the differences between the mean values in table 4.2 are significant at a 90% level.

4.1.2.2 Open Ended Willingness to Pay: Test for the Whole-Part Effect

To investigate the presence of the whole-part effect, a t-test was conducted to determine if the Canadian and Saskatchewan values were significantly different from each other. The null hypothesis is described as:

C1=S0, where C1 is the larger good (Canadian caribou maintenance program) presented first and S0 is the subset good (Saskatchewan program) presented alone.

Table 4.3 presents the t-test results for the above hypothesis. The null hypothesis could not be rejected at the 99% level. Despite these results, the presence of the whole-part effect is not confirmed. According to Kahneman and Knetsch (1992) for the whole-part effect to be identified as present the S0 value must be greater than the S2 value; this was not found in the previous section. One possible reason for the Canadian and Saskatchewan values not being significantly different could be that respondents are demonstrating their point of satiation for woodland caribou. The marginal gains to the individual from 3600 caribou, in the Saskatchewan program, to 700 000 in the Canadian program may be very small and

Table 4.3: Results of t-Test Comparing Canadian and Saskatchewan Programs

	Canada/Saskatchewan	
Question Order	C1	S0
Mean	11.24	11.75
t-stat	- 0.094371	
p-value	0.78600	

Note: C1 represents Canada question present first; S0, Saskatchewan presented alone

this is reflected in the valuation of the programs. This behaviour may appear to violate the non-satiation axiom of economic theory. However, this observed preference may not be irrational when a spatial perspective is used in interpreting the results, as described in the following paragraph.

Although the t-test indicated that the values were not significantly different at a 99% level, the p-values showed that most of the values were significantly

different at the 90% level, as stated in the previous section (Table 4.2). Since some of the mean values are significantly different at a 90% level, a comparison between the mean values for both the Canadian and Saskatchewan programs was conducted. In comparing the values between the Saskatchewan and Canadian programs, from the same question order (eg. C1 compared to S1), it was found that the Saskatchewan values were consistently higher than the corresponding Canadian values (Table 4.4). These results indicate that the respondents may have a greater preference for the Saskatchewan program than for the Canadian program. This result may be due to

Table 4.4: Comparison of OE WTP Mean Values

Question Order	CS	SC	Single
Canada	11.24	17.73	10.86
Saskatchewan	12.58	20.53	11.75

Note: CS, presentation order, Canada, first/Saskatchewan, second; SC order reversed; "single" presentation.

the fact that the questionnaire was sent only to Saskatchewan residents. When the questionnaire was designed it was felt that respondents, for the two question formats, would view each question independently. The Saskatchewan program would be viewed as a subset of the national program. Consequently, with the implementation of the national program, provincial benefits through the national program would equal those received from the Saskatchewan program when it was valued separately. However, respondents may not have viewed the questions in this way. Although both programs stated an objective to maintain caribou numbers, only the Saskatchewan

program identified levels for the province, while the national program did not identify regional distribution levels for the caribou. Consequently, the respondents may be showing a regional preference in maintaining a known level of caribou within the province. It is quite plausible that the individual gains greater utility by directing his/her monies directly to maintaining wildlife closer to where that individual lives as opposed to some national program.

4.1.3 Open Ended Willingness To Pay Models of Social Characteristics

To investigate which socioeconomic characteristics of the respondents influenced the amount individuals were willing to pay, a number of cross-tabulation tables were constructed. The demographic variables displayed a high amount of variance when cross-tabs were preformed on the willingness to pay variable for all the data sets. Consequently, it was decided that regressions should be developed to determine which socioeconomic attributes of respondents influenced willingness to pay amounts. Models for the Canadian and Saskatchewan programs were estimated for each of the question orders. Because of the nature of the data, tobit models were developed. The results of these models are presented in Tables 4.5 and 4.6 for the Canada and Saskatchewan programs, respectively.

Age proved to be the most important attribute in determining an individual's willingness to pay for a caribou maintenance program. The sign on the coefficient was negative for all of the models. This indicates that the older a respondent is, the less s/he is willing to pay for the caribou maintenance program. Two possible factors

may explain this behaviour. First, it is possible that the older generation may not be as aware of environmental issues as the younger generation. Second, work done by Cullen and Moller (1985) indicates that as people age they may not be as willing to pay or take actions that will produce benefits they may not receive. Consequently as people age their time preference may change to the point where they will contribute to future benefits if there is a probable chance they will not benefit from the gains. Younger individuals are more likely to pay more since they may not have realized their own mortality and subsequently their time preference for future benefits will be different than older individuals.

The level of education was a significant variable, at a 95% level, for all the

Table 4.5: Canada OE WTP Tobit Models

Variable Name	Canada		
	C2	C1	C0
Education	7.8741** (3.667)	4.3614** (1.992)	3.5939** (1.849)
Age	-2.0541* (0.6338)	-1.1390* (0.3686)	-0.80135** (0.3403)
Rural/Urban	-36.319** (18.27)	-14.127 (11.28)	3.8091 (11.01)
Region	-34.567** (18.15)	-16.262 (12.55)	2.7565 (11.81)
Income	0.12797[1] (3.884)	5.4930* (2.160)	-1.1990 (2.096)
Northwest	5.5383[1] (21.41)	8.2308 (11.92)	31.924** (13.26)
Constant	28.153[1] (60.70)	-20.693[1] (41.87)	-62.932[1] (39.47)
σ	82.893 (7.928)	52.559 (5.238)	58.761 (5.446)

Note: Top term is the coefficient of the variable and the bracketed term is the standard error. * Significant at a 99% level; ** Significant at a 95% level; [1] Not significant at a 20% level; C,

represents Canada question, S, Saskatchewan question; 1 and 2 represent question order, and 0 represents questions presented alone.

models but S0. The sign on the coefficient was positive indicates that the higher the education level of the respondent, the more the individual is willing to pay for a caribou maintenance program. The reason for this behaviour may be that educated people tend to be well read and more aware of issues that will affect their lives or the lives of others. With the high media profile woodland caribou has received it is not surprising that this group places a higher positive value on the maintenance program.

The other demographic attributes were not consistent across models. For example, it was expected that income would be positively signed and significant but

Table 4.6: Saskatchewan OE WTP Tobit Models

Variable Name	Saskatchewan		
	S1	S2	S0
Education	8.0198** (3.628)	3.9122** (1.672)	-0.86487[1] (3.218)
Age	-1.7923* (0.6145)	-0.91735* (0.3105)	-1.4213* (0.5521)
Rural/Urban	-23.280 (17.99)	-16.589 (9.390)	37.467** (16.89)
Region	-19.432 (17.69)	-5.8137 (10.10)	-19.981 (17.50)
Income	-2.1512 (3.945)	5.9232* (1.796)	9.3501** (3.867)
Northwest	4.1575 (21.30)	14.299 (10.40)	19.166 (19.31)
Constant	7.3554[1] (60.65)	-34.837[1] (35.25)	-12.493[1] (56.45)
σ	85.192 (7.865)	45.406 (4.238)	78.630 (7.846)

Note: Top term is the coefficient of the variable and the bracketed term is the standard error. * Significant at a 99% level; ** Significant at a 95% level; [1] Not significant at a 20% level; C, represents Canada question, S, Saskatchewan question; 1 and 2 represent question order and 0 represents questions presented alone.

this was not the case for half of the developed models. For the Canada question in C2 and C0 and the Saskatchewan question S1, income was insignificant in predicting willingness to pay responses and in two of these models it had a negative sign. The income coefficient was not robust and the variable income was found to be significantly correlated[16] with education. The high correlation could explain the lack of significance of the income variable in these models.

Initially, it was believed that the population distribution between rural and urban residents; and between the Saskatchewan and Northwestern regions would be significant in identifying how much respondents would be willing to pay. The results did not bear this out. In the majority of the models these two factors were insignificant.

In summary, the amount an individual is willing to pay for a caribou maintenance program appears to be affected by two demographic factors. The older the respondent the less s/he is willing to pay for a caribou maintenance program. In most of the models as the education level of the respondent increased the larger the amount the individual is willing to pay for the caribou program. The residence or region an individual lives in appears to have no significant influence on the amount s/he is willing to pay.

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[16] A Spearman Correlation Coefficient was calculated between income and education. The results showed a significant amount of correlation between the two variables. For a detailed description of the Spearman Correlation Coefficient see Mason, pp 552-553, (1982).

The above models were tested to determine if they were significantly different. The null hypothesis assumes that the coefficients for the same variables are not significantly different across regressions (eg. H_0: S0=S1). The results are presented in Appendix B. The null hypothesis could not be accepted at a 99% level for all of the models. Therefore, the previously described tobit models were found to be significantly different. These results may seem to contradict previous t-tests which found no significant difference in welfare measures. The reason for this discrepancy is due to the different values tested. In the t-test the mean WTP values are examined to determine if they are significantly different. These values are not population dependent and different populations may value the described programs similarly. However, when testing the tobit models, to determine if they are significantly different, the populations used for each model can have an impact on the results. The characteristics of the sample populations, for each model, will influence which variables are significant in determining willingness to pay amounts. It is the different significant variables between the models that has influenced these results. Consequently, the coefficients, in the tobit models, between the different versions were found to be significantly different. As a result, the individual models for the Canadian and Saskatchewan programs were not merged.

4.2 Dichotomous Choice Willingness to Pay Models of Welfare Measures and Social Characteristics

Dichotomous Choice Willingness to Pay models were estimated so that

household[17] willingness to pay values could be estimated and to investigate social characteristics which may influence WTP. Several specifications and functional forms were examined (Appendix C). The two linear functional forms described by Hanemann (1984) Bid and the log of Bid divided by income[18] were estimated.[19] It was determined that for this study the linear functional form using the variable Bid[20] would be the most acceptable. A description of the models can be found in Table 4.7. The variable Actwld, was binary and was assigned a value of 1 if the respondents indicated participation in any outdoor wilderness activities in 1992. The variable Impl (importance of caribou to respondents) was originally ordinal[21] in structure and consequently was transformed into a binary variable, (1 for categories important to very important and 0 for unimportant to very unimportant). Bid was at least significant at a 95% level, with the exception of Bid in S0 which was significant at an 80% level, and impl was significant at a 99% level in all models. The variable outdoor wilderness activity (Actwld) was shown to be insignificant at a

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[17] The dichotomous choice questions asked household willingness to pay values as opposed to the open ended format which asked individual willingness to pay amounts.

[18] The log of 1 - Bid divided by income is approximately equivalent to bid divided by income. This linear form was used in the estimated models.

[19] In addition to the linear functional forms a semi-log functional form was also examined. For the Canada questions in C1 and C0 and the Saskatchewan question S1 log(bid) value was found to be highly significant. An integration of this functional form was performed and the function did not converge. Consequently, this form was deemed unacceptable and no further analysis was performed.

[20] The specification of Bid divided by income (Bid/m) was found to be highly significant for the Saskatchewan question which was presented alone (S0). Sellar et al.(1986) showed that welfare measures are sensitive to the specifications used in logit models. Because much of this study involves the comparisons of WTP values the linear functional form using Bid was used in S0.

[21] The variable Impl was structured on a scale of 1 to 4. No neutral position was available to the respondents.

80% level in all but version S1. In S1, Actwld was significant at a 99% level and was consequently retained in this model only.

Table 4.7: Results For the DC WTP Models

	Canada			Saskatchewan		
	Versions					
Var. Name	C2	C1	C0	S1	S2	S0
Const.	- 0.72504 (0.6113)	- 0.31875 (0.5675)	- 0.33767 (0.6523)	- 0.72188 (0.6100)	0.29589 (0.4654)	- 0.69048 (0.5444)
Bid	- 0.014575 (0.005841)	- 0.016174 (0.006038)	- 0.01466 (0.00580)	- 0.016305 (0.006562)	- 0.020985 (0.005851)	- 0.007122 (0.005481)
Impl	1.8693 (0.6063)	1.7327 (0.5051)	1.8732 (0.6132)	1.6784 (0.5767)	1.3943 (0.4693)	1.8261 (0.5089)
Actwld				0.90299 (0.3715)		
n	149	171	174	147	169	176
McF R^2	0.08284	0.09846	0.07772	0.1285	0.09548	0.0888

Note: The top term is the coefficient of the variable and the bracketed term is the stand error. The constant was insignificant in all the models, Bid in S0 was significant at a 80% level, all other variables shown were significant at least to a 95% level. The versions are described as follows C represents the Canadian question; S, Saskatchewan question. Numeric values identify question order, 0 is single presentation.

The Saskatchewan question, in version 9, which dealt with increased expenditures, produced unusable results. Several specifications and functional forms were attempted, but the bid variable remained highly insignificant. Consequently, no further analysis was performed on this version and no results will be presented[22].

[22] It is possible that the respondents interpreted this question differently then the other questions. Over 90% of respondents accepted the Bid presented. Because this question used increased expenditures as a payment vehicle it was phrased slightly different then the other CV questions. It is possible that the respondents thought they were purchasing more than the caribou maintenance

The welfare measures were calculated using the means of the "other" variables[23] and coefficients from these initial models as described in section two. These initial coefficients were incorporated into a Monte Carlo simulation[24] and the variances for the WTP measures were generated[25]. Two Monte Carlo simulations were run for each model. The first set of simulations incorporated the mean values of the independent variable from the individual models. The second set of simulations used "representative" values for the independent variable to mitigate the influences from the different sub-sample populations in the WTP measures and the variance calculations. The initial variances for the DC WTP values were high. The Monte Carlo results contained some extreme outliers in the negative and positive value range. Since WTP values must be positive all negative values were discarded. Adamowicz *et al.* (1989) point out that if the coefficients on the price term approach zero it is possible for welfare measures to be infinite. The potential for large variances is possible if the demand parameter has a low t-statistic. Therefore, if the WTP value was greater than 1000 it was removed from the observation set[26]. The

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program described.

[23] The term "other" variables references all independent variables, other than Bid, that were found to be significant. The means of these variables are used in the calculation of the median and mean willingness to pay values as described by Loomis and Cooper (1992).

[24] Monte Carlo simulations use the variance/covariance matrix and the coefficients from the initial models to generate a "new" data set. This set is then used to re-estimate the coefficients. This procedure is repeat 1000 times. For a general overview of a Monte Carlo simulation read "A Guide to Econometrics" P. Kennedy (1985). For a mathematical interpretation read Judge et al. (1989).

[25] The parameters used in the Monte Carlo simulations are assumed to be distributed asymptotically normal.

[26] The extreme upper and lower outliers were discarded and not set to some minimum or maximum value so that the integrity of a normal distribution could be maintained.

$1000 value was chosen for similar reasons stated in the OE WTP analysis. Values that were greater than 1000 were considered to be too large of a percentage of the respondents average household income to pay for the described good. The results can be found in Table 4.8.

From the results presented in Table 4.8, it appears that household WTP values are similar between the Canadian and Saskatchewan programs. With the exception of version S0, the median values are similar in value, with individual values ranging from $62 to $93 with the majority in the $70 range. The mean values generated from the individual regressions show less variation (with the exception of S0) with the

Table 4.8: Means and Medians for DC WTP Models

	Canada			Saskatchewan		
Version	C2	C1	C0	S1	S2	S0
Median	62.15	71.13	92.99	75.55	70.32	125.942
Mean	85.44	88.13	108.53	91.26	80.13	173.9745
Mean from Monte Carlo[1]	99.8584	100.0042	125.2758	105.6408	84.8028	218.8580
Std. Dev.[1]	50.9799	42.7992	56.0312	54.90617	18.4016	159.9134
Mean from Monte Carlo[2]	98.94157	101.5378	119.9826	105.6408	85.8389	217.6064
Std. Dev.[2]	50.54223	43.45545	53.51610	54.90617	18.83892	158.9011
N	996	999	996	990	1000	868

Note: C represents Canada; S, Saskatchewan; 1,2 represent question order, 0 indicates question presented alone. [1] indicates that the Monte Carlo simulation incorporated the mean values for the independent variables from the sub-samples. [2] indicates that a "representative" value for the independent variables were used.

majority of the values being in the 80 to 90 dollar range. The mean values generated by the Monte Carlo analysis produced the highest values with the greatest variation,

excluding version S0, the mean values ranged from $84 to over a $125. The high variance for the Monte Carlo analysis could be due to the demand parameter having a low t-stat as discussed previously. The median value for S0 was over $125 and the mean value generated by the Monte Carlo analysis was over $218. Version S0 showed the greatest differences in the value estimates. Its mean and median values were consistently higher than the other versions and also showed the largest disparities between its median and mean values. In version S0 the linear functional form used produced an extremely low t-stat on the demand parameter. This low t-stat is the likely reason for the high value estimates and large variance within this version.

Two types of significance tests were conducted. The first test discussed in the following text was used to examine if the individual willingness to pay values from the individual regressions were significantly different. This latter test was used to determine the presence of the ordering and the embedding effects. Pairwise t-tests were used to determine if the mean willingness to pay values are significantly different. These mean values and variances used in this test were those generated by the Monte Carlo simulations. The second test was performed to determine whether the individual regressions were significantly different. A chi-squared test is calculated using the restricted and unrestricted Log-Likelihood values. This test determines if the coefficients are different across the different models.

4.2.1 Dichotomous Choice Willingness to Pay: Test of the Ordering Effect

To determine if the ordering and whole-part effects influenced WTP values,

pairwise t-tests of the Monte Carlo generated mean values were conducted[27]. One set of pairwise t-tests were conducted using the means and variances from the Monte Carlo simulation which incorporated the mean values from the individual sub-sample independent variables. A second set of pairwise t-tests incorporated the Monte Carlo simulation results which used a "representative" value for the independent variables. This was done so that the t-test would be "fair", when comparing the influences of the ordering effect and later when analysing for the whole-part effect. By using the representative value, differences in the sub-sample populations, that could influence the results, were removed. The null hypothesis for comparing the individual question values relative to their presentation order is $WTP_i = WTP_j$, where subscript i and j, represent question order 1^{st},2^{nd} or 0 for single presentation and i is not equal to j. The null hypothesis is rejected at the 99% level for all the t-tests except C2 vs C1 (Table 4.9). Therefore, it can be concluded that most of the DC WTP values were

Table 4.9: Pooled Variance t-test Results For the Ordering Effect

	Canada		Saskatchewan	
Version	C2 vs. C1	C2 vs. C0	S1 vs. S2	S1 vs. S0
t-stat[1]	- 0.0691536	- 10.583896*	11.34568*	- 20.9109*
t-stat[2]	- 1.23158	- 9.01593*	10.7745*	-20.7890*

Note: C represents the Canada question, S, Saskatchewan question; 1,2 question order and 0 represents single question. [1] indicates that the t-stat was generated from the mean value of the independent variable from the sub-samples. [2] indicates that the t-stat was generated from a representative value of the independent variable. The * indicates significance at a 99% level.

[27] The mean values from the Monte Carlo simulation were used since they correspond to the variances which were used in the t-test. The t-test for pooled variances was used. The observations (N) used are given in Table 4.8.

influenced by the ordering of the questions.

The questions presented alone for both Canada and Saskatchewan programs were found to be significantly different from the values estimated when the programs were presented together. The single presentations of the Canada and Saskatchewan programs enhanced its importance to the respondents.[28]

4.2.2 Dichotomous Choice Willingness to Pay: Test of the Whole-Part Effect

As in Section 4.1.2, the values between the Canadian and Saskatchewan programs were tested to determine if the whole-part effect was present. The null hypothesis is:

i) C1=S0, where C1 is the whole good (Canadian caribou maintenance program) presented first and S0 is the partial good (Saskatchewan program) presented alone.

Table 4.10 presents the t-test results for the above hypothesis. The null hypothesis

Table 4.10: T-test for the Whole-Part Effect

	Canada/Saskatchewan	
Question Order	C1	S0
Mean[1]	101.5378	217.61
t-stat	- 22.1418	

Note: C1 represents Canada question first; S0, Sask. question presented alone. [1] indicates the values used were derived from the Monte Carlo simulation using the representative values for the independent variable.

[28] In two cases the Saskatchewan program received a higher value than the Canadian program. This is a similar result as was found in the Open Ended format of the questionnaire.

is rejected at the 99% level and the C1 value was significantly different from the S0 value. Although the results of the t-test were as expected, the direction of the values were not. It was hypothesized that the value for the Saskatchewan program would be valued less than the Canadian program. The opposite result was found[29]. Kahneman and Knetsch (1992) point out in their evaluation of the whole-part effect that question order influences the values respondents place on environmental goods. Their results found that the values placed on a subset of goods were equal to the full set of goods depending on the question order. As shown in the above table this result was not found in this study. The comparison between the Canadian and Saskatchewan values does not indicate the presence of the whole-part effect since the subset value was greater than the full set value. The above results also can not be explained away as the respondents having reached satiation with the Saskatchewan caribou program. For satiation to be considered for the above results, the values for the Canadian and Saskatchewan programs should be approximately equal, this was not found. What the evidence does suggest is that there could be some inherent weakness within the CVM question. This weakness could be attributed to a number of reasons, from faults in question design to the mostly likely cause being the sensitivity of value estimates related to the functional form used in estimation.

Not all the DC WTP mean values displayed the same trend as those shown in Table 4.10. In some models the Canadian DC WTP values were greater than the corresponding Saskatchewan values. Because of the disparity in results, conclusions

[29]Unlike the OE WTP values the DC WTP values for the Saskatchewan program were not greater than the Canadian program's in the other versions of the questionnaire.

similar to those discussed in Section 4.1.2.2 may not be relevant[30]. In the cases where the Saskatchewan programs were valued higher than the corresponding Canadian programs, it is feasible that the respondents are behaving similar to that discussed in section 4.2.1. In the case where the Canadian values were found to be higher than the Saskatchewan values respondents may be demonstrating the non-satiation axiom.

4.2.3 Dichotomous Choice Willingness to Pay Significance Test of the Regressions

The models in Table 4.7 were analyzed to determine if the coefficients between models were significantly different. The null hypothesis is $B_{ij}=B_{ik}$ where i is the coefficient on the variable and j,k are the regressions where $j \neq k$. Likelihood

Table 4.11: Results from Log-likelihood Ratio Test

	Canada			Saskatchewan		
	Bid was Dependent Variable					
Version	C2 vs C1	C1 vs C0	C2 vs C0	S1 vs S2	S2 vs S0	S1 vs S0
Unrestricted Log-likelihood	- 198.584	- 209.9758	- 199.0773	- 183.5287	- 205.3514	- 193.2344
Restricted Log-Likelihood	- 199.3437	- 210.3347	-200.3572	- 184.8519	- 207.4276	- 195.0456
# Restrict. (q)	3	3	3	4	4	4
Chi-square	1.3706	0.7178	2.5598	2.6464	4.1524	3.6224
Null Hypothesis	accepted	accepted	accepted	accepted	accepted	accepted

Note: All values were shown to be insignificant at a 90% level

[30] It is possible that the disparity in results are reflecting the influences of the ordering and whole-part effects, as discussed earlier in section 4.2.1.

ratio[31] tests were used. The results from the analysis are presented in Table 4.11. The chi-squared values were not significant at the 90% level and the null hypothesis could not be rejected. Therefore, the coefficients are not significantly different. This result is opposite to what the previous t-test, in section 4.2.1, using welfare measures found. The probable reason for this result is the non-linear transformation of the welfare measures as described in chapter 2.

Since the coefficients of the models were not found to be significantly different, aggregate models were developed for the Saskatchewan and Canada questions.

4.2.4 Dichotomous Choice Willingness to Pay Aggregated Models

The aggregate models for the DC WTP questions are presented in Tables 4.12 and 4.13. As in the sub-sample models, Bid and the importance of caribou (Imp1) were highly significant. The negative sign on the Bid coefficient was as expected.The coefficient for the Imp1 had a positive sign and was found to be quite robust. In addition to Imp1, the binary variable Envqty[32] was shown to be highly significant with positive signs in both of the final models.

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[31] The Likelihood ratio is described as: -2(restricted Log-likelihood - Unrestricted Log-likelihood) is approximately a chi-square. For a more detailed description see Judge et al. (1988)

[32] The binary variable Envqty was equal to 1 if the respondent identified caribou as an indicator of environmental quality, and 0 if it was not chosen.

Table 4.12: DC WTP Model For Canada

Maximum Likelihood Estimates	
Log-Likelihood	- 325.5448
Restricted (Slopes = 0) Log-Likelihood	- 362.7094
Chi-Squared (3)	74.32914
Significance Level	0.000000
N[0,1] used for significance levels	
Mcfaddens Pseudo R^2	0.1025[33]
Number of Observations	535

Variables	Coefficient	Std. Error	t-ratio	Prob|t|≥X	Mean	Std. Dev. of X
Constant	-0.54011	0.3294	-1.639	0.10111		
Bid	-0.015851	0.003293	-4.813	0.00000	50.21	29.356
Impl	1.5461	0.3064	5.046	0.00000	0.873	0.3334
Envqty	0.77686	0.1925	4.035	0.00005	0.467	0.4994

Table 4.13: DC WTP Model For Saskatchewan

Maximum Likelihood Estimates	
Log-Likelihood	- 326.8902
Restricted (Slopes = 0) Log-Likelihood	- 362.7835
Chi-Squared (3)	71.78661
Significance Level	0.000000
N[0,1] used for significance levels	
Mcfaddens Pseudo R^2	0.0989
Number of Observations	543

Variables	Coefficient	Std. Error	t-ratio	Prob|t|≥X	Mean	Std. Dev. of X
Constant	-0.28668	0.2851	-1.006	0.31461		
Bid	-0.015089	0.003226	-4.677	0.00000	47.350	29.731
Impl	1.3432	0.2725	4.929	0.00000	0.856	0.35105
Envqty	0.80601	0.1951	4.132	0.00004	0.442	0.4971

In summary, although Bid was highly significant in the two models presented,

[33] The McFadden Pseudo R squared is described as R2 = 1- (logLΩ/logLω), where LΩ is the maximum log-likelihood with respect to all parameters (constant and all betas), and Lω is the maximum when maximized with respect to the constant only and all slopes are set to zero. For a more detailed description see Maddala p 40 (1983).

it was not the only factor in determining bid acceptance. The models showed attitudes towards wildlife and the environment played an important role in determining the bid's acceptance or refusal.

4.2.5 Aggregate Dichotomous Choice Models: Goodness of Fit

Table 4.14 contains the data showing the percent correct prediction rates of the DC WTP models. Both the Canada and Saskatchewan models achieved over an 80% correct prediction rate for bid acceptance. However both models suffered with respect to predicting bid refusal. The average correct prediction rate for bid refusal

Table 4.14: Correct Prediction Ability

Prediction Rate (Predicted/Actual)					
Models	Correct Pred. 1	% Correct	Correct Pred. 0	% Correct	Total % Correct
Canada	266	84.71	94	42.53	67.29
Saskatchewan	272	81.93	92	43.60	67.03

for both models was just over 40%. The average rate of correct predictions was just over 67% for both models. The disparity in the model in its prediction rate between acceptance and refusal causes some concern. It is desired that the prediction rates be approximately equal for acceptance and refusal. One reason for the disparity could be caused by the low number of bid refusals. For both models approximately 40% of the bids were refused. Although this provides some level of variation in the models it may not be enough for the functional form that was chosen. To improve the prediction rate more complex models were estimated. The correct prediction rate remained robust at around 60%.

4.3 Welfare Measures from Aggregated Open Ended and Dichotomous Choice Willingness to Pay Models

Welfare measures from the aggregated OE WTP were calculated and are presented in Table 4.15 As with the individual questionnaire version means, the mean WTP for the Saskatchewan program is higher than the value for the Canada program. The Saskatchewan total welfare measures for the Canadian and Saskatchewan caribou program are calculated by multiplying the mean values by the

Table 4.15: Aggregated means and Total Welfare Measures for OE WTP

	Canada	Saskatchewan
Average Mean	12.90	14.66
Saskatchewan Total Welfare Measure	9 127 653	10 372 976

population of Saskatchewan which is 18 years or older[34]. The 1991 Canada census estimated the population of citizens 18 years and older for Saskatchewan, at 707 570. The benefits identified for the Canada and Saskatchewan programs for the OE WTP CV questions were approximately 9.1 and 10.4 million, respectively.

The DC WTP welfare measures were calculated using the median and mean values given in Table 4.16. Since these values represent **household** values they were

[34] This portion of the population was used since the questionnaire was limited to respondents who were 18 years and over. Inclusion of individuals less than this threshold age would lead to an over estimation of the total benefits.

divided by 3.2[35] so that values represent individual measures (Table 4.17). Total number of Saskatchewan residents were used in this calculation since the question valuation represented households. Households would included all individuals residing within the household regardless of age, consequently total population values can be used.

Table 4.16: Household Mean and Median values for the DC WTP Models

	Canada	Saskatchewan
Median	73.97	80.84
Mean	90.98	97.99
Mean (Monte Carlo)	91.62	101.54
Variance	190.99	284.77

Table 4.17: Individual Mean and Median values for the DC WTP Models

	Canada	Saskatchewan
Median	23.11	25.26
Mean	28.43	30.62
Mean (Monte Carlo)	28.63	31.73

Table 4.18 contains the total welfare measure estimates for the people of Saskatchewan gained from the implementation of a caribou maintenance program.

[35] This value represents the average number of individuals per household in Saskatchewan as identified by Statistics Canada (1991).

Table 4.18: Total Welfare Measures For The DC WTP Models

Value Used	Canada	Saskatchewan
Median	22 854 126	24 980 321
Mean	28 313 009	30 280 975

Although value estimates for the OE and DC were positive indicating that there is a positive value for the described caribou program, the DC WTP estimates are approximately 2.0 to 3.0 times greater than the OE WTP welfare measures. This disparity is similar in magnitude and direction to the results found by Kealy and Turner (1993) of 2.5 times between the two measures. Kealy and Turner suggest the disparity could be caused by several factors including the potential for strategic behaviour in the open ended format, the ability and willingness of respondents to formulate their preferences and the differences in question formats.

4.4 Capitalized Values of WTP estimates for Aggregated Dichotomous Choice and Open Ended Models

The capitalized values of the welfare measures were examined. The capitalization formula for a fixed term annual payment (Gunter and Haney, 1984) is:

$$PV = a\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right] \qquad (25)$$

where: PV = Present value
a = Annual Payment
i = Discount Rate
n = Periods

Two discount rates, 3% and 5%, were used to estimate the capitalized welfare

measures. The WTP questions elicited payments for a 10 year period (**n**) and **a** represents the annual median or mean values as required.

The capitalized values represent the present value of a caribou maintenance program. The calculations assume that the annual values will remain constant over the ten year period. Since these values would be used in a Benefit Cost analysis Johansson *et al.* (1989) suggest that the means are the appropriate values to include. The results of the calculation are presented in Table 4.19.

One difficulty with incorporating these values into a Benefit Cost analysis is the disparity between the OE and DC WTP mean values. A t-test was performed on the dichotomous choice and the open ended mean values to determine if they

Table 4.19: Capitalized Benefits for Aggregated Individual Welfare Measures

	Canada		Saskatchewan	
	Discount Rates (%)			
	3	5	3	5
Mean (OE WTP)	77 860 731	70 481 317	88 483 589	80 097 371
Mean (DC WTP)	241 515 000	218 625 000	258 302 000	233 821 000
Median (DC WTP)	194 950 000	176 473 000	213 087 000	192 891 000

were significantly different. The null hypothesis that the means were not significantly different was rejected at a 99% level (Appendix D) and that the mean values are significantly different between the question formats. At present there is no economic theory which suggests which is the correct mean to incorporate into the analysis.

Despite the disparity between values generated by both approaches the values for both types of questions are positive. Consequently, non-implementation of the

caribou program could cause society to forgo between 70 and 258 million dollars in benefits. From a policy perspective these values are quite large. This indicates that the citizens of Saskatchewan place a high value on the caribou maintenance program. Consequently, any provincial forest management program that did not attempt to maintain caribou numbers in Saskatchewan would result in a large loss to the people of Saskatchewan[36].

[36] These positive values represent a gross benefit measure. If the cost of the maintenance program are greater than the benefits the net value would be negative and the loss to society would be associated with the implementation of the caribou program.

CHAPTER 5 Conclusions, Implications and Future Research

This study was conducted to investigate the influences of the whole-part and ordering effects in contingent valuation survey design and to determine the value of a woodland caribou maintenance program to the citizens of Saskatchewan. To meet these objectives 9 versions of a contingent valuation survey were developed. Of these 9 versions, 4 contained open ended willingness to pay CV questions and 5 were composed of dichotomous choice CV questions. The estimated values from these two CV formats were determined and compared. To investigate the whole-part and ordering effects CV question orders were randomized within the nine versions. Analyses were conducted to determine if these effects were present within the willingness to pay results.

5.1 Welfare Measures

Two types of contingent valuation questions, Open Ended (OE) and Dichotomous Choice (DC), were used to estimate willingness to pay values. The results from this study produced mean value estimates for the Saskatchewan caribou maintenance program of between $14 and $30[37] per individual for the OE and DC WTP methods, respectively. These figures represent what a resident of Saskatchewan would be willing to pay annually for ten years to implement a woodland caribou maintenance project. The values for the OE questions were found to be consistent

[37] The estimated values for the Canadian caribou maintenance program for the OE and DC questions were $12 to $29, respectively.

and robust across the different survey formats. The values derived from the DC questions displayed a high degree of variability between the different question presentation formats. This variation in willingness to pay values was attributed to the ordering and whole-part effects and inherent weaknesses within contingent valuation methods.

The range of estimated values for both formats were similar to values estimated in other existence value studies (Samples *et al.* 1986; Stevens *et al.*, 1991). The individual values for this program on an annual basis may not seem very large, but these values, aggregated for the province of Saskatchewan and discounted at a 5% interest rate equate, to a welfare gain of between 70 to 233 million dollars for the Saskatchewan caribou program. Clearly, the people of Saskatchewan have indicated a substantial value on the existence and maintenance of caribou within the province. This value can be attributed to the guarantee of maintaining the present caribou population within the Northwest region of Saskatchewan. If the residents of Saskatchewan were told that there was a probability that the caribou could disappear even with the incorporation of the maintenance program the WTP values would be lower.

5.2 Ordering and Whole-Part Effects

The evidence presented in this study indicated that the ordering and whole-part effects were not present in the Opened Ended format. However, in the Dichotomous Choice format the range in the mean values may be the result of the

ordering effect. The guidelines incorporated into the dichotomous choice survey design did not adequately mitigate this effect. Consistently, questions that were presented first in a series of questions or questions presented alone received significantly higher values than if place second in a series.

Due to the fact that the questionnaire was designed to remove the effects of question ordering and embedding from the results it is possible that other factors may have influenced the results. The significance test for the DC WTP models and the median values were found not to be significantly different and yet in testing the mean values the opposite results were found. It is possible that the linear transformation in the mean value calculations and Monte Carlo procedures skewed the results. Consequently, what the results from this thesis indicate is that CVM estimates are fragile but the results do not clearly implicate the ordering or the whole-part effects as the cause.

Although the dichotomous choice value estimates were not consistent and were found to be significantly different than the open ended formats, both estimates were not greatly different. The problem, as identified by Kahneman and Knetsch (1992) is to determine which of the value estimates generated by the DC and OE formats is the correct value to use in an economic analysis. Recently, CVM have been attacked for just such disparities in the measurement of existences values and it has been suggested that it should therefore not be used in economic analyses (Desvouges *et al.*, 1993). However, Randall (1993) argues that although there are failings in contingent valuation it is the only tool presently available to measure

existence values. To discard CVM as a measuring tool would mean that existence values would be excluded from litigation cases and the like. CVM allows the economist to determine value estimates for a given non-market good, in the case of damage assessments the courts can use this value as a reference and then determine fair compensation.

This study identified large benefits to society from maintaining woodland caribou populations in northwestern Saskatchewan and Canada. The disparity between the welfare measures does not negate the positive benefits associated with maintaining caribou. To ignore these values, because of the disparity in value estimates, in the development of a forest management plan would cause a loss to society. It is the responsibility of the forest manager to recognise the positive benefits gained in maintaining caribou and incorporate mitigating practices so in forest harvesting operations that some level of caribou will continue to exist.

5.3 Implications

In many analyses of this type, benefits are readily estimated with little consideration given for the involved costs in achieving these benefits. One type of cost for such a program is the opportunity cost related to the impact this program would have on the forest industry. Woodland caribou require large tracts of old growth forest to ensure their survival. If these tracts of land are removed from a timber firm's harvestable landbase the firm could expect a decrease in its allowable cut. If we assume that the timber resources are fully committed then the foregone

timber volumes would be the opportunity cost of the program which would be carried by the firm. Associated with the loss of volume to the firm there is the cost to governments. These costs would include foregone stumpage revenues and possibly increase protection charges. For example, if the area surrounding the reserve is being harvested, increased fire protection may be required within the reserve area to maintain the age structure required by the caribou. This would be an additional cost to society. During extremely dry years, which has been the case recently in Northwestern Saskatchewan, the cost of fire control could be very high.

In addition to opportunity costs to the firms and governments, there are also other foregone values which must be estimated. A study on the value of moose and deer hunting in the Northwest region was conducted at the same time as this study (Morton, 1993). The hunting study's results have found large benefits are derived from harvesting due to the increase populations of early forest successional game species like moose and deer from improved habitat. If large tracts of land are excluded from harvesting then the opportunity costs borne by the hunters of Saskatchewan must be estimated and included in the analysis. Other regional opportunity costs must also be analyzed if an optimal solution is to be determined. For example, the indigenous people of the Northwest region rely on plentiful game for subsistence, do they prefer moose or caribou as a food source?

All of the opportunity costs discussed thus far have concentrated on the impacts of a regional program, if the Canadian program was implemented the impacts could possibly be felt globally. Canada is a major exporter of wood products

to the world. If this supply is reduced due to landbase withdrawals new sources of supply may be sought from other countries. In a recent paper by Sedjo (1993) the opportunity cost of maintaining bio-diversity are discussed within a global context. If the North American timber supply is decreased due to landbase removals for maintaining bio-diversity and timber demand is inelastic, prices will rise and attract supply from new areas. If the new supply is of timber is derived from a rainforest region it is possible that the gains from maintaining national bio-diversity will be affected by the loss of bio-diversity in another country.

The challenge to the resource economist is to be able to identify and accurately measure the gains and losses that are applicable for the task at hand. This challenge cannot be met alone, it will require the assistance of other professionals and experts to aid the economist as to what is or is not relevant to the analysis. Only once the objectives and elements of the analysis are identified can the economist realistically meet his/her goal of determining an optimal solution.

5.4 Future Research

This study has identified several areas where future research should be pursued. In the DC WTP format the use of increased expenditures as a payment vehicle was used in one version of the questionnaire. Increased expenditures was considered a realistic consequence of restricted forest harvest due to the implementation of a caribou maintenance program. It was believed that the respondent's evaluation of a caribou maintenance program would be more concise

using increased expenditures. This may have been the case, however it was found that bid values remained insignificant in determining the probability of a respondent accepting or refusing the bid offered. Additional research should be undertaken to determine how applicable increased expenditures are in a DC WTP format and how respondents are motivated in their decision process when faced with this type of payment vehicle.

The whole-part effect and the ordering effect were both determined to be present in this research project within the dichotomous choice format. Many of the guidelines set out by Smith (1992) and Harrison (1992) to mitigate the impact of these two effects were incorporated into the questionnaire design. Even with the addition of these mitigating features the two effects were persistent in the dichotomous format. Additional research is therefore required in the area of questionnaire design and Contingent Valuation question presentation to develop methods which remove these two effects in the dichotomous format.

In closing, this study estimated the value of woodland caribou to the citizens of Saskatchewan using a contingent valuation method. Non-market value estimation techniques, like the one used in this study, are increasing in importance because of society's insistence that non-market goods' values be included in natural resource project evaluations and damage assessments. In conjunction with the value estimates for woodland caribou this study investigated the ordering and whole-part effects; these effects can influence the magnitude of the value estimates. Evidence for the presence of these effects was found in the dichotomous choice experiments.

Although this means that values may have been influenced by these effects it does not mean the values are unusable. It is important to remember that contingent valuation methods are a tool to be used by resource managers and values identified are not absolutes. The information provides the decision maker with a better understanding of the potential trade-offs which may occur under different scenarios. The trade-off between environmental quality and economic development has grown in importance as society re-adjusts its value system. Consequently methods that can provide additional information in the decision making process deserve due consideration.

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Appendix A

Saskatchewan Woodland Caribou Survey

University of Alberta
Edmonton

Saskatchewan Woodland Caribou Survey

You have been chosen to participate in a survey to determine the importance of Woodland Caribou to the people of Saskatchewan. It is important that you take the time to complete the questionnaire and return it as soon as possible. The information collected can then be used to better manage one of our natural resources.

This first section asks about your interest/participation in outdoor recreation activities (canoeing, hiking, fishing, wildlife watching, etc)

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1. During the last year [from (1/Jan./92) to (15/Nov./92)] have you (please ☑)

- Read books, magazines or articles on wildlife or outdoor activities? ☐ Yes ☐ No
- Watched films or T.V. on wildlife or outdoor activities? ☐ Yes ☐ No

2. During the last year [from (1/Jan./92) to (15/Nov./92)] (please ☑)

- Did you hunt or fish? ☐ Yes ☐ No
- Were you involved in other wildlife activities (some examples are: viewing, feeding, attracting or photographing wildlife)? ☐ Yes ☐ No
- Were you involved in other outdoor activities (some examples are: canoeing, cross country skiing, hiking or camping)? ☐ Yes ☐ No

If you answered yes, to any of the above in Question 2, please state the approximate total number of days that you participated in these activities during the last year.

_____ days

3. Are you a member of a wilderness/environmental/outdoor activity club/organization, such as Ducks Unlimited or The Canadian Parks and Wilderness Society? (please ☑).

☐ Yes. ☐ No

If yes, please indicate approximately how much in total you spent on memberships etc. and about how many days you were involved in club activities.

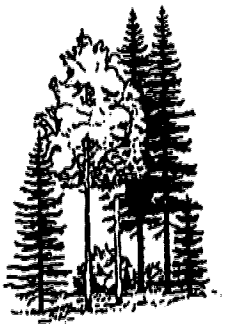
$ _____ spent on memberships/donations

_____ days active in club activities

Please circle the response that best describes your attitudes towards wildlife and wildlands for each statement below.

4.

	Strongly Agree	Moderately Agree	Moderately Disagree	Strongly Disagree	No Opinion
Wildlife is important for people to use and enjoy	4	3	2	1	N
Even wildlife which has no direct benefits to people should be protected and preserved	4	3	2	1	N
Species of wildlife that can damage property or harm people should not be protected	4	3	2	1	N
Wildlife is important but people's needs should come first	4	3	2	1	N
Preserving wildlife for the future is not important as the future will take care of itself	4	3	2	1	N
People have a moral obligation in preserving the environment	4	3	2	1	N



The following questions ask for your opinions about Woodland Caribou. The Woodland Caribou is a member of the deer family which lives in mature forest and muskeg areas in the Northern Canadian Evergreen forest zones. Both the male and female grow antlers, with the female's antlers being smaller in size. The caribou of the woodlands do not travel great distances like their cousins in the north, the Barren-Ground Caribou. As a result, this species has been shown to be sensitive to logging and associated activities.

Figure 1. Male (Left) and Female (Right) Woodland Caribou

5. Have you heard of Woodland Caribou before this survey? (please ☑)

☐ Yes ☐ No

If you answered No please go to Question 7

6. Have you ever seen a Woodland Caribou in the wild? (please ☑)

☐ Never ☐ A few times (1-5 times) ☐ A lot of times (more than five times)

7. How important/unimportant is it to ve nat Woodland Caribou exist? (please circle appropriate number)

Very Important			Not at all Important	No Opinion
4	3	2	1	N

8. Which of the following statements best describe the reasons why Woodland Caribou are important to you (please check the appropriate box(es))?

a) ☐ I want the chance to see a caribou in the wild.

b) ☐ All animals including caribou, have a right to exist.

c) ☐ Woodland Caribou should be preserved for future generations.

d) ☐ I feel Woodland Caribou are an indicator of environmental quality.

e) ☐ There should be opportunities for others (family, friends, etc) to view Woodland Caribou.

f) ☐ I feel Woodland Caribou are important for maintaining the balance of nature.

g) ☐ Woodland Caribou are a part of our Canadian heritage.

h) ☐ I feel Woodland Caribou are important for hunting.

9. If you chose more than one of the above, please identify the response you consider most important. (Place letter from above responses in blank provided)

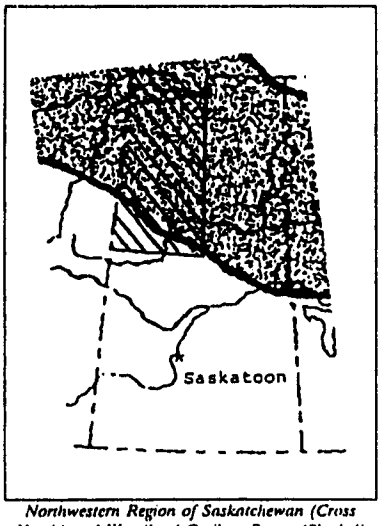
Most Important ____

The Preservation of Woodland Caribou.

Woodland Caribou live in mature forest and treed muskeg regions. Mature forests are considered areas in which the forest has reached a state of slower tree growth and a closed canopy. Treed muskegs are wet areas that have moss ground cover and small scattered black spruce and tamarack. Since world demand for forest products is increasing, areas that were once not considered for logging are now being cut. The result of this action is a changing forest (a greater amount of younger trees) and increasing access to remote areas. The logging of these forests allows for the stability of consumer prices for paper and wood based products. An additional benefit from logging is the creation of jobs in small remote communities in Canada's more northern regions.

A consequence of these changes from logging, has been a gradual decline of Woodland Caribou populations in localized areas due to increased hunting (from man and wolves) and to a lesser extent loss of habitat. Therefore the removal of the forest in remote areas may not hurt the Woodland Caribou directly, but the associated actions and outcome of logging does have an impact on them. Some of these effects may be offset through the development of regulations to retain critical habitat and limit access.

The following is a <u>hypothetical</u> situation and is not being considered as part of any government policy.



Northwestern Region of Saskatchewan (Cross Hatch) and Woodland Caribou Range (Shaded)

Present Range of Woodland Caribou in Canada

The above map shows the present range of Woodland Caribou (shaded region) in Northern Saskatchewan. The cross hatch zone is the Northwestern region of Saskatchewan. It is estimated that 3,600 Woodland Caribou live in this area. Across this same broad region logging activities are expected to increase in the near future. Research has shown that in areas where logging activity occurs the local Woodland Caribou population disappears due to increased hunting from people and wolves, some habitat loss and animals leaving the region.

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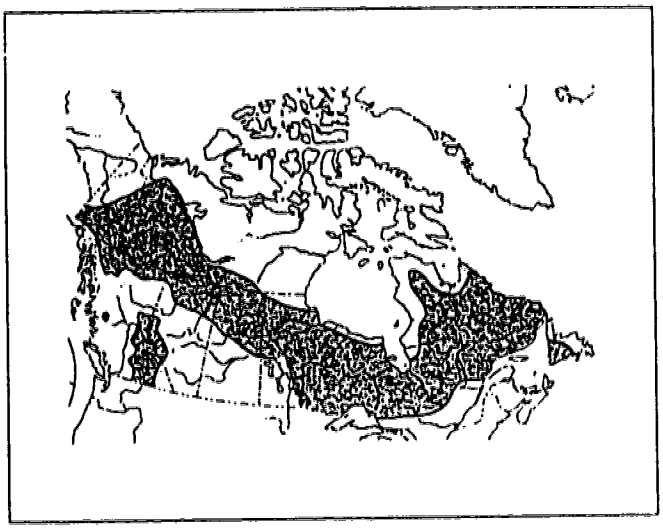
10. *It is possible that by the year 2002 there will be 1,800 Woodland Caribou in Northwestern Saskatchewan. A Woodland Caribou Maintenance program could be developed and implemented to ensure that Caribou maintain their current numbers at approximately 3,600 and their range within Northwestern Saskatchewan. What is the maximum amount you would be willing to pay annually for the next ten years into a trust fund run by an independent foundation for this Caribou Maintenance Program? (fill in amount)* $_____

The following is a hypothetical situation and is not being considered as part of any government policy



Present Range of Woodland Caribou in Canada

The above map shows the present range of Woodland Caribou (shaded region) in Canada. It is estimated that within this area there is a population of 700,000 Caribou and that this species is not considered threatened. Across this same broad region logging, mining and recreational activities are occurring. Research has shown that in areas where logging or human activity occurs, the local Woodland Caribou population disappears due to increased hunting by people and wolves, habitat loss and animals leaving the area.

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11. ***It is possible that by the year 2002 there will be 350,000 Woodland Caribou in Canada. A Woodland Caribou Maintenance program could be developed and implemented to ensure that Caribou maintain their current numbers at approximately 700,000 and their range within Canada. What is the maximum amount you would be willing to pay annually for ten years into a trust fund run by an independent foundation for this Caribou Maintenance Program? (fill in amount) $_____***

If you wish you may go back to the previous question page and change the value that you gave.

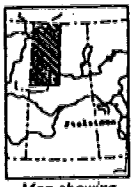
11. If you voted for Option A in the previous question, please give your reason for doing so: (please ☑ only one)

- ☐ I do not receive any benefits from Woodland Caribou.
- ☐ I am not interested in spending my money on the preservation of Woodland Caribou.
- ☐ I do not think Woodland Caribou should get in the way of the forestry industry.
- ☐ Other (please specify) _____

_____

_____

We would like to ask a few questions about your household. These questions are necessary because they help us understand how people feel about these issues. Your answers to these questions will be kept in absolute confidence and will never be related to your name.



Map showing Northwestern Saskatchewan

12. What is your sex? (please ☑) Male ☐ Female ☐

13. How old are you? _____ years

14. Have you ever been to Northwestern Saskatchewan? (please ☑)

Yes ☐ No ☐

15. Size of present place of residence? (please ☑)

☐ Rural, Farm ☐ Village (less than 1000) ☐ Urban (more than 1000)

16. What is your place of residence (name of nearest city or town) _____

17. Number of individuals who reside in your household? (including yourself) ____

18. Please check one of the following categories that best represents the TOTAL ANNUAL HOUSEHOLD INCOME from all sources before taxes in 1992? (please ☑)

☐ $0 - $10,000	☐ $10,001 - $20,000	☐ $20,001 - $30,000
☐ $30,001 - $40,000	☐ $40,001 - $50,000	☐ $50,001 - $60,000
☐ $60,001 - $70,000	☐ $70,001 - $80,000	☐ $80,001 - $90,000
☐ $90,001 - $100,000	☐ Over $100,000	

19. Please circle the highest number of years of education completed.

- Elementary School 1 2 3 4 5 6 7 8
- High School 9 10 11 12
- University/Technical School 13 14 15 16
- Post-Graduate 17 18 19 20 20+

20. What is your occupation? _____

21. If you have any concerns or opinions you would like to share concerning the questionnaire or wilderness preservation, please use the space provided below.

If you have questions about this survey please call Mark Tanguay at:

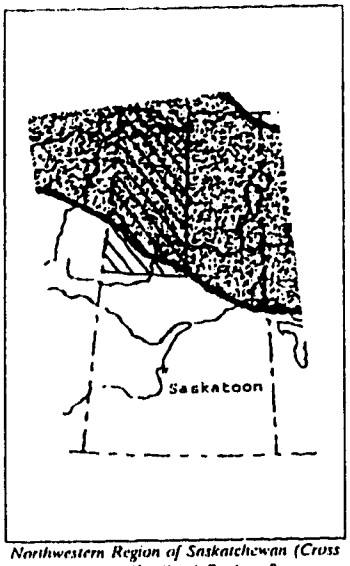
1 - 800 - 267 - 6413 (Toll Free)

THANK YOU FOR TAKING THE TIME TO PARTICIPATE IN THIS SURVEY

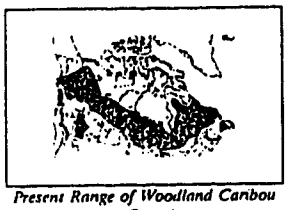
Please remember to return your completed questionnaire in the self-addressed stamped envelope to:

DEPARTMENT OF RURAL ECONOMY
MATERIALS MANAGEMENT BLDG
UNIVERSITY OF ALBERTA
EDMONTON AB
T6G 9Z9

The following is a <u>hypothetical</u> situation and is not being considered as part of any government policy.



Northwestern Region of Saskatchewan (Cross Hatch) and Woodland Caribou Range



Present Range of Woodland Caribou in Canada

To the left is a map that shows the present range of Woodland Caribou within Northern Saskatchewan (shaded area). The cross hatch area is the Northwestern region of Saskatchewan. It is estimated that 3,600 Woodland Caribou live in this area. This region is also an area where logging activity is expected to increase in the coming years.

Suppose you have a choice between two options, given below. The action described will be carried out for the option that receives the majority of votes.

11. *Option A, Have No Maintenance Program to preserve Woodland Caribou. Local populations will disappear within 10 years of logging activities due to increased hunting from people and wolves, habitat loss and animals leaving the area. The end result is that Woodland Caribou populations will decrease to 1,800 in Northwestern Saskatchewan by the year 2002.*

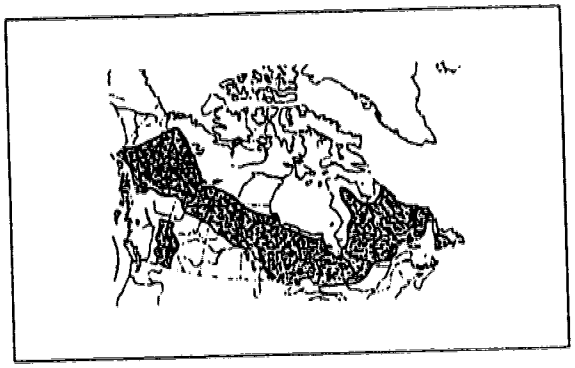
Option B, Have every household in Saskatchewan pay $____ per year for the next ten years into a trust fund to be spent on a Caribou Maintenance Program. This maintenance program will be run by an independent foundation and will maintain the current range and numbers of approximately 3,600 Woodland Caribou within Northwestern Saskatchewan.

Given the opportunity to vote for Option A or B which one would you choose? (please ☑)

☐ Option A ☐ Option B

If you wish you may go back to the previous question and change your vote.

The following is a <u>hypothetical</u> situation and is not being considered as part of any government policy.



Present Range of Woodland Caribou in Canada

The above map shows the present range of Woodland Caribou within Canada (shaded area). It is estimated that the Canadian Woodland Caribou population is approximately 700,000 and is not considered a threatened species. This region also represents areas in which logging, mining and recreational activities are taking place or are being considered.

Suppose you have a choice between two options, given below. The action described will be carried out for the option that receives the majority of votes.

10. *Option A, Have No Maintenance Program to preserve Woodland Caribou. Local populations will disappear within 10 years of logging and mining activities due to increased hunting from people and wolves, habitat loss and animals leaving the area. The end result is that Woodland Caribou populations will decrease to 350,000 in Canada by the year 2002.*

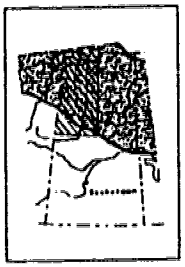
    Option B, Have every household in Canada pay $____ per year into a trust fund over the next ten years to be spent on a Caribou Maintenance Program. This maintenance program will be run by an independent foundation and will maintain the current range and numbers of approximately 700,000 Woodland Caribou within Canada.

    If you could vote for either Option A or B which one would you choose? (please ☑)

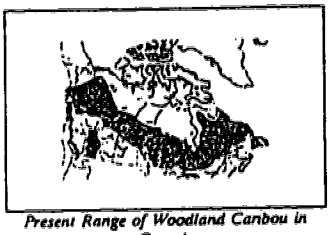
    ☐ **Option A** ☐ **Option B**

The following is a hypothetical situation and is not being considered as part of any government policy.

To the left is a map of the present range of Woodland Caribou within Northern Saskatchewan (shaded area). The cross hatch area is the Northwestern region of Saskatchewan where logging activity is expected to increase in the coming years.



Northwestern Region of Saskatchewan (Cross Hatch) and Woodland Caribou Range (Shaded) in Saskatchewan



Present Range of Woodland Caribou in Canada

It is estimated that Woodland Caribou numbers are currently 3,600 in Northwestern Saskatchewan. If these are to be preserved, new logging regulations will have to be enforced by government. This could result in you paying higher prices for paper products such as newspapers and toilet paper. In Saskatchewan we estimate the average household spent $427.10 last year on paper products. This compares with about $3,690.00 spent on food.

Suppose you have a choice between two options, given below. The action described will be carried out for the option that receives the majority of votes.

10. *Option A, You will continue to pay 427.10 per year for print and paper products. No New Regulations to preserve Woodland Caribou will be developed for Northwestern Saskatchewan. Some local populations of Woodland Caribou will disappear within 10 years of logging due to increased hunting by people and wolves and some Woodland Caribou leaving the logged areas. The end result is that there will be 1,800 Caribou in Northwestern Saskatchewan by the year 2002.*

    Option B, You will pay an additional $ _____ per year for paper products for a total of $ _____ per year for the next ten years. New Regulations will be used to maintain the current range and numbers of Woodland Caribou, approximately 3,600, in Northwestern Saskatchewan.

    If you could vote for either Option A or B which one would you choose? (please ☑)

    ☐ Option A ☐ Option B

Appendix B

Table B.1: Results from Log-likelihood Ratio Test for Open Ended WTP

	Canada			Saskatchewan		
Version	C2 vs C1	C1 vs C0	C2 vs C0	S1 vs S2	S2 vs S0	S1 vs S0
Unrestricted Log-likelihood	- 775.877	- 874.035	- 846.092	- 841.454	- 795.632	- 818.742
Restricted Log-Likelihood	- 778.502	- 881.922	- 852.141	- 846.090	- 801.499	- 827.545
# Restrict. (q)	7	7	7	7	7	7
Chi-square	5.2492	15.775**	12.0982*	9.2728	11.7338	17.5984[1]

Note: [1] significantly different at a 99% level, ** significantly different at a 95% level, * significantly different at a 90% level.

The null hypothesis is $B_{ik} = B_{ij}$ where i is the coefficient and i=i and j,k are the regressions where j≠k. The null hypothesis is rejected at the 90% level, for models C2, C0, and S0 and the coefficients were significantly different. Consequently, the individual tobit models were not merged.

Appendix C

Table C.1: Probability of Independent Variables Being Greater Than Zero With Different Functional Forms

	Canada			Saskatchewan				
	Version							
Variables	1	2	3	1	2	4	9	9*
	Bid Equation							
Bid	98	99	98	98	99	80	67	73
impl	99	99	99	99	99	99	62	96
actwld				98				
Const.	76	42	39	76	47	79	98	57
	Bid/Income (Bid/Y) Equation							
Bid/y	97	94	94	76	99	98	56	14
impl	99	99	99	99	99	99	58	95
actwld				99				
Const.	93	99	83	97	4	74	98	83
	Log-Bid Equation							
log(bid)	97	99	98	98	99	81	57	74
impl	99	99	99	99	99	99	59	96
actwld				98				
Const.	2	78	66	39	97	18	95	13

Question order:
Version 1 Sask/Can
Version 2 Can/Sask
Version 3 Can
Version 4 Sask
Version 9 Sask - expenditure question.

Values given are [1-(prob|t|chi-square)], rounded to the nearest whole number.
Version 9* corresponds to truncated data set were n=all no values (15) + 2*(15) yes values=45.
Integration was done on the following log(bid) models Can (2 and 3) and Sask (1), the functions did not converge.

The following models were chosen for further analysis,

Bid - Can 1, 2 and 3.
Sask. 1 and 4.

Bid/y - Sask 2.

Appendix D

Table D.1: Data used in t-test for difference of means

Question	Obs. DC	Obs. OE	Mean DC	Mean OE	Var. DC*	Var. OE
Canada	1000	658	28.63	12.90	18.65	1104.23
Saskatchewan	1000	615	31.73	14.67	27.80	1488.41

* Individual variance for dichotomous choice equal to variance from household divided by 3.2 squared.

DC = dichotomous choice format

OE = open ended format

Null Hypothesis: Mean DC_i = Mean OE_i , where i is question type.

Results of t-test: Canada question t-stat = 9.2703066

Saskatchewan question t-stat = 6.96

The null hypothesis was rejected for both questions and the mean value estimates are significantly different between question formats of the same question.