VALUING OLD-GROWTH FORESTS AND RELATED QUALITIES IN SOUTHWEST MAINLAND BRITISH COLUMBIA USING CONTINGENT CHOICE

by

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RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF RESOURCE MANAGEMENT

In the
School of Resource and Environmental Management

Project No. 470

SIMON FRASER UNIVERSITY

Fall 2009

APPROVAL

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Degree: **Master of Resource Management**

Title of Thesis: **Valuing Old-Growth Forests and Related Qualities in Southwest Mainland British Columbia using Contingent Choice**

Project No: **470**

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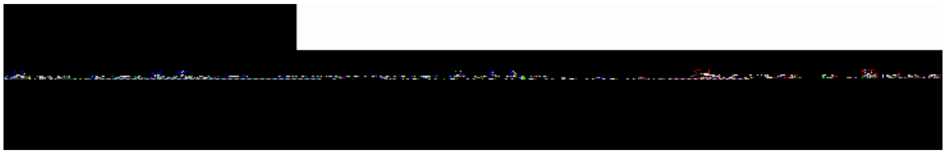

STATEMENT OF ETHICS APPROVAL

The author, whose name appears on the title page of this work, has obtained, for the research described in this work, either:

(a) Human research ethics approval from the Simon Fraser University Office of Research Ethics,

or

(b) Advance approval of the animal care protocol from the University Animal Care Committee of Simon Fraser University;

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(c) as a co-investigator, collaborator or research assistant in a research project approved in advance,

or

(d) as a member of a course approved in advance for minimal risk human research, by the Office of Research Ethics.

ABSTRACT

The Northern Spotted Owl is an endangered species that requires old-growth forests in southwest mainland British Columbia for its survival. Policies to save the owl

DEDICATION

I dedicate this to anyone who is planning, undergoing or has finished a career change;

or any parent pursuing higher education; or both.

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GLOSSARY

Contingent Choice	A stated preference, multi-attribute, trade-off method.
Value	The worth of a forest good or service that can be expressed in an equivalent amount of money or other goods or services.
Existence Value	The value an individual places on an environmental good or service that is independent of use.
Option Price	The maximum, ex-ante, state-independent payment that an individual is willing to make to move from the status quo risk to an improved situation.
Old-Growth Forest	Unique, complex systems, containing live and dead trees of various sizes and species composition that are part of a slowly changing and dynamic ecosystem.
Risk	The probability of an event occurring, multiplied by the magnitude of that event if it does occur.
Species at Risk	A species that is in danger of extirpation or extinction.
Compensating Surplus	The amount of income an individual is willing to give up for an environmental improvement over the current situation so the individual remains at the same utility level as before the change.

CHAPTER 1: INTRODUCTION

1.1 The Northern Spotted Owl

The Northern Spotted Owl is close to extirpation in Canada (Chutter *et al.* 2004).

should be in

(Miller 2004. Modified with permission from Western Canada Wilderness Committee)

suitable old-growth condition), for each breeding pair. However, this number may be too low for suitable habitat purposes (Miller, 2004). Figure 1-1 shows the current extent of suitable old-growth habitat in southwest mainland BC; however, at this scale it is impossible to show the fragmentation of the forest, which makes large tracts of land unsuitable as owl habitat.

Figure 1-1: Southwest Mainland British Columbia

different levels of protection for old-growth forest would affect the Owl's chances of survival. After much deliberation, the Province adopted the Spotted Owl Management Plan (SOMP) in 1997, which aims to preserve old-growth forest (i.e. forest suitable for Spotted Owl habitat) without affecting the forestry industry. The goal of the SOMP is to increase and stabilise the Canadian population of the Spotted Owl by setting aside suitable old-growth forest and limiting harvesting within these areas.

Out of approximately 1.2 million hectares of potential[2] Spotted Owl habitat, the

However, when the Province adopted SOMP in 1997, the Spotted Owl Recovery Team did not endorse the plan because it only estimated a 60% chance of stabilising the Owl population. SORT believed 70% was the minimum acceptable limit. Conversely, the Province felt that SOMP was the best compromise between conservation efforts and timber harvesting. As a result, the Province dissolved SORT and proceeded with the Spotted Owl Management Plan.

Unfortunately, the 1997 SOMP has shown little, if any, success in halting the decline of the Spotted Owl. In 2002, the Province established a new Spotted Owl Recovery Team, which subsequently created a new interim recovery strategy in 2004 to combat this decline in the Owl population (Chutter *et al.* 2004). The 2004 strategy builds on the 1997 plan by putting a lot more emphasis on research and identification of threats to the Spotted Owl population. It highlights the need to evaluate the qualitative and quantitative aspects of suitable habitat for the Spotted Owl, as well as critically evaluate the requirement of maintaining at least 67% of the Long Term Activity Centres in suitable habitat condition. Although habitat loss through logging may be the primary threat to the Spotted Owl's survival, these animals also face other threats such as competition from and hybridization with the Barred Owl, disease, climate change and the negative effects associated with small population sizes (Chutter, *et al.* 2004). However, a focus on habitat preservation will also allow for the reintroduction and/or re-colonization of the Spotted Owl in Canada, should it become extirpated. A 2007 report by the Spotted Owl Population Enhancement Team evaluates various population augmentation strategies such as captive breeding, or the over-wintering of juveniles, in order to maintain a wild population (Fenger *et al.* 2007).

1.3 The Human Dimension

a 50% chance of survival up to $148.22 to avoid a loss (in 2008 Canadian dollars[3]; Richardson and Loomis, 2009). Although the US evidence suggests that the southwest mainland BC public will place a high value on the Spotted Owl, the BC Owl population constitutes only 8% of the total population; and willingness to pay estimates in the US do not necessarily reflect a Canadian perspective. With little empirical work covering a Canadian perspective, it is uncertain how the general public may value the existence of the local Spotted Owl population and related conservation efforts.

Measuring the existence value of the Spotted Owl is a complex issue. Simply asking the general public how they value the existence of the Spotted Owl can be confounded with an existence value for their habitat, that is to say, old-growth forests. Local events and studies suggest that the general public has an especially high existence value for old-growth forests. The largest mass arrest in Canadian history occurred because of clear cutting of bFgT(Q4TtIF4TiIFVλIjT IFgTbtIF4TiIFVλIFgTTTIFgTTTIFgTTTIFgTTTTc

he

be a priority with the general public, as recent rallies in the provincial capital show where removing old-growth forest from the timber harvesting landbase (THLB) results in forgone timber benefits. Stone and Reid (1997), show that the opportunity cost of these

species is perceived as too low. For example, the original SORT considered a 60% chance of survival as an unacceptable probability of survival for the Spotted Owl population. The general public may also show a level of acceptability when confronted recovery plan according to the presented levels. A statistical analysis of the choices made by the respondents decomposes each attribute into marginal values and then reassembles the attributes to determine the willingness to pay, or support, for any alternative of interest (Alberini, Longo and Veronesi, 2007). Chapter 2 presents a more thorough description of the methodological differences between CVM and contingent choice.

1.5 Purpose and Research Questions

1.5.1 Purpose

The purpose of this research project is to measure the existence value of the general public living in the Lower Mainland of BC for Spotted Owls, old-growth forests and old-growth dependent species at risk in southwest mainland BC. Using a multi-attribute trade-off approach, this project provides separate estimates for each of these existence values. The study design combines these existence values with preferences for outdoor recreation and timber harvesting to investigate the general public's support for conservation policies.

The project boundaries are the known habitat range of the Spotted Owl in southwest mainland BC and the sample population is the general population of Metro Vancouver and the Fraser Valley; collectively known as the Lower Mainland. Data were collected in a web-based contingent choice survey.

1.5.2 Research Questions

The research questions posited below reflect the purpose of the project.

From the perspective of the general public:

1. What is the existence value of Spotted Owls in southwest mainland British Columbia under conditions of implied certainty?

2. How does the existence value for Spotted Owls change under conditions of risk?

3. What is the existence value of old-growth forests in southwest mainland British Columbia?

4. What is the existence value of old-growth dependent species at risk in southwest mainland British Columbia?

5. What are acceptable trade-offs between the existence values listed above and other prominent forest use values (i.e. recreation and timber harvesting)?

1.6 Organization of Report

Chapter 2 contains a literature review of the concepts, theories and potential problems that are pertinent to environmental valuation. Chapter 3 reviews the development of the contingent choice survey, the rationale and expected results for each of the included attributes, and the deployment of the survey. Chapter 4 summarizes the results from the contingent choice survey. Chapter 5 discusses the relevance of the results to the research questions and Chapter 6 concludes with the main points of this work.

CHAPTER 2: LITERATURE REVIEW

This chapter provides a review of the environmental valuation literature as it relates to the project's topic. The chapter begins with clarifying the terms used in this particular valuation study. Next follows a description of the environmental values relevant to forest ecosystems and the appropriate methods for measuring the various values. A discussion of the strengths and weaknesses of the stated preference methods follows. Finally, the current state of the existence value literature as it relates to forest ecosystems is discussed.

2.1 Environmental Valuation

The purpose of this research project is to estimate the value the general public has for the existence of old-growth forests, the Spotted Owl and other associated old-growth dependent species at risk. Environmental valuation is a complicated procedure that requires careful planning and execution if the results are to be meaningful. As stated by Daily *et al.* (2000), "valuation is a way of organisina of tvi

2.2 Defining ‘Value’

To avoid ambiguity, it is necessary to define the term ‘value’. For this project, the term ‘value’ refers to the worth of a forest good or service that can be expressed in an equivalent amount of money or other goods or services (Freeman, 2003). In other words, the value of a particular attribute of a forest is the amount of money, or other good or service that a person would be willing to trade, which would leave them with the same amount of utility, or welfare.

For the purposes of this project, existence value is the value someone places on an environmental good or service that is independent of use (Kramer, Holmes and Haefele, 2003; Freeman, 2003). For example, existence value would be the benefits that an individual receives from just knowing a species is extant, or from knowing old-growth forests will be around for future generations. Other terms for existence values include non-use values, or passive-use values (Freeman, 2003) and although there may be subtle differences in definition, no distinction is made between these terms for this project.

between the various goods and services available to them (Duffield, 1997). In this case, existence value is an instrumental value because an individual may want to use it later, or for ethical or altruistic concerns (Freeman, 2003).

2.3 Existence Value in the Larger Context

Benefits accrue to society from forests well beyond simply knowing they exist. Old-growth forests are complex ecosystems and provide timber, places for recreation, water filtration, control of soil erosion, and more. In environmental valuation, the Total Economic Value (TEV) framework separ2FgTsIFgjTU4IF4TsIFjT InmyF4TTaI4TrIIFgT2FggQ4mTpIF

Table 2-1: Total Economic Value Framework.

Total Economic Value		
Use Values		Non-Use Values
Direct Use	Indirect Use	(Existence Values)
Timber products Fruits, vegetables, fungi Game animals, fish Medicinal plants Recreation and tourism Education and research Human habitat	Nutrient cycling Hydrological regulation Control of soil erosion Amelioration of climate Groundwater recharge Greenhouse gas sink Ecosystem stability Weather damage protection	Biodiversity Culture, heritage

The primary purpose of the Total Economic Value framework is to guide valuation work and minimise double-counting by measuring each value independently of one another and is subject to a specific management regime. The summation of these separate values is then an approximation of the economic value of the study site. However, as Pearce and Moran (1994) point out, the TEV framework only accounts for economic values and will be an underestimation of the total value of a study site. However, the specifics of the TEV framework is beyond the scope of this project, the level, two classes of methods exist for measuring preferences for multi-attribute goods and services: revealed preference and stated preference techniques (Louviere, Hensher and Swait, 2000). Revealed preference methods measure the value of different attributes of a good or service through actual behaviour (i.e. choices) in the market. In contrast, stated preference methods aim for the same result by asking respondents to choose their preferred alternative to hypothetical scenarios. Since existence values are akin to public goods, no market data exists to determine how much people have paid or traded in exchange for this type of good (Louviere *et al.* 2000). In the absence of a real market, stated preference methods create a hypothetical market to measure how much the general public is willing to pay, or trade for this type of good (Adamowicz, Boxall, Williams and Louviere, 1998).

2.4.1 Stated Preference Techniques

Two broad categories of stated preference techniques exist with respect to an environmental good or service being valued (Adamowicz, Boxall, Louviere, Swait, Williams, 1999). The contingent valuation method (CVM) belongs to one category while contingent choice (CC), rating and ranking techniques belong to the other.

CVM is a binary approach to valuing the environment. CVM presents respondents with an accurate as possible description of a situation facing the environment. Respondents then face a 'take-it-or-leave-it' task where they must either accept or reject a payment to move from the current situation to a hypothetical future situation. By varying the amount of money involved in the choice task across their sample population, a researcher is able to determine how much a respondent is willing to pay for the

in turn, does not translate readily into welfare estimates for reasons listed above (Hanley, Mourato and Wright, 2001).

As an environmental valuation tool, contingent choice surged in popularity during the 1990s and is now regarded as an alternative to traditional CVM approaches. Early on, applications of contingent choice (CC) were primarily in the marketing and transportation fields (e.g. Ben-Akiva and Lerman, 1985, Louviere and Woodworth, 1983). The rise in popularity of CC experiments was the greater flexibility and wealth of information these types of experiments provided in relation to CVM. By describing scenarios according to attributes, CC experiments can incorporate multiple scenario changes within one survey,

2.5 Environmental Valuation with Stated Preference Methods

The preceding section highlighted various stated preference techniques. This section will present findings from other stated preference methods that can provide insights into expected results for this study.

The expectation is that existence value will be positive (i.e. the general public will gain utility from knowing old-growth forest and associated species at risk are present). Hagen, Vincent and Welle (1992) and Rubin, Helfand and Loomis (1991) found people were willing to pay anywhere from US$15.21 up to US$189.64 (depending on assumptions made) to help protect the Northern Spotted Owl population in the US. Loomis and Ekstrand (1997) found that, on average, people are willing to pay US$40.49

The general public also cares about protecting other species at risk. Loomis and Ekstrand (1997) found that people were willing to pay more for protecting the Mexican Spotted Owl and 61 other species at risk, than for the Mexican Spotted Owl alone. However, the difference between the two WTP estimates were only weakly different (i.e. at the 10% level). Although it is unclear whether this weak difference is due to survey design or a true preference for the Mexican Spotted Owl, the data suggest that the general public may value (albeit small in this case) the protection of other species at risk that inhabit the same area as a charismatic species.

With respect to habitat, the expectation is that the general public will gain utility from knowing specialised habitat is protected regardless of the number of species at risk present. Loomis, Gonzales-Caban and Gregory (1994) used CVM to demonstrate that people are willing to pay to protect old-growth forest against fire risk in Oregon. Beyond North America, Christie *et al.* (2006) found that the general public of the UK support policies that recreate or restore habitat for species at risk. The Danish public also gains utility from knowing a culturally significant heath is protected regardless of the amount of species at risk that may reside there (Jacobsen *et al.* 2008).

However, land is a fixed commodity and allocations made for conservation purposes require trade-offs with other uses. A contingent ranking study by Garrod and Willis (1997) shows that the general public of the UK prefers a balance between forests set aside for conservation versus forests set aside for commercial purposes. On the other hand, Adamowicz *et al.* (1998) reported the Edmonton public prefers increasing amounts of forests set aside for caribou habitat at the expense of taking it away from managed areas. Both these studies suggest that the general public gains utility from knowing land is set aside for conservation purposes, but regional differences may exist for the exact allocation between forests set aside for commercial purposes versus conservation purposes.

When weighing various use values with non-use values, the general public prefers options that do not limit their personal options for forest use. A 2001 survey of British Columbians suggests that the general public sees harvesting rates as the second biggest threat to forest biodiversity, after insects and diseases (McFarlane, 2005). When presented with options for conserving biodiversity, the general public views restricting the public's access to forests as one of the least favourable options (McFarlane, 2005). McFarlane's findings suggest that the BC public perceives threats to local forests from different sources but restricting access to these forests is not the preferred conservation solution. Respondents to a CC experiment from Finland prefer biodiversity management policies to occur at other forest recreation sites if these policies were to affect the scenic beauty at the respondent's local recreation site (Horne, Boxall and Adamowicz, 2005).

In all, the expectation is that the general public of British Columbia will gain utility from protecting old-growth forests, the Spotted Owl and other species at risk. The general public will not prefer any plans that limit their individual options for forest use but may have strong preferences for the level of harvesting that occurs in local forests. In addition, an increase in taxes should result in decreasing utility.

2.5.1 Environmental Preferences for Supply under Conditions of Risk

Conservation efforts to save an endangered species are inherently risky. The Spotted Owl faces many threats to its survival such as competition and predation from other animals, habitat loss, climate change and disease. At best, conservation efforts can only reduce the risk of these threats, not remove the threats entirely. From the general public's perspective, any risk associated with a conservation plan could potentially alter the preferences associated with such a plan. Given that the general public derive value from protecting species at risk and also ultimately pay for such efforts, policy makers can benefit from understanding the public's perception of risk when attempting to preserve any species.

Risk is a multi-dimensional concept and therefore, to avoid ambiguity, it is necessary to define this term. At a broad level, risk is the combination of two properties: the probability or chance of an event occurring and the magnitude or consequence if the event does occur (Hanley, Shogren and White, 2007). A risky outcome is different from an uncertain outcome. Risk refers to a situation where the probability of achieving an outcome is known, and uncertainty refers to situations where there is no way to quantify the chance of an outcome. For this project, we assigned a probability to any potential outcome and, therefore, the correct terminology would be risk.

In environmental economics, two broad types of risk prevail: endogenous and exogenous risk (Hanley, Shogren and White, 2007). Endogenous risk refers to situations where an individual is capable of altering the probabilities or consequences of a risky situation. For example, an individual can alter the health risks associated with drinking tainted water by buying bottled water, placing a filter on their tap, or boiling the water. Exogenous risk refers to a situation where the individual has no control over the probabilities. For example, an individual has no control over the probability or severity of an earthquake, or climate change. In the context of this project, the survival of a species at risk is an exogenous risk because an individual cannot influence the probability of Spotted Owl survival. Although an individual could technically affect the Owl's survival by rounding up the Owls and commencing a captive breeding program, or by purchasing large plots of suitable habitat, these situations appear unfeasible. Given the limited success of captive breeding programs and that buying enough suitable habitat is out of reach of the majority of individuals, suggests this risk is exogenous.

With few exceptions, stated preference surveys present options to respondents with certainty, or at least, implied certainty. A respondent states his or her willingness-to-pay to protect an endangered species under the instructions that any future outcome could happen. As pointed out by Roberts, Boyer and Lusk (2008), some may argue that uncertainty or risk is of no consequence in stated preference work, as the respondent's value for the final state of nature is the primary focus, and adjustments that incorporate risk can occur from an ex-post perspective (i.e. after the state of the world has been revealed).

Expected utility theory (EUT) has played a leading role in modelling people's choices under risk. Generally, the model is formulated as such:

$$EU(P) = \pi_1 * U(x_1) + \pi_2 * U(x_2) + ... + \pi_h * U(x_h) \quad (1)$$

Where the expected utility (EU) of a plan (P) is equal to the utility (U) for outcome (x) multiplied by the probability (π) of this outcome happening, summed over all possible states of the world (where there are '1' through 'h' possible states). Put into the context of this project, the expected utility for a conservation plan that could save the Spotted Owls is equal to the utility associated with all possible states of nature (i.e.

success and failure) multiplied by the probability of each state of nature actually occurring. However, numerous empirical studies suggest that ex-post adjustments to respondents treat the low probability (approximately 0-35%) of poor water quality as if it were 0% and high probability (approximately 75-100%) as if it were certain.

Applying probability in the context of species at risk, respondents may perceive the associated probability differently because they feel extinction is never certain, in other words, a probability of zero does not exist. Using CVM, Tkac (1998) and Samples, Dixon and Cowan's (1986) found that respondents were willing to allocate part of a budget to save a non-descript species that is certain to become extinct. In addition, these allocations are not consistent, as they increased when respondents were informed that the doomed species was charismatic such as a marine mammal or a monkey (i.e. after the species was iconised). When Samples, Dixon and Cowan (1986) queried the motives of respondents for allocating money to a species with no hope of recovery, respondents' replies ranged from a show of solidarity for a species facing tremendous adversity or investment in the remote possibility that the species will recover.

Beyond an individual's perception of probability, numerous other factors can also alter their preferences for risky outcomes. For example, when facing a risky prospect, respondents may use various heuristics (i.e. rules of thumb) in order to make a decision. Respondents may only focus on one component of risk (i.e. the outcome or the probability of the outcome) and make their decision based on this single attribute (see

Paradox). Some respondents favour risk-taking if they feel they have a personal stake in making an improvement (Patt and Zeckhauser, 2000). Introducing background risk, (i.e. a non-insurable, exogenous risk that cannot be resolved at the time of making a choice) can make some respondents more risk-adverse while others more risk-loving (see Roberts et al. 2008 for a review). In total, the models that attempt to describe how people make decisions under risk "…number well into double figures" (Starmer, 2000, p.332). For this project, all these factors may or may not play a role in describing how individuals make decisions under risk for endangered species conservation.

At an aggregate level, a number of different possibilities exist in trying to model how our sample population make choices under risk. An ex-post perspective may be sufficient in describing our sample population. Conversely, the sample population may be heterogeneous enough that we need more than one model to describe them accurately. Whatever model ultimately describes how people make decisions under risk requires the proper method for measuring people's choices.

From an environmental valuation perspective, option price (OP) is the correct measure for valuing preferences under conditions of risk. OP is the maximum, ex-ante, state-independent payment that an individual is willing to make to move from the status quo risk to an improved situation (Freeman, 2003, p.213). In order to help a species at risk, an individual cannot afford to wait and see what state of nature actually transpires before making a payment because extinction and falling below a threshold population is irreversible[8]. In addition, in order to help a species at risk, individuals must make certain payments now, which are not contingent upon the event of a successful (or failed) recovery of the species. In other words, an individual must make a payment before the state of the world is known (i.e. ex-ante), that is not contingent on which state of the world actually transpires (i.e. state independent).

Formally, option price (OP) is equal to the expected consumer surplus plus option value (Freeman, 2003). Where option value (OV) is, essentially a risk premium an individual is willing to make to secure provision of an uncertain resource (Shogren and Crocker, 1990). OV is not a separate value but rather the algebraic difference between expected consumer surplus and OP. OV can be positive, negative or zero depending on various conditions such as changes in an individual's marginal utility of money over the various states of nature that can occur[9] (Freeman, 2003). From a micro-economic perspective, neither option price nor expected consumer surplus provide a superior approach to environmental valuation under conditions of risk, because both these welfare measures are simply two points along a willingness to pay continuum (Freeman, 2003). Instead, estimating both welfare measures will provide a more robust economic understanding of the public's preferences for conservation work under risky outcomes.

From the literature presented above, it appears that the value for a supply of an environmental amenity under conditions of risk is dependent on the individual's perception of probability, the context of the environmental issue, heuristics, and the measurement method. All these factors can combine in different ways to produce a value for an unsure environmental amenity (in this case, a species at risk) that can differ in size and sign from a sure bet and differ between groups of individuals. In order to account for risk, it is necessary to measure the welfare gained from protecting a species at risk under cases of both certainty and risk, and between groups of respondents. A fuller picture of the differences between certain and risky outcomes provides decision makers with a greater understanding of the general public's perception, and possible acceptance, of a conservation plan that targets species at risk.

CHAPTER 3: METHODOLOGY

The layout for this chapter follows the standard framework for creating a contingent choice experiment (Hanley, Mourato and Wright, 2001 or Hensher, Rose and Greene, 2005 p.102 and summarised in Table 3-1).

Table 3-1: Framework for Creating a Contingent Choice Experiment

Steps		Description
1.	Characterisation of the decision problem	Scope research problem and develop specific research questions.
2.	Selection of attributes and levels	Use key informant interviews, focus groups and literature reviews to determine the salient attributes and associated levels.
3.	Choice of experimental	Y©14Y7YQjj1©1jm0VmV1m1δm.gYY27gTfIF0T Iβ4 asTF0TmIjYY0g1m1m1δm.gYY2IF

the Owl. Furthermore, measuring preferences for conservation work also needs to account for the main uses of forests, namely timber harvesting and outdoor recreation.

The division between forest that remains in the timber harvesting land base (THLB) and forest that will remain as old-growth is one of the main issues for Spotted Owl survival. Timber harvesting and Spotted Owl habitat are mutually exclusive as fragmentation of old-growth forest caused by logging is one of the leading causes of the hectares). Both the commercial forest and the old-growth forest, when summed together in the choice sets, must equal 1 million hectares.

The ratio of these two attributes will give decision makers a clearer picture of the types of trade-offs that the average Lower Mainland citizen is willing to make with regards to forest allocation for timber harvesting versus old-growth at the landscape level.

3.2.2 Recreation Zoning within Commercial and Old-Growth Forests

Recreation zoning is the method for allocating parts of a forest between different uses. For the purposes of outdoor recreation management, the province zones its forests into motorised and non-motorised areas (i.e. large areas where certain uses are permitted).

The survey informed respondents that each type of forest (i.e. commercial or old-growth) has various zoning designations. Motorised zones permit all activities. Non-motorised zones exclude activities that rely on a motor (e.g. off-road vehicles, snowmobiles, etc.) and only include activities such as hiking, mountain biking, backcountry skiing, etc. Respondents also read that for any type of recreaoldincludes the typical trade-offs associated with forest management decisions and how they affect the individual user.

3.2.3 Amount Harvestable in Old-Growth Forest

The 'amount harvestable' attribute has direct relevance to the management strategies associated with Spotted Owl habitat. Under the 1997 Spotted Owl Management Plan, a minimum of 67% of forest managed for Spotted Owls is to be kept as suitable habitat (i.e. forests older than 100 years old, taller than 19.4 meters, and below 1370 meters in elevation; Chutter *et al.* 2004). In other words, 33% of old-growth forest may be harvested on a rotating basis. However, the Spotted Owl Recovery Plan suggests a critical evaluation of this number because of the impacts that harvesting has on Spotted Owl survival (Chutter, *et al.* 2004). Varying the level of this attribute from 0% to 33% harvesting within old-growth forest will provide decision makers with the socially acceptable limits of harvesting within old-growth forests. However, this survey makes no claim about the ecologically acceptable limits of harvesting in old-growth forests.

3.2.4 Number of Breeding Pairs of Spotted Owls

As the name implies, this attribute refers to the number of Spotted Owl breeding pairs that are alive in southwest mainland BC. The importance of using breeding pairs instead of total Spotted Owls is because this animal is monogamous and if single owls are unable to find a mate then total numbers may be meaningless to the long-term survival of the species.

In creating the Spotted Owl attribute the levels 0, 5 and 125 were identified as relevant benchmarks. The zero level represents extirpation of the species. Given the current survival rates, the Recovery Team reports that extirpation of the species is imminent (Chutter *et al.* 2004). Five represents the current status quo (although this number may have decreased since writing the survey). Finally, the Spotted Owl Recovery Team reports that 125 breeding pairs are necessary for a self-sustaining population in southwest mainland BC (Chutter *et al.*2004).

While reaching 125 breeding pairs is important from an ecological point of view, respondents did not receive this information for two reasons. First, if recovery of the

3.2.5 Number of Other Species at Risk Recovering

disappearing, helped to ‘iconize’ these species (as per Jacobsen *et al.* 2008) and potentially place them on a similar level as the Spotted Owl.

The status quo was set at ‘7 species recovering,’ because the Province has created recovery strategies for seven of these 21 species at risk. Although creating a recovery strategy does not guarantee survival[11], this number provides a baseline for measuring gains and losses of species at risk. Setting one of the levels at 0 also allows for the measurement of respondents’ utility when all other species at risk are extirpated. Overall, the purpose of this attribute is to remind respondents about other complements and substitutes to protecting the Spotted Owl and permits the measurement of the existence value of other species at risk independently of the Owl.

3.2.6 Total Harvestable Area Compared to Status Quo

‘Total harvestable area’ refers to the change in the amount of forested land that is available for harvesting when compared to the status quo. Each level of the ‘total harvestable area’ is calculated from the amount of commercial forest and the amount of

For each profile, the total amount of harvestable land was calculated and the negative (i.e. WTA compensation for environmental damage). For this particular project, WTP is the proper choice of measure for two reasons. First, respondents are asked to pay an increase in taxes to move from the current situation (i.e. the reference point for this study) to an improved situation; this type of scenario is consistent with the WTP measure (Knetsch, 2007). Second, WTA scenarios did not work for this survey as they implied the government was foregoing their legal responsibilities to protect species at risk by compensating respondents for an impending environmental loss.

'Willingness to pay' scenarios were more effective as respondents understood that taxes may have to increase in order to pay for conservation work. Extensive pre-testing determined payment levels should range between \$0 and \$250, as extremely few respondents chose scenarios with payment levels greater than \$200. In consideration that old-growth forests and Spotted Owls are iconic in BC, the upper payment level was further split into \$250 and \$300[13] to capture all potential payees. These payment levels reflected other stated preference surveys on Spotted Owls. Loomis and Ekstrand (1997) used a range between US\$0 and US\$350 for a CVM-DC on Mexican Spotted Owls, and Hagen, Vincent and Welle (1992) only had 4% of their bids greater than US\$200 for their CVM on the Northern Spotted Owl.

3.2.8 Probability of Occurrence

In total, respondents saw eight choice sets. The first five choice sets had nine that a certain amount of Spotted Owls would be alive in the future. ‘Probability of occurrence’ was the probability that one of two states of nature would occur with respect to the number of breeding pairs of Spotted Owls on the landscape in 25 years. The two states reflected a ‘successful’ and ‘unsuccessful’ outcome within each profile. The successful outcome was presented as the probability (P) that X amount of breeding pairs would be present in 25 years. The unsuccessful outcome was the residual probability (1-P) that 0 Owls would be present. From an ecological perspective, the survival of the Spotted Owl is more realistically represented through a continuous probability distribution function. However, presenting such information to respondents would have created too much of a cognitive burden. Instead, the survey informed respondents that the presentation of the two states of nature was to simplify this complex topic. The two states of nature had to be shown to respondents, as there is utility, be it positive or negative, associated with either outcome (i.e. successful or unsuccessful).

With respect to presentation, this survey utilized a within-subjects design[14]. Respondents went through five choice sets showing the number of breeding pairs of Spotted Owls to be certain. Thereafter, respondents encountered an information page stating that there is no guarantee of success in conservation efforts and then respondents answered three more choice sets with a probability associated with the Spotted Owl attribute. Very few stated preference studies explicitly incorporate the probability of an outcome into the survey design when valuing an environmental good, making the assignment of levels in this study an additional challenge. Through a series of literature

by a fractional factorial, orthogonal, main-effects design of resolution III (Addelmann, 1962). A fractional factorial design contains only a portion of the total number of possible combinations. A main effects design means that only main effects of attributes can be estimated, but no interaction effects. Orthogonal means that the main effects are independent from all other attributes. Fractional factorial, main-effects designs make the number of profiles more manageable but inevitably reduce the estimation power. Main effects explain the majority of variance in respondents' choices (approximately 70%-90% of the variance; Louviere *et al.* 2000, p.94).

The attributes combine to make profiles. Two or more profiles combine into one choice set. For this survey, the 64 choice sets also contained a 'status quo' option as a third alternative in each choice set. Every profile describes a different outcome of forest management around the southwest mainland BC in 25 years. Each choice set showed an Outcome A and B and a 'Status Quo' option (i.e. an outcome that reflects the future outcome associated with the current management direction). Figure 3-1 and Figure 3-2 provide examples of the choice sets under cases of certainty and risk, respectively. A respondent would choose their preferred profile from each set of three alternatives and repeat this task five times[15]. For the next three choice sets, the number of alternatives was reduced to two (i.e. Outcome A and the 'Continuation of Status Quo')[16]. Pre-tests showed that this structure of choice sets reduced the cognitive burden of having to assimilate the 'probability' attribute. The status quo option remained constant throughout the entire choice task to provide a baseline for comparison between respondents' choices.

[15] The first five choice sets were the choice sets under certainty.
[16] The last three choice sets were the choice sets under risk.

3.4 Step 4: Construction of Survey

area, and the status of the Spotted Owl. The next seven pages showed how these attributes fit together for the entire study area and how they related to the survey, especially the choice task.

Figure 3-3: Simplified Representation of Forested Area in Southwest Mainland BC

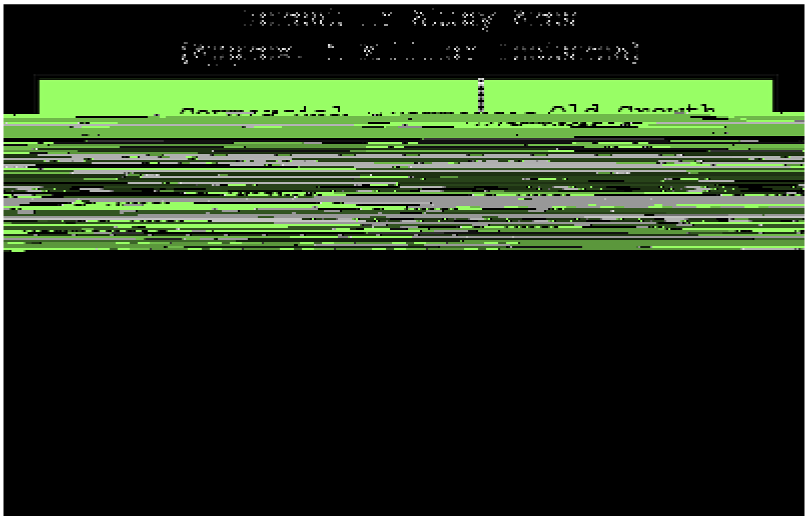


Figure 3-4: Representation of Recreation Zoning in Study Area

Figure 3-5: Representation of how Parks and Protected Areas fit into the Study Area

3.5 Step 5: Data Collection

Data for the web survey were collected by E-rewards, a market research firm

3.6 Step 6: Estimation Procedure

After data collection, various statistical models estimate how the different attributes affected respondents' choices. This section provides an overview of the models this project used in measuring the different attributes described earlier.

3.6.1 Random Utility Model

The random utility model provides the foundation for stated preference surveys, which makes it possible to combine choice behaviour with economic valuation (Rolfe, 2006). The random utility model formulates the idea that people are rational decision makers and will choose a certain good if the utility gained from that good is greater than the utility associated with the alternative. The formula below describes this relationship:

$$P_{ij} = Prob(U_{ij} > U_{ih}) \quad (3)$$

Where the probability of individual 'i' choosing alternative 'j' is equal to the probability that the utility 'U' of alternative 'j' is greater than the utility of alternative 'h' (for all 'h' in a given choice set where 'j' does not equal 'h').

From the perspective of a researcher, the assumption is that utility is the sum of Qg α2TrIjTg

The observable component of utility can be further described as a function of the characteristics of a good and the characteristics of an individual, as represented below:

$$U_{ij} = (Z_{ij}+S_i) + \varepsilon_{ij} \qquad (5)$$

Where Z_{ij} is the characteristics of the good or service associated with alternative 'j' (i.e. the characteristics are the attributes from the particular choice set that individual 'i' saw) and S_i are the socio-demographic variables associated with individual 'i'. Expanding the above equation to include all attribute and socio-demographic variables produces the following:

$$V_{ij} = [\beta_{0ij}+\beta_{1ij}Z_{1ij}+ \beta_{2ij}Z_{2ij}+\ldots+\beta_{nij}Z_{nij}]+[\beta_{aij}S_{ai}+ \beta_{bij}S_{bi}+\ldots+\beta_{kij}S_{ki}]. \qquad (6)$$

Where Z is the attribute associated with alternative 'j' that individual 'i' chose and there are '1' through to 'n' attributes (denoted by the subscripts '1' and 'n'). In addition, the socio-demographic variables of individual 'i' are represented by 'S' where there are 'a' through 'k' socio-demographic variables included as explanatory variables in this particular model. β_{1ij} is the parameter (or coefficient) associated with attribute Z_1

3.6.3 Measuring Compensating Surplus

In addition to predicting the probability of choice (or choice behaviour), the coefficients from the MNL model can also be used to estimate the economic value of changes in welfare (Rolfe, 2006). Estimating welfare change from the MNL model is possible with the formula below:

$$CS = -1/\beta_{paymentvehicle}[\ln\Sigma\exp V_{i0} - \ln\Sigma\exp V_{i1}] \quad (9)$$

Where $\beta_{paymentvehicle}$ is the marginal utility of income (represented by the parameter for the cost attribute in the choice experiment), V_{i0} and V_{i1} are the indirect utilities associated with two choice profiles where '1' represents a change in environmental quality from '0' and CS is compensating surplus (the welfare measure). CS is the amount of income an individual is willing to give up for an environmental improvement over the current situation so the individual remains at the same utility level as before the change (Hanley and Spash, 2003). The entire equation is negative, which represents a willingness to pay (WTP) scenario. If the changes in the state of nature reflect an environmental loss (i.e. going from '1' to '0') then the appropriate sign for equation 9 would be positive which implies willingness to accept compensation for an environmental loss (Rolfe, 2006).

If the states described by '1' and '0' differ in only one attribute (i.e. the choice profile between two alternatives is constant with the exception of one attribute that will differ according to its levels), then equation 9 simplifies to equation 10:

$$CS = -1/\beta_{paymentvehicle}[V_{i0} - V_{i1}] \quad (10)$$

In words, equation 10 represents the amount of money an individual is willing to pay if faced with two alternatives that only differ in the level of only one attribute. If V_{i0} accurately represents the status quo, and not a hypothetical alternative, then the CS estimated from equation 10 will reflect a WTP for an environmental improvement from a real reference point.

In addition, if a researcher is analysing marginal changes in the data (i.e. analysing continuous data), then equation 10 simplifies to equation 11 below (Rolfe, 2006):

$$W = -\beta_{attribute} / \beta_{paymentvehicle} \qquad (11)$$

Where welfare (W) is equal to the 'utility per attribute' divided by the 'utility per dollar' which provides a monetary estimation of an attribute in question. Rolfe (2006, p41) describes equation 11 as the "…marginal rate of substitution between income change and the attribute in question." In other words, equation 11 represents the amount of money that could be substituted (assuming weak sustainability) for any given attribute described in the choice experiment.

3.6.4 Latent Class Model

The latent class approach is an expanded, mixed logit[20] form of the MNL and permits measurement of preference heterogeneity. At a broad level, the LCM assumes that the sample population is heterogeneous as a whole but is made up of 'Xh1mmgsam characteristics of the respondents such as socio-demographics, attitudinal and psychometric effects (Boxall and Adamowicz, 2002), and each class will have different preferences or choice behaviour from one another (Train, 2003). The number of classes comprising a sample population is performed endogenously through choice patterns and sorted into ‘X’ groups according to statistical information criteria (Milon and Scrogin, 2006; Semeniuk *et al.* 2008).

The LCM is the product of two probability distributions, where the probability ‘P’ of a randomly chosen individual ‘i’ choosing alternative ‘j’ is:

$$P_{ij}= (P_{ix})*(P_{ij|x}) \qquad (12)$$

Where P_{ix} is the probability that individual ‘i’ will be part of class ‘x’ and $P_{ij|x}$

$$\frac{\exp(\alpha_x S_i)}{\sum_{x=1}^{X} \exp(\alpha_x S_i)}$$

risk. The probability is multiplied by the decision weight δ, which will be a number or the probability that an individual will choose a conservation plan based on the levels specified by a decision maker.

CHAPTER 4: RESULTS

did not finish. Deleting these responses reduced the sample population from 1004 respondents to 949.

dropping out. However, these 28 respondents were not included in data analysis for two

The differences in socio-demographic characteristics between the census population and the sample population may be because some groups have a lower willingness to respond to the survey; or the differences may be a reflection of membership in the E-rewards database by respective socio-demographic groups. E-rewards invites members of sponsoring agencies, (i.e. businesses targeting a usually wealthier clientele, such as Continental Airlines, US Airways, Hilton Hotels), to respond to surveys, and receive reward points for their respective programs. However, it should be mentioned at the outset that any differences between the census data and the sample population is not necessarily a concern because none of the socio-demographic variables was significant in explaining responses to the valuation questions. Therefore, no weighting of results was undertaken in the end.

4.4 One and Two Class Models

Analysis of the data suggests the sample population has heterogeneous preferences. In total, 1, 2, 3, 4 and 5 class models were assessed and Table 4-2 shows these results. In Latent Class Models, the researcher exogenously imposes the number of segments on the data and then judges the resulting models through various statistical criteria (Boxall and Adamowicz, 2002). No formal assessment procedure exists in which criteria should be used; however, similar to Boxall and Adamowicz, (2002) we used the level of penalisation (Vermunt and Magidson, 2005). Considering the BIC, AIC and AIC3 together, suggests that the 2-class model produces the best model fit overall. The BIC is the lowest for the 2-class model and only marginal gains occur for both the AIC and AIC3 when moving from a 2-class to 3-class model or higher. In addition, the R^2 and $R^2(0)$ confirm[25] the goodness-of-fit for the 2-class model, as the improvement of the R^2 from 0.05 to 0.35 between the one and the two class model are huge, as estimates between 0.2 and 0.4 are indicative of a good model fit (Louviere *et al.* 2000, p.54).

Table 4-2: Statistical Criteria Used to Assess Model Fit for Different Latent Classes

	1-Class	2-Class	3-Class	4-Class	5-Class
LL	-4942.67	-4174.07	-4065.82	-3999.33	-3949.08

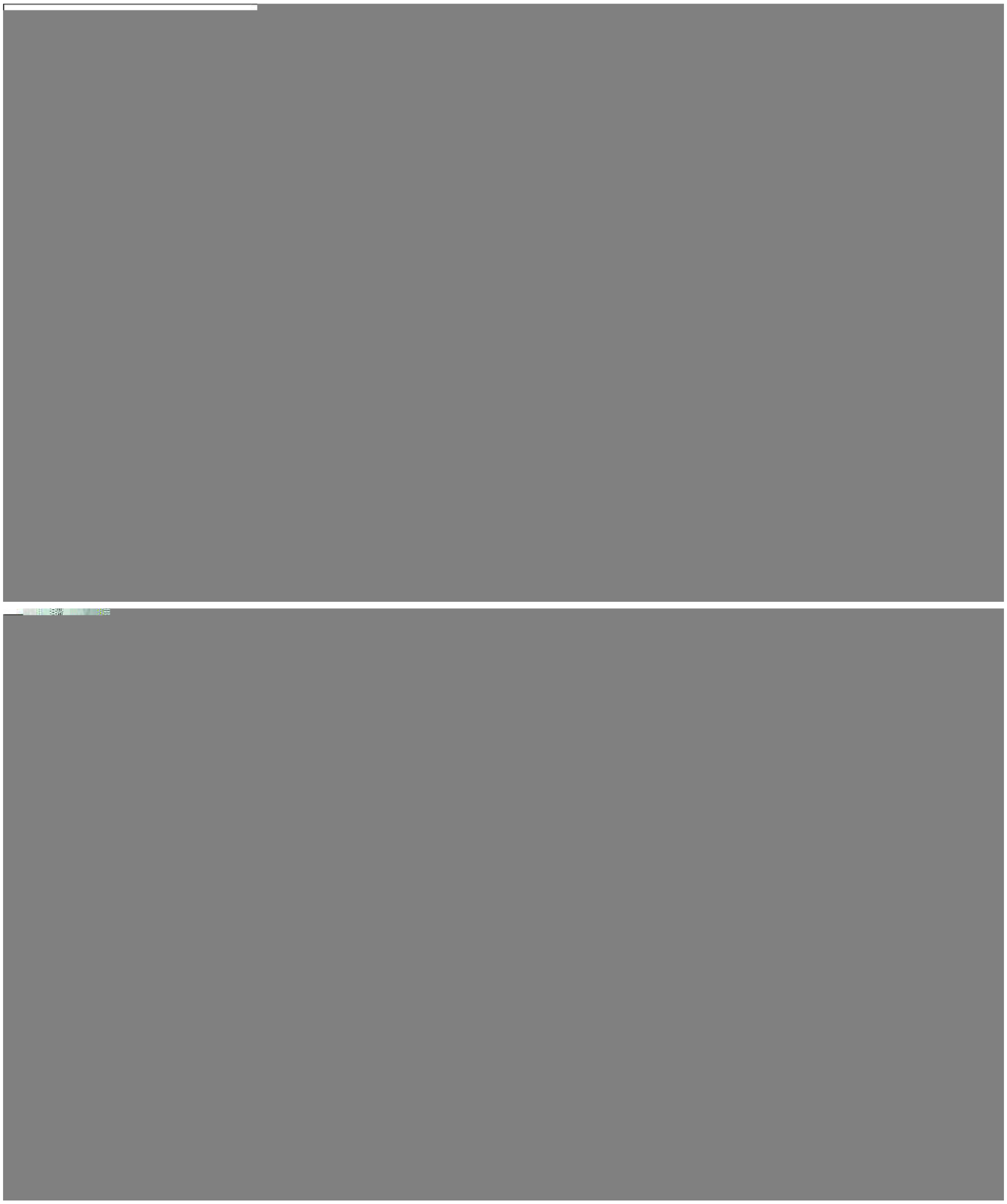
demonstration of how heterogeneity in the data set influences the overall model. Figure 4-1 contains a graphical representation of the untransformed levels of each attribute, documenting the exact distribution of each level.

In the 2-class model, 66% (n=629) of respondents belonged to the first class and 34% (n=320) to the second class. In the first class, all parameters are significant at the 5% level. In the second class, all parameters are significant except for the attributes pertaining to recreation zoning for both the old-growth and commercial forests, and the number of Spotted Owls. The intercept for the second class is weakly significant at the 10% level. The differences between the classes occur on the variables ‘percent motorised in commercial forests’, ‘number of Spotted Owl breeding pairsl fb

Table 4-3: Part-Worth Utility Estimates for the 1 and 2 Class Models

	1 Class	2 Class	
	Overall (n=949)	Preservationist (n=629)	Bottom-Line (n=320)

Figure 4-1: Part-Worth Utilities for the 2-Class Model



* = Significant difference between the two levels at the 5% level based on the t-statistic (as per Ben-Akiva and Lerman, 1985, p.202).

Members of Class 1 (66%) can be labelled 'Preservationist' because of their strong preferences for protecting increasing amounts of old-growth forest and species at risk. Members of Class 2 (34%) can be referred to as 'Bottom-Line members' because of their focus on minimising their additional tax payment while maximising protection of all other species at risk.

For both classes, the ratio of old-growth forest to commercial forest resembles a quadratic relationship. This implies both classes gain the greatest utility from a balance between the amount of forests set aside for old-growth forests and the amount set aside for harvesting purposes. However, Bottom-Line members are very sensitive to increases in old-growth forest and strongly oppose full protection.

The recreation attributes were only significant for the Preservationist members. They prefer increasing amounts of non-motorised areas within commercial forests and prefer the amount of motorised zoning for old-growth forests to be approximately 20%. Although the recreation zoning attributes were not significant for Bottom-Line members, this class still seems to actively pursue forest recreation, given the lack of statistical relationship between users/non-users of the forest and class membership[26]. However, more specific aspects of recreation behaviour may explain the apathy of Bottom-Line members to motorised zoning. For example, motorised zoning may only concern people who travel into the backcountry (this survey did not make a distinction between front-country and backcountry forest recreation). Alternatively, Bottom-Line members may not perceive a conflict between motorised and non-motorised recreation users.

[26] A Pearson bivariate test shows a correlation of 0.117 (significant at the 1% level) for non-users of the

The ‘amount harvestable in old-growth forest’ attribute resembles a linear, positive relationship for both classes, implying that respondents prefer not to lower the harvestable area in old-growth forests. Although harvesting seems counter-intuitive to the idea that old-growth represents pristine wilderness, this result could reflect a deeper appreciation of the trade-offs between preservation and the economic value of old-growth timber. The survey informed respondents that only old-growth outside of parks and protected areas would be subject to harvesting and that only a portion of these forests would be harvested conditional that the rest remain in old-growth condition. Therefore, respondents may agree that this practice is a method of sustainable harvesting, in other words, a method to allow harvesting of the economically valuable old-growth timber.

The attributes pertaining to the ‘Spotted Owl’ and ‘species at risk’ provided crucial information about class membership for both classes. The Spotted Owl attribute approximates a positive, linear relationship for Preservationist members, suggesting they gain a great amount of utility from increasing numbers of owls. On the other hand, the Spotted Owl attribute was not significant for Bottom-Line members, which implies this attribute did not affect these respondents’ decisions. One possible interpretation would be that Bottom-Line members may simply not care about protecting endangered species and represent a class of respondents who want to liquidate the forest. However, examining the ‘species at risk’ attribute shows this is not the case. The ‘species at risk’ attribute resembles a positive, linear relationship for both classes, suggesting both classes gain utility by growing and stabilising endangered species populations. While Preservationist members gain utility from protecting all species at risk, Bottom-Line members value the protection of multiple species at risk higher than the protection of one single species, even if it is a charismatic one. An alternative explanation is that Bottom-Line members may perceive the Spotted Owl as doomed with only five breeding pairs left, and therefore did not focus on this attribute.

The cost attribute approximates a negative, linear relationship and is significant for both groujTbIFj©e members

Table 4-4: Welfare Estimates for the 1-Class and 2-Class Models

	1-Class	2-Class	
		Preservationist (n=629)	Bottom-Line (n=320)
Spotted Owl ($/Breeding Pair)	$1.67	$3.03	$0.06*
Other Species at Risk ($/Species Recovering)	$9.85	$14.92	$2.68

As discussed in Chapter 2, risk is the magnitude of an outcome multiplied by the probability of that outcome occurring (i.e. Risk = Magnitude * Probability), summed over all potential outcomes. From the survey design, we are able to estimate magnitude and probability independently from one another. The magnitude is equal to the parameter estimates for Spotted Owls which were estimated under conditions of risk (i.e. β_{SPOW}^{Risk}) and implied certainty (i.e. $\beta_{SPOW}^{Certainty}$). Under conditions of implied certainty, a respondent is presumed to perceive probability as equal to 100% (i.e. $\pi = 100\%$), but under conditions of risk, probability is presented as a varying percentage (i.e. $\pi = X\%$; where 'X' varies between 0 and 100%).

This section explores how a difference in perspective (ex-post versus ex-ante) can alter welfare measures. First, we consider how the parameter estimates (i.e. the magnitude) change under conditions of risk and implied certainty. Second, we explore how respondents perceive probability and compare this subjective perception to objective probability. Third, we combine both the altered parameters and the subjective probabilities to explore how welfare measures change under conditions of risk.

4.6.1 Comparing Parameter Estimates

Based on the literature presented in Chapter 2, the perceived magnitude of an outcome (or the preference for a particular outcome) can change under conditions of risk. In other words, $\beta_{SPOW}^{Certainty} \neq \beta_{SPOW}^{Risk}$, independent of the probability associated with the outcome[28]. Table 4-5 shows the parameter estimates for both the 'Spotted Owl' and

[28] The 'Probability' and 'Spotted Owl' attribute are independent of one another in the survey design, and as such, allows us to estimate these parameters separately from one another.

Although Table 4-5 provides an indication of how respondents' preferences may alter with risky outcomes, model parameter estimates are confounded with a scale factor (denoted as λ). The correct specification of $\beta_{SPOW}^{Certainty}$ and β_{SPOW}^{Risk} is actually $[\lambda^{Cer}\beta_{SPOW}^{Cer}]$ and $[\lambda^{Risky}\beta_{SPOW}^{Risk}]$, respectively (Louviere *et al.* 2000). Casual examination of parameters between models, as we have just done, might show that preferences have shifted (i.e. $[\lambda^{Cer}\beta_{SPOW}^{Cer}] \neq [\lambda^{Risk}\beta_{SPOW}^{Risk}]$), while the reality may be that preferences have not shifted (i.e. $\beta_{SPOW}^{Certainty} = \beta_{SPOW}^{Risk}$) but rather ε1m44m2m2m2m2mTjIπ j .Fj0Qjg7Q47jY1TeI4TeI4TsIFjT T IF0©

$L_{joint\ model}$ is the log-likelihood value for the joint model, $L_{certainty}$ and L_{risk} are the log-likelihood values for the choice models under conditions of certainty and risk, choice sets as opposed to fundamentally different ways of processing the information provided. These implications are discussed further in Chapter 5.

4.6.2 Welfare Estimates under Risk

Although we can reject the hypothesis that the parameters are equal under cases of implied certainty and risk, respondents may still have similar welfare estimates because both the marginal utility of money and marginal utility of Spotted Owls have altered under cases of certainty and risk. Converting parameters into welfare estimates for the two respective models produces Table 4-6 below.

The 1-class model shows that welfare estimates have altered. Respondents' welfare in the 1-Class model decrease from $1.67 per breeding pair of Spotted Owls to $1.00 per breeding pair. However, the 2-Class model portrays a different picture than the 1-Class model. Under conditions of risk, the difference between the Preservationists and the Bottom-Line members shrinks when compared to the welfare estimates under certainty. The Bottom-Line members gain greater welfare from an increase in taxes going towards Spotted Owl conservation efforts, while the Preservationist members experience a decrease in welfare.

Table 4-6: Welfare Estimates under Conditions of Risk

		Spotted Owl ($/Breeding Pair)	
		Certainty	Risk
1-Class (n=949)		$1.67	$1.00
2-Class	Preservationist (n=629)	$3.03	$1.02
	Bottom-Line (n=320)	$0.06*	$0.69

However, risk is a function of probability times the magnitude of the outcome. As

Table 4-7: Part-Worth Utilities for the 'Probability of Occurrence' Attribute

	1 Class	2 Class	
Probability of Occurrence	Overall (n=949)	Preservationist (n=629)	Bottom-Line (n=320)

probability in a linear manner. Converting the part-worth utilities from Table 4-7 into a

4.6.4 Measuring Risk

Evaluated separately the parameter estimates for magnitude of the outcome and probability appear to be different between the ex-post and ex-ante perspective. However, risk is a function of both magnitude and probability summed over all states of nature, and as such, welfare estimates could still be equivalent under either perspective.

Table 4-8 shows the differences between ex-ante and ex-post welfare measures. For the ex-ante[34] perspective, we multiplied the parameter estimates from Table 4-5 by the subjective probability calculated from Fig8TaI4TrIjTaI4TmIF7TeπIFgT-IjT5IFgT VmmjIF3me sc asltiplied the paatcalbmjjtiy©e probability chy2x-e ex-F4TeIFF4TlIF4TtIFg4TmgI4atcbTeI4TvIFgTume

Table 4-8: Incorporating Probability into Ex-Ante and Ex-Post Welfare Measurements when the Alternate Outcome has an Explicit Probability of Success.

Attributes	Alternate Outcome		Status Quo
Number of Spotted Owls	5 breeding pairs (100%) 0 breeding pairs (0%)		5 breeding pairs (25%) 0 breeding pairs (75%)
Class	Welfare		
	Ex-Ante (Option Price)	Ex-Post (Expected Compensating Surplus)	
Overall (1-Class) (n=949)	$0.80	$6.27	
Preservationists (n=629)	$0.67	$11.37	
Bottom-Line (n=320)	$1.21	$0.23*	

However, the results between the ex-post and ex-ante welfare measures will differ according to combinations of the probability and the magnitude of outcome used in the calculations. Table 4-9, shows how ex-post measures may underestimate the welfare

Table 4-9: Incorporating Probability into Ex-Ante and Ex-Post Welfare Measurements when the Alternate Outcome has an Explicit Probability of Success and Failure.

Attributes	Alternate Outcome	Status Quo

CHAPTER 5: DISCUSSION

The purpose of this project was to measure the existence value of the Spotted Owl. However, simply asking the public for their willingness to pay for Spotted Owl conservation efforts might be confounded with a value for the Owl's habitat (i.e. old-growth forests), or other old-growth dependent species at risk. Furthermore, setting aside habitat for the Spotted Owl also affects direct-use values (i.e. recreation and harvesting) associated with such land. In addition, conservation efforts are inherently risky, where risk can alter the value society places on such efforts.

In order to control for all these potentially confounding relationships, we applied a multi-attribute trade-off approach (i.e. contingent choice), which enabled us to measure the value for these attributes separately, yet in the context of each other. We also compared our measurements for different classes of respondents in order to explore and describe the heterogeneity of preferences within the sample population.

5.1 The Existence Value of Old-Growth Forest and Related Qualities

Existence value is the value someone places on knowing that an environmental amenity exists, regardless of use. 'Value' is the worth of the environmental amenity, expressed in an equivalent amount of money, or other goods or services. For this project, existence value is the amount of money the general public is willing to pay through increases in provincial household income tax for conservation policies to help the Spotted Owl, old-growth forest, and other old-growth dependent species at risk.

Before quantifying the existence values relevant to this study, it is necessary to highlight the fact that the marginal existence values for Spotted Owls and other old-growth dependent species at risk follows a linear relationship. In other words, the general public gain the same level of utility from every additional breeding pair of Spotted Owl, or every additional species at risk that is protected, regardless of the numbers of Owls or other species that may already be present on the landscape. This linear relationship appears to contradict current economic theory, which suggests that marginal existence values should diminish with successive gains. However, this apparent contradiction may be due to the scope of the survey. For example, our study elicited preferences for only a small proportion of the entire Spotted Owl population and other old-growth dependent species at risk, essentially focusing on one small section of the entire willingness to pay curve. Therefore, as suggested by Rollins and Lyke (1998), our study may not have the appropriate range to detect diminishing marginal existence values.

Quantifying existence value is not straightforward. If the population of the Lower Mainland is assumed to have homogenous preferences for Spotted Owls, then the existence value of a breeding pair of Spotted Owls is worth $1.67 per household in increased taxes. The fact that existence values are positive accords well with other valuation studies of the Northern or Mexican Spotted Owl (e.g. Hagen, Vincent and Welle 1992; Rubin, Helfand and Loomis, 1991; Loomis and Ekstrand, 1997); however, the magnitude of the existence values between this study and other studies differs according to the assumptions made. A meta-analysis by Richardson and Loomis (2009) shows an average willingness to pay of $74 to help avoid a loss[35] of the Northern or

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35

Mexican Spotted Owls. Specifically for the Northern Spotted Owl, CVM-derived value estimates ranged from a low of $43.95 to ensure a 50% chance of survival up to $148.22 to avoid a loss. Placing our existence values within a similar context to the studies above suggests our values cover a wider range. For example, assuming that five breeding pairs of Spotted Owls are present in southwest mainland BC today, then our model predicts that households would be willing to pay $8.35 to avoid any type of loss for the Owl. However, if we assume that 125 breeding pairs constitutes a sustainable population, then our model predicts households are willing to pay $208.75 for the continued survival of the Spotted Owl in Canada. Although the existence values provided by this project cover a wider range, they are extremely sensitive to the assumptions on what constitutes a surviving population. Furthermore, the difference between our study and the values derived from the other studies might be due to any number of variables, for example, the cited studies pertain to the US, a larger Spotted Owl population, a different time period (i.e. the 1990s), and were derived with CVM. The fact that the existence values derived from this study are similar to other studies suggests a certain amount of convergent validity for the welfare associated with the continued existence of the Northern Spotted Owl.

Measured independently of the Spotted Owl, the existence value for recovering an old-growth dependent species at risk is $9.85. Although this attribute pertains to actual species, the survey did not inform respondents which particular species were recovering, making comparisons with other studies problematic. However, instead of comparing values for the same species, we can compare welfare estimates of different species. For example, comparing welfare estimates from Richardson and Loomis' (2009) meta-analysis, other species that generate similar welfare estimates include the Striped Shiner ($9.10), the Squawfish ($13.67) and the Wild Turkey ($14.80), which suggests the value for an almost non-descript species at risk may be within reason.

In addition, measuring the existence value for the Spotted Owl and other species at risk within the same choice set permits us to check for embedding issues. Examining the welfare estimates (Table 4-4) it appears that embedding may not be an issue. In all cases, the welfare estimate for the Spotted Owl is lower in comparison to other species at risk recovering. However, the two estimates are not so easily comparable, as welfare for the Spotted Owl pertains to one breeding pair, while welfare for species at risk pertains to the entire species. The difference in magnitude between the two measures shows the species at risk welfare measure is approximately six times greater than the welfare associated with the Spotted Owl suggesting that respondents are willing to pay approximately the same amount to recover an entire species, as they are to have six breeding pairs of Spotted Owls. Six breeding pairs of Spotted Owls do not necessarily reflect a ‘recovering’ Owl population, but this result suggests that respondents perceive a difference between individuals of a species versus an entire species. In other words, respondents are willing to pay a substantial amount to save another species, even in the presence of the iconic Spotted Owl.

In contrast to the ‘Spotted Owl’ and ‘Other Species at Risk’ attributes, the existence value for old-growth forests does not follow a linear distribution but instead is a quadratic function dependent on the ratio of commercial forests to old-growth forests in southwest mainland BC. Therefore, it is impossible to calculate a per unit welfare estimate for old-growth forests (e.g. the value per hectare of old-growth). Instead, calculating the maximum value from the quadratic function suggests that the socially optimal amount of old-growth that should be retained in southwest mainland BC is driven by the homogenous preferences of two-thirds of the respondents we labelled as Preservationists, who have strong preferences for preserving the Spotted Owl, old-growth forest and other old-growth dependent species at risk. The other third we labelled as Bottom-Line members and they show no specific preferences for the Spotted Owls per se, but have specific preferences for helping other species at risk and strongly oppose raising taxes. Obviously, any policy that attempts to collect revenue to help the Spotted Owl specifically will not be the preferred form of conservation action by a large minority of the population. Instead, this large minority may prefer to see revenue directed to conservation efforts that aid the broader species at risk population.

A thorough investigation of which variables best describe the Preservationists and Bottom-Line members revealed that socio-demographic characteristics, including income, did not explain these differences well, while psychometric data (i.e. environmental attitude and perception of the survey) best describe these groups. Although participation in forest recreation is a weak explanatory variable in describing the different classes, this variable is less powerful than the environmental attitude statements or survey perception statements in explaining class membership. From a policy perspective, identifying the preferences of individuals through easily obtained information such as census data may not be possible. The relatively poor performance of socio-demographic variables in explaining different classes of environmentally sensitive people is a common theme in western cultures, as these values now seem to be wide-spread across all socio-demographic groups (Diamantopoulos *et al.* 2003).

Another important topic is the significance of the intercept in the estimated relationships. The intercept represents all unobserved sources of utility and it was significant and positive for Preservationists but weakly significant (i.e. at the 10% level) and negative for Bottom-Line members. These contrasting results may not be surprising considering the amount of media attention focused on environmental issues over the preceding years prior to this survey. For example, Preservationists may see old-growth forests as a tool to combat global warming through carbon capture and storage, which is supported by the comments from three respondents fitting this group classification.

these factors such that it affects overall welfare for Spotted Owl conservation efforts when comparing ex-post and ex-ante perspectives.

Under risky prospects, the underlying utility for Spotted Owls changes when our study, then we must assume that Bottom-Line members did not actually perceive the first five choice sets as certain, but as uncertain. Unfortunately, we did not explicitly test for this perception.

The other factor that can alter someone's preferences for a risky outcome is the perception of probability. Respondents appear to consistently overweight the objective probability of success, a result that differs from other findings in other studies about the distortion of probability. In the context of monetary lotteries, researchers have found that individuals will consistently overweight low probability events and underweight high probability events. Conversely, Roberts *et al.* (2008) found the opposite effect when examining individual's perceptions of probability that various water quality events will occur at a recreational lake. In our study, respondents do not underweight probabilistic events at all, but instead consistently overweight any probability of success. However, our survey does not permit the testing of how respondents perceive any probability between 0 and 25%; therefore, it is possible that respondents actually view the range of probabilities from 0 to 24% as equivalent to 0%. H T(IFgTiIgt w .πD.εTFgTeI4TlIFjT©mFgTsIFjTumF to 0% relative to the moderately positive slope from 25% to 100% may be due to a loss aversion bias. Where, from an individual's reference point, losses will have a greater effect on a person's choices than gains of the same magnitude (Kahneman and Tversky, 1979). However, the results from this project are not sufficiently conclusive to test for this effect. The levels for success were set at 0, 25, 50, 75 and 100%[36] and the movement from the status quo of 25% either up or down 25 percentage points leaves the individual at either 0% or 50% probability of success, where the difference between certain failure and a 50:50 chance of success is radically different. To measure loss aversion bias our study design would have needed to test for multiple levels on either side of status quo for both the 'probability of occurrence' attribute and the 'number of Spotted Owls' attribute. We know from our pre-tests that respondents find such tasks rather challenging, and for that reason, we stayed with one simple 'risk' task.

Although differences exist between outcomes with implied certainty and risk, these observed differences may be due to structural differences between the choice sets as opposed to fundamentally different preferences. As outlined in Chapter 4, the differences between the two choice sets are the number of alternatives presented, the number of choice sets seen and the inclusion of the 'probability of occurrence' attribute and highlighting the Spotted Owl and 'probability' attribute in blue. Both Rolfe and Bennett (2009) and Boyle and Ozdemir (2009) report differences between contingent choice experiments that present two versus three options. Rolfe and Bennett (2009) report that serial non-response is higher for the two versus three alternative format and Boyle and Ozdemir (2009) report that there is a lack of convergent validity between choice sets that

[36] 0% chance of success was shown as 100% chance of 0 breeding pairs.

differ between two and three alternatives. While these findings suggest that the change from three to two alternatives might be the reason for a change in preferences, both these studies used a between-subjects survey design as opposed to the within-subjects survey design in our study. Unfortunately, we are unable to test whether a within-subjects design is free from the problems listed above. However, the lack of comments from respondents and very few respondents (n=6) dropping out of the 'risky' choice sets suggests that, at the very least, respondents did not find the changes from the certain choice sets to the risky choice sets to be distracting enough to warrant action against it. In addition, the 'probability of occurrence' attribute was significant, signifying that individuals were able to assimilate this information into their decision making process.

5.3 Management Implications

The results from this project may provide some insight into how different governments, non-governmental organizations and industry groups can gain greater support from the general public for their conservation strategies. First, any broad-based land-use plan for southwest mainland BC should explicitly look to balance old-growth forests with commercial (or working) forests. Although the provincial government is already allocating forests in such a manner, the socially optimal levels are approximately 54% old-growth versus 46% commercial forests, which is in contrast to the 40:60 ratio that is forecast by the province. In other words, our model suggests the socially optimal level is reached, if the provincial government sets aside 54% of all forested areas in southwest mainland BC for conservation (i.e. 54% of forests in southwest mainland BC will remain as, or grow into, old-growth forest), while the remaining 46% is part of the timber harvesting landbase. This finding also extends beyond the provincial government and suggests that any group, or industry, who advocates for setting aside more, or less, forest for conservation will receive less support from the general public.

Second, the discrepancies emerging between the two classes in the latent class models show that to gain greater support for conservation work, it is necessary to position Spotted Owl conservation within the broader context of preserving other species at risk. In other words, at least a significant fraction of the general public may provide greater support for an overarching, coherent plan that brings together the conservation work for multiple species at risk instead of a single species focus.

Finally, the existence values presented here suggest the amount of revenue (or at

statistical design of the choice sets did not allow us to estimate interaction effects and that, at the very least, the general public gains value from protecting species at risk regardless of external factors.

CHAPTER 6: CONCLUSION

An overarching goal of this study is to aid decision makers in land-use decisions involving local forests. Tangible benefits can be reaped by incorporating the public's preferences in the policy-making arena, as it is this group that ultimately owns the provincial forests. One tangible value associated with local forests is the knowledge that this area is providing habitat to local species, irrespective of use. To this end, this study examined the existence value the general public places on the Spotted Owl. However, we widened the scope to include other relevant, possibly confounding attributes, such as old-growth forest, old-growth dependent species at risk, and different use values. Through a random sample of the general public of the Lower Mainland, we were able to estimate existence value for this group.

The results suggest that the general public places significant value on the existence of old-growth dependent species at risk. However, they do not appear to place conservation over all other values, but instead gain the greatest welfare when both use values (in the form of harvesting and recreation) are balanced with non-use values (in the form of old-growth dependent species at risk). Pure policies involving species at risk, it may be beneficial to incorporate the risk involved in such plans, as welfare appears to be path dependent.

With respect to decision making under risk, the purpose of this project is to provide a useful starting point for further work involving risky outcomes. The results from this project further this goal in two important ways. First, the results suggest that the public are capable of understanding probabilistic outcomes (exemplified by the significance of the ‘probability’ attribute), and second, are willing to make choices in the presence of risky outcomes (as exemplified by the negligible dropout rate during the uncertainty choice sets). This information should help researchers and land-use decision-makers not to shy away from incorporating probabilistic outcomes in their management or research plans when involving the general public. Furthermore, hopefully this research will provide a useful stepping-stone for further work into incorporating risk into the general public’s preferences for public goods.

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APPENDICES

Appendix A: Total Harvestable Area Attribute and Associated Levels

Levels used for the 'Total Harvestable Area (compared to status quo)' Attribute

	Amount Harvestable in Old-Growth			
Amount of Old-Growth (hectares)	**33%**	**20%**	**10%**	**0%**
150,000	n/a	n/a	n/a	25% more
300,000	10% more	10% more	5% more	5% more
400,000	No Change	5% less	10% less	10% less
600,000	20% less	30% less	35% less	40% less
800,000	40% less	50% less	60% less	70% less
1,000,000	60% less	75% less	90% less	100% less

n/a = not applicable. 150,000 hectares of old-growth represents the parks and protected areas in southwest mainland BC; therefore, harvesting of any level is not permitted.

Appendix B: Web Link to Survey

The internet survey instrument has been permanently archived at the following web address: http://www.oldgrowth.rem.sfu.ca/index.php?id=ws&ftouch=remmers.

Appendix C: Postal Codes used to Target Respondents

Postal Codes used for Targeting Respondents.

Area	First 3 Digits of Postal Codes
ABBOTSFORD	V2S, V2T, V3G, V4X
BURNABY	V5C, V5G, V5H, V5J, V5A, V5B
CHILLIWACK	V2P, V4Z, V2R
COQUITLAM	V3J, V3K
DELTA	V4L, V4M, V4G, V4K, V4C, V4E
LANGLEY	V2Y, V2Z, V3A, V4W
MAPLE RIDGE	V2W, V2X, V4R
MISSION	V2V, V4S
NEW WESTMINSTER	V3L, V3M, V3N, V5E
NORTH VANCOUVER	V7N, V7P, V7R, V7L, V7M, V7gmmgV7LI1m1m1δm4j0g1m1m1mQgSIONg1m1m1

Appendix D: Full Model Parameter Estimates

Part-Worth Utilities for the 2-Class Model under Certainty and Risk (Full Model)

	1-Class		**2-Class**			
	Overall (n=949)		Preservationist (n=629)		Bottom-Line (n=320)	
	Certainty	Risk	Certainty	Risk	Certainty	Risk
OG/Com Forest (q)	-0.0325 (0.0035)***	-0.0152 (0.0058)***	-0.0370 (0.0044)***	-0.017 (0.0079)**	-0.0568 (0.0114)***	-0.0173 (0.0121)