Economic Non-Market Valuation Techniques: Theory and Application to Ecosystems and Ecosystem Services.

A Case Study of the Restoration and Preservation of Pekapeka Swamp: An Application of the Contingent Valuation Method in Measuring the Economic Value of Restoring and Preserving Ecosystem Services in an Impaired Wetland

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ABSTRACT

This thesis explores the theoretical basis of non-market valuation techniques; discusses in detail, the Contingent Valuation Method (CVM) and the Travel Cost Method (TCM); highlights the advantages and disadvantages of various non-market valuation techniques and their suitability under different conditions; and identifies the Contingent Valuation Method as the most appropriate non-market valuation technique to apply to Pekapeka Swamp, the case study site.

The overall objective of the study is to apply the most appropriate non-market valuation technique to estimate the total economic value (TEV) of the restoration and preservation of Pekapeka Swamp and to test Hawke's Bay Regional Council's (HBRC) restoration programme for the Pekapeka Swamp using economic efficiency criteria. An appropriate contingent valuation mail survey questionnaire was designed to elicit responses to the dichotomous choice (DC) and open-ended valuation questions, and to collect socio-economic data and information on households' attitude towards the environment. Responses to the survey questionnaire were analysed (using ordinary least squares regression for the open ended question, and logistic regression, for the DC question) to identify the factors that influence households' willingness to pay (WTP) for the restoration and preservation of the Pekapeka Swamp and to estimate TEV. A number of functional forms of the logit and open-ended WTP models were fitted from which WTP functions were estimated.

Households were asked a DC question followed by an open-ended question regarding the value they placed on the restoration and preservation of Pekapeka Swamp. Out of an initial mail-out of 958 questionnaires, an overall response rate of 46.13% was achieved after two follow-ups. Results from the final usable sample of 231, after removing protests and inconsistent responses, indicate that households in the Hawke's Bay region would pay, on average, between NZ$30.00 and NZ$76.89 per annum for five years. Unit value ranges between NZ$17,898 and NZ$45,866 per hectare per year; and net present values for the restoration and preservation programme for Pekapeka Swamp based on our 'best estimates' range between NZ$5.05 million and NZ$18.20 million depending on the model and discount rate used.

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CHAPTER 1

Thesis Topic Discussion

1. Study Background and Motivation

1.1 Introduction

Standard economic theory predicts that under a perfectly competitive market resources are allocated efficiently. It postulates that an invisible hand operates in such a way that Pareto optimality is achieved where equilibrium in production, consumption and exchange coincide (i.e. the marginal rate of transformation (MRT), marginal rate of substitution (MRS), and the terms of trade (TOT) or the price ratio are equal). Under such conditions government policy intervention is unjustified. However, in practice only a few markets such as the global currencies market and the agricultural commodities markets approximate a perfectly competitive market. Where conditions necessary for perfect competition are frequently violated, the market system fails to deliver Pareto optimal outcomes and government intervention is justified. When intervention occurs the assumption is that governments act in the best interest of the people and the policies adopted are therefore expected to reflect public interest. The public register their preferences in a manner similar to their dollar votes under the market system by voting for a political party with a manifesto that most closely aligns with their interest.

Natural and environmental resources such as wetlands, beaches, forest parks, rivers and lakes yield flows of goods and services such as fish, recreation, aesthetics, flood protection, clean air, and clean water. These goods and services are generally classified as public goods. They exhibit special characteristics of non-rivalry and non-excludability[1] in consumption. These characteristics make it difficult or impossible for the market system to operate normally. The supply of such goods and services may be facilitated through public policy where the government, through its various institutional arms, plans and manages natural and environmental resources for the benefit of all consumers. Goods and services provided outside the market system do not have a price (market value) although some may carry shadow prices where comparable goods are

[1] The concepts of non-rivalry and non-excludability are discussed in detail in chapter 2.

supplied through the market. In New Zealand, the Resource Management Act 1991 (RMA) provides for government intervention in promoting the sustainable management of natural and physical resources.

Cost-benefit analysis of public policies that deliver environmental improvement often understate or ignore the value of non-market goods and services because their values are not readily available compared to their market counterparts. The lack of such values makes comparison between alternative policy options difficult and may lead to sub-optimal allocation of resources that does not improve or maximize welfare. To facilitate resource management decision-making that is consistent with welfare maximization through the optimal allocation of resources, all costs and benefits (both market and non-market) of alternative policies should be considered. Non-market valuation techniques have been developed and employed to estimate monetary values for non-market goods and services (Davis, 1963; Bishop & Heberlein, 1979; Costanza *et al*., 1997). Where values of non-market goods and services are recognized and incorporated in the decision making process, public policy better reflects the socially optimal allocation of resources. The availability of information on these values also assists policy makers in justifying the level of expenditure for the projects concerned. Policy options adopted and the funding levels should reflect the relevant communities' preferences if welfare is to be maximized.

The Pekapeka Swamp provides a good illustration of a public good and the tragedy of the commons. Being a common-pool asset, Pekapeka Swamp was over exploited and allowed to degenerate over a number of years. With no clearly defined and assigned property rights and no resource management plan to protect and conserve the wetland system, uncontrolled commercial fishing drastically reduced the eel stocks in the swamp. Early local Maori tribes depended on the Pekapeka Swamp for food and other goods and services. Agricultural activity around the swamp impacted negatively on the ecosystem by reducing water level. Drains were constructed to take water from the swamp and backfilling was carried out to create more dry land for pasture. Further, controlled outflow of water from Lake Poukawa into the Poukawa stream reduced the inflow of water into the swamp (Hawke's Bay Regional Council, 1999). A more detailed historical background of the Pekapeka Swamp is provided in chapter 4.

1.2 Statement of the Problem, Objectives and Justification of the Topic

1.2.1 Statement of the Problem and Objectives of the Thesis

Hawke's Bay Regional Council (HBRC) and the Department of Conservation (DoC) rate Pekapeka Swamp as the second most important wetland system in the Hawke's Bay region. The wetland system as a limited resource is subject to competing needs – conversion to agricultural land versus conservation (provision of ecosystem services). From the time of the early settlers in the 1800s, the ecosystems supported by the wetland system have been under stress from over fishing, pollution, pest and weed invasion, and drainage to create more pasture land to support increasing agricultural activity within the wetland catchment area. In 1968 approximately half the area of the swamp was brought under the ownership of HBRC for the purposes of soil conservation and river control. Lack of a proper resource management plan resulted in the wetland area being neglected. Invasive plant species, namely, grey and crack willows spread rapidly clogging and chocking the wetland, covering nearly 90% of the area.

In 1998 the HBRC adopted a long-term management plan for the swamp. The main objective was to preserve and restore the wetland, as close as possible, to its natural state. A decision to adopt a policy programme of this nature may be based on one or more criteria such as; economic efficiency, equity, sustainability, environmental justice, ecological impact, environmental stewardship, ethics, public participation, and advancement of knowledge (Kahn, 2005).

The programme cost for the 1997/8–2003/4 plan period were NZ$518,351 and cost estimates for the 2005 – 2010 plan period are NZ$630,900. The programme costs are clearly stated in the HBRC's management plans but there is no indication of the monetary value of the welfare benefits of the policy which may be used to justify the programme and level of expenditure. The programme is expected to continue into the future and additional costs will be incurred. Knowledge of what the benefit of the programme is worth to the Hawke's Bay community would provide valuable insight and enhance policy decision within council.

The thesis estimates the total monetary value of welfare benefits that the restoration and preservation programme could potentially deliver to households in Hawke's Bay. As such, the main goals of this research are to apply the most relevant non-market valuation technique to estimate a monetary value of the restoration and preservation of the Pekapeka Swamp using the household as an economic decision making unit, and to test the theoretical (or internal) validity of the applied valuation method. To achieve these goals we will:

1. Review current non-market valuation techniques, with special emphasis on the contingent valuation method (CVM), relevant to ecosystem and ecosystem service valuations. Valuing ecosystems and ecosystem services is not a new concept, but remains a developing area with much complexity (Defra, 2007). The challenge is in the appropriate application of relevant and up to date valuation techniques to ecosystems and ecosystem services to ensure that their 'true' values are taken into account in policy decision-making. The valuation methodologies' respective advantages and disadvantages will be discussed.

2. Identify and properly apply the most appropriate and up to-date valuation methodology to the case study. The null hypothesis is that, given a plausible hypothetical market scenario concerning the restoration and preservation of ecosystem services of an impaired wetland, respondents are able to, and will, state their "true" willingness to pay for this change in the quality of the wetland. Several alternative hypotheses are possible such as; respondents will not take the contingent valuation survey seriously and state untrue values; respondents may see an opportunity to influence the results in their favour by behaving strategically (under or over bidding) if they suspect that the results of the survey will determine policy; and respondents may not understand the question actually asked and instead answer the question they think is being asked. Proper application of an appropriate methodology will ensure that a realistic, valid and reliable value estimate of the welfare benefits of improving the quality of the wetland is obtained and used in analysis of the policy. The main challenges will be;

    i. The design and administration of an appropriate contingent valuation survey questionnaire. The hypothetical scenario must be plausible and describe as simply as possible exactly what the respondents will be asked to value and the payment vehicle must be acceptable to reduce payment vehicle bias (Mitchell & Carson, 1989; Arrow *et al*., 1993; Bateman *et al*., 2002). "Part of the survey designer's art lies in the crafting of language that elicits the answer to the question that the researcher intended to ask" (Carson, Groves & Machina, 2000, p. 7). In addition to the hypothetical scenario, other challenges will include the determination of sample size, bid range, specific bid levels, and the allocation of the total sample among the bid levels.

ii. Identifying an incentive that will maximize the response rate. Incentives may be monetary (Zhongmin *et al*., 2003), or the instrument may be constructed to be incentive-compatible by reducing the respondents' cost and convincing them that they will benefit from the outcome of the study**.** A financial incentive is not an option for this study as it is avoided to comply with Massey University policy.

iii. The analysis of willingness to pay (WTP) response data and the selection of an appropriate model that best fits the data. The factors which influence households' willingness to pay will be examined. The main challenge is to obtain a utility-theoretic measure of the dollar (money) value of the restoration and preservation of the Pekapeka Swamp to a typical or average household in the Hawke's Bay region using a fitted binary response model. The estimated monetary value is the maximum WTP for a household with income (Y) and characteristics (z).

iv. Explore whether the CVM as applied to the case study provides meaningful value estimates (i.e. does the CVM provide valid, reliable and economically meaningful value estimates of WTP for the restoration and preservation of the Pekapeka Swamp?) In this regard the CVM used in the case study will be tested for convergent and construct (theoretical or internal) validity. To test for convergent validity, two value estimates obtained from different elicitation methods will be compared. Construct validity will test whether the responses to the CVM survey instrument are consistent with standard economic theory. This will involve analyzing the signs of the variables' estimated coefficients to see if the partial effects of individual variables on WTP and the probability of a "yes" response to a given bid amount can be explained in terms of economic theory. Bateman and Brouwer (2006) cite a number of studies that have sought to validate contingent valuation estimates by examining their consistency with expectations derived from standard economic theory.

v. Presentation, interpretation, and discussion of the results.

1.2.2 Justification of the Topic

The justification for the valuation of ecosystems and ecosystem services is that it contributes towards better decision-making by ensuring that policy appraisals fully take into account all relevant costs and benefits of the natural environment. The exclusion of non-market values of ecosystems and ecosystem services understates the total value of environmental resources and may lead to under-funding of projects that are socially warranted. The valuations highlight much more clearly the implications of changes in environmental quality or quantity for human wellbeing and also provide policy development with new insights on the factors influencing the public's valuation of gains/losses resulting from policy changes.

The author is currently employed by New Zealand Centre for Ecological Economics (NZCEE) as a Resource Economist contracted to work on the projects 'Iwi Ecosystem Services' and 'Sustainable Pathways'. The topic is relevant to the author's occupation and important for his future development. It is hoped that the author will acquire knowledge and skills in non-market valuation techniques to a level that permits the author to plan and carry out research and apply the knowledge and skills gained to produce results of a high standard and provide valuable input in policy decision-making.

There are competing uses for the study site - agriculture versus conservation and preservation. Agricultural activity draws water from the wetland reducing the water level and size of the wetland. This has serious repercussions on the preservation of the wetland as an amenity and habitat for fauna, birds and other species whose existence may be under threat. The study will provide a total monetary value estimate (use plus non-use value) of the wetland and therefore provide a basis for policy recommendation on the way forward that will represent the socially and economically preferred option.

Costanza *et al.* (1997) estimate global ecosystem services (benefits) at 1.8 times the global gross domestic product (GDP) at 1994 prices. They contend that this value is a conservative estimate of the true value of global ecosystem services. Despite controversy surrounding the methodology used to estimate the global ecosystem services and the idea of a unit value estimate for each ecosystem service, Costanza *et al.* (1997) contend that the estimates lend objectivity to the policy decision-making process. Despite the lack of consensus on the methodologies and value estimates, there is no disagreement that ecosystem services are priceless since they support life. Main stream economists tend to place more emphasis on commercial transactions whose values are readily available through market prices. The conservative value estimate of the global ecosystem services compared to global gross national product (GNP) suggests that more effort and attention should instead be given to the environment when formulating economic policies for sustainable development; hence the need for non-market valuations of policy impacts on the environment.

1.3 Outline of the Thesis

Chapter 2: The Theory of Value and the Basis for Non-market Valuation

In this chapter we explore the concept of economic value as it relates to the welfare of human beings, and also look at welfare measures and the conceptual framework for non-market valuations.

Chapter 3: Non-market Valuation Techniques

Non-market valuation techniques are described and the economic rational behind each technique is highlighted. The CVM and Travel Cost Method (TCM), representing the two classes of non-market valuation techniques (revealed and stated preference methods), are described in detail including their strengths and weaknesses.

Chapter 4: Study Site – Pekapeka Swamp

The study site is described with particular reference to its location, historical background, stakeholders and their interests. Land (resource) use alternatives and conflicts of interest are discussed. The objectives of the current restoration and preservation programme are highlighted.

Chapter 5: Methodology

This chapter describes method selection and survey design in detail. Literature on application of the contingent valuation method, survey design, payment vehicle, sample selection, sample size, socio-economic factors and model selection is explored.

Chapter 6: Responses, Analysis of Data, and Presentation of Results

This chapter covers the analysis of survey data, interpretation, and presentation of results. Different methodological approaches (models) are explored and compared to select the models that best fit the data.

Chapter 7: Summary and Discussion

The chapter discusses the findings and its implications for current and future policy on the restoration and preservation of Pekapeka Swamp and other wetland systems in New Zealand. A summary of the objectives and how they have been met is given.

CHAPTER 2

The Theory of Value and the Basis for Non-market valuation

2.1 Value, Welfare Measures, and the Conceptual Framework for Non-market Valuation

In this section we explore the concept of economic value as it relates to the welfare of human beings, and also look at welfare measures and the conceptual framework for non-market valuations.

2.1.1 Economic Value

Non-market valuation literature distinguishes between two types of value; use value and non-use value (Pate & Loomis, 1997; Sutherland & Walsh, 1985; Wilson & Carpenter, 1999). Use value may be direct if the good or service is used directly to satisfy a need, or indirect when the good or service provides benefits indirectly. For example humans derive a direct benefit from fishing in a wetland (direct use value), but the wetland also provides an important habitat for many species that are valuable to human beings (indirect use value).

In addition to use value (direct and indirect), we may place additional value (option value) on the wetland to reflect a premium which we are prepared to pay over and above what we are currently paying to secure an option to have the wetland available in future. Non-use value refers to the satisfaction derived by human beings from the knowledge that certain species, ecosystems and ecosystem services exist (existence value), or that these goods and services will be available for enjoyment by future generations (bequest value) (Krutilla, 1967; Sutherland & Walsh, 1985; Mitchell & Carson, 1989; Champ, Boyle & Brown, 2003)**.**

The total economic value (TEV) of a resource or ecosystem consists of the use value and non-use value or passive-use value which humans derive from it (Wattage & Mardle, 2007). Non-market valuation techniques such as CVM and TCM attempt to quantify TEV or its components in monetary terms by estimating the area under the compensated or Hicksian demand curve for the resource or ecosystem service(s). The concepts of the compensated or Hicksian demand curve and Marshallian demand curve are discussed later in this chapter.

Goods and services have value to human beings in as far as they provide a stream of benefits which directly or indirectly enhance human well-being. For example, ecosystems are very valuable because they provide a diversity of services that enhance our well being (Freeman III, 1999) and provide a habitat for other organisms that are valuable to humans (Curtis, 2004). When we value ecosystems and ecosystem services we consider their uses in meeting human consumptive and non-consumptive needs. The concept of economic value is therefore instrumental and anthropocentric (Bateman *et al*., 2002).

Under the market system, the value of goods and services is measured by their market price. The assumption is that the price which consumers pay for a given good or service is a measure of the value of that good. The total value of a given quantity or stock (Q) of goods and services is the product of the price (P) and quantity - (P*Q). This represents the total expenditure by consumers on that good or service and does not include consumer surplus[2]. The advantage of expressing the value of goods in monetary terms is that money is fungible and allows for comparisons between different types of goods and services using the same standard unit of value measurement (Bateman *et al*., 2002). As the bulk of ecosystem services are not provided through the market system, they have no monetary value hence the need for alternative methods of valuation.

The market price of a good or service is determined by the forces of supply and demand. Under perfect competition, consumers are assumed to be rational and utility maximizers, while producers are assumed to be profit maximizers. Economic theory predicts that under these conditions resources are efficiently and optimally allocated. Therefore market equilibrium under perfect competition is Pareto optimal and represents the highest possible level of welfare under the given conditions. However, markets fail for a number of reasons resulting in the suboptimal allocation of resources. One example of market failure is the existence of public goods, a class of goods to which most ecosystem services belong. Public goods may be distinguished by their non-

[2] Consumer surplus is defined in the next section.

rivalry and non-excludability in consumption. Non-rivalry in consumption means that consumption of the good by one person does not diminish consumption of the same good by others; while non-excludability means that once the good is available to one person others cannot be excluded from consuming the same good. For example, a scenic view in a forest park is available for everyone to enjoy. Enjoyment by one visitor to the park does not diminish the view or exclude others from enjoying the same view as long as there is no congestion in the park and/or the visitor does not prefer solitude. A market for such goods and services cannot operate properly because of the potential for free-riding where it would be in the best interest of individuals not to reveal their true preferences and willingness to pay for the goods and services.

Since ecosystem services are not normally provided through the market, they are not priced and therefore have a zero implicit price (value). Even if ecosystem services were to be provided through the market, economic theory predicts that their market price would be very low despite their importance in supporting human life (Bateman *et al*, 2002). This phenomenon or apparent contradiction is typified by the diamonds-water paradox. Diamonds are not necessary for human survival but water is, yet diamonds are very expensive and water is very cheap (sometimes it has a zero implicit price). The explanation for this paradox may be found in the law of diminishing marginal utility.

Water, like ecosystem services, is usually available in abundance and its consumption is high while diamonds are very scarce and limited in supply (availability) and their consumption is relatively low. According to the law of diminishing marginal utility, the amount of satisfaction (marginal utility) derived from the consumption of an additional unit of a commodity diminishes as more units of the commodity are consumed. The values (prices) of the marginal units of water and ecosystem services are therefore low whereas the marginal utility and price of diamonds is high. The market prices for water and diamonds determine the exchange or trade-off (rate of substitution) between the two commodities. These marginal values or prices should not be confused with the total value of a commodity. For example, water or ecosystem services may be worth a little (or seem worthless) in terms of their market prices but they have a large total value because they are consumed in large quantities and also available in abundance.

2.1.2 Consumer Surplus and Welfare

The concept of consumer surplus and welfare will be illustrated using numerical examples with the aid of diagrams - Figures 2.1 and 2.2 below.

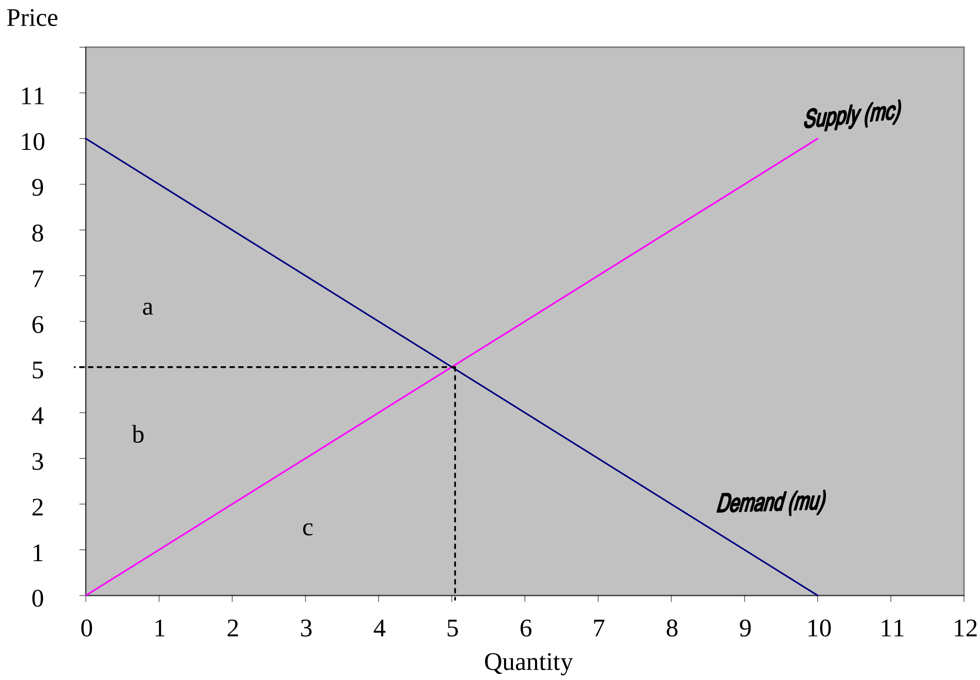

Figure 2.1 Private goods

Figure 2.1 represents a typical market for a private good. At equilibrium, the market price is $5 and the quantity demanded is 5 units. $5 is the marginal value of the 5th unit. All previous units are valued higher than $5 yet the consumers pay the same price for all the units purchased. The total expenditure by consumers on the 5 units is $25 which is represented by the sum of the areas of triangles ‘b’ and ‘c’. However, consumers are prepared to pay a maximum amount totalling $37.50 (represented by the sum of the areas of triangles ‘a’, ‘b’ and ‘c’) for the 5 units, which is the TEV. The area of triangle ‘a’ is a measure of welfare and represents the Marshallian consumers’ surplus which may be defined as the additional amount of money consumers are willing to pay over and above the actual expenditure on a given quantity of a good or service in order to secure consumption of the good or service at the same level (Hicks, 1941, 1942, 1943; Willig, 1976). The area of triangle ‘b’ represents producer surplus whilst that of triangle ‘c’ represents production cost. The welfare effects of a policy change can be analysed in terms of what happens to the magnitude of the consumers’ surplus. Policies that increase consumers’ surplus increase the welfare of the people and are therefore desirable compared to those that reduce consumers’ surplus and hence reduce welfare.

The market for non-market ecosystem services is difficult to model as such markets do not normally exist. The reasoning behind Figure 2.2 below is adopted from Costanza *et al*. (1997). The figure depicts what a market for ecosystem services could possibly look like. As ecosystem services are necessary for human life support, there is a certain minimum quantity (critical threshold) below which life as we know it can not exist. This is represented in the diagram by the dotted line touching the x-axis at 5 units. Up to this level of consumption, the ecosystem services provided are priceless and their value is infinity.

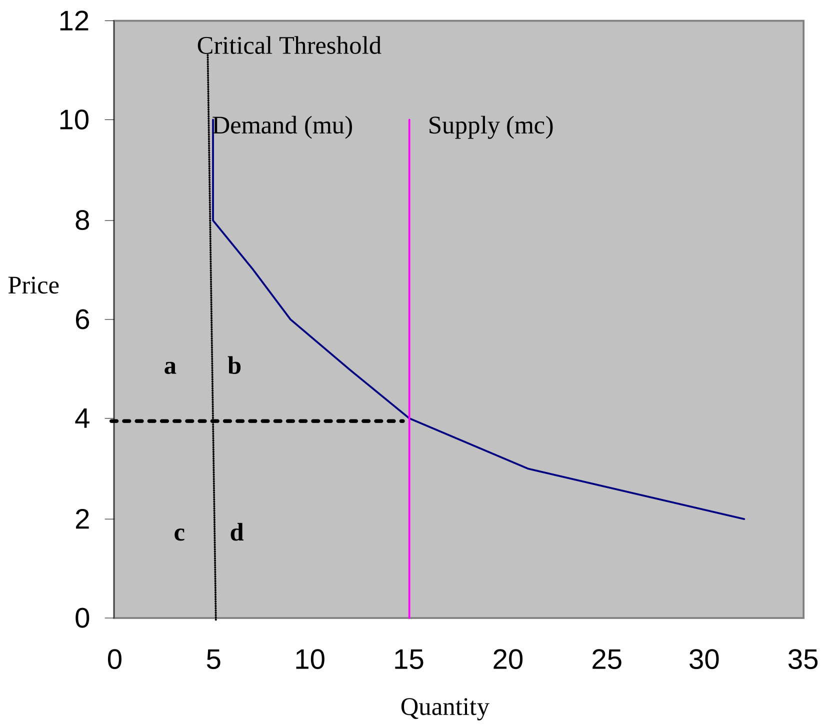

Figure 2.2 Ecosystem services

The supply curve for ecosystem services is vertical indicating that policy changes are likely to have very little effect on their supply in the short-run. At equilibrium, the equilibrium price and quantity are $4 and 15 units respectively. Consumers' surplus is represented by area (a + b), which approaches infinity (Costanza *et al*., 1997). Area (c + d), equal to $60, is the total expenditure on the equilibrium quantity of 15 units. Total economic value (TEV) is given by the area (b + d) (Turner *et al*., 2003).

2.1.3 The Marshallian and Hicksian Compensated Demand Curves

The Marshallian demand curve is often referred to as the ordinary demand curve. The curve maps out the relationship between the price and quantity demanded at fixed nominal income (Hicks, 1941; Willig, 1976). Suppose the demand curve in Figure 2.1 is a Marshallian demand curve, a fall in the price of the good from $5 to, say, $3 will increase the quantity demanded from 5 to 7 units with expenditure falling from $25 to $21.

Increased consumption, at a lower level of expenditure, results in increased welfare for the consumer. The assumption here is that the marginal utility of income (money) is constant. However if we assume diminishing marginal utility of income, the consumer can maximise his satisfaction by equating the marginal utility of income across all types of goods consumed. This entails reducing consumption of the good to a level between 5 and 7 units depending on the nature of the good in question, and diverting the money saved to purchase other goods. The new quantity demanded would not lie on the Marshallian but on the Hicksian compensated demand curve which is steeper than the Marshallian demand curve (Currie, Murphy, & Schmitz 1971; Perman, *et al*., 2003).

The main difference between the two curves is that the Marshallian demand curve reflects both income and substitution effect of a price change while the Hicksian compensated demand curve reflects the substitution effect only by eliminating the income effect and holding utility constant at its original level. Welfare changes due to a price change may be measured using both the Marshallian and Hicksian demand functions. The different measures resulting from these two approaches are discussed in detail in the next section.

2.1.4 Measures of Welfare Change: Compensation Variation, Equivalent Variation, Compensating Surplus, and Equivalent Surplus

Literature identifies two classes of welfare measures – "equivalent" measures and "compensating" measures which are defined as follows (Currie, Murphy, & Schmitz 1971; Brookshire, Randall, & Stoll 1980; Seller, Stoll, & Chavas 1985; Knetsch, 2007):

1. Equivalent measures [equivalent variation (EV) and equivalent surplus (ES)]: the amount of compensation, paid or received, which would bring the consumer to the subsequent welfare level if the change did not take place
2. Compensating measures [compensating variation (CV) and compensating surplus (CS)]: the amount of compensation, paid or received, which would keep the consumer to the initial welfare level after the change had taken place

The above measures, compensating variation (CV), compensating surplus (CS), equivalent variation (EV), and equivalent surplus (ES), are the most widely used monetary measures of welfare change in environmental valuation studies. Currie, Murphy and Schmitz (1971, p. 746) define these concepts as follows:

1. "Compensating variation" is the amount of compensation, paid or received, that will leave the consumer in his **initial welfare position** *following the change in price if he is free to buy any quantity of the commodity at the <u>new price</u>*[3].

2. "Equivalent variation" is the amount of compensation, paid or received, that will leave the consumer in his **subsequent welfare position** *in the absence of the price change if he is free to buy any quantity of the commodity at the <u>old price</u>.*

3. "Compensating surplus" is the amount of compensation, paid or received, that will leave the consumer in his **initial welfare position** *following the change in price* [change in environmental quality or quantity] *if he is constrained to buy at the <u>new price the quantity</u> he would have bought at that price in the absence of compensation.*
4. "Equivalent surplus" is the amount of compensation, paid or received, that will leave him in his **subsequent welfare position** *in the absence of the price*

[3] Some of the phrases have been underlined, bolded, or italized to highlight the differences in the definitions of the concepts.

[environmental quality or quantity] *change if he is constrained to buy at the* <u>*old price the quantity*</u> *he would have bought at that price in the absence of compensation.*

The concepts defined above are illustrated in Figures 2.3 and 2.4.

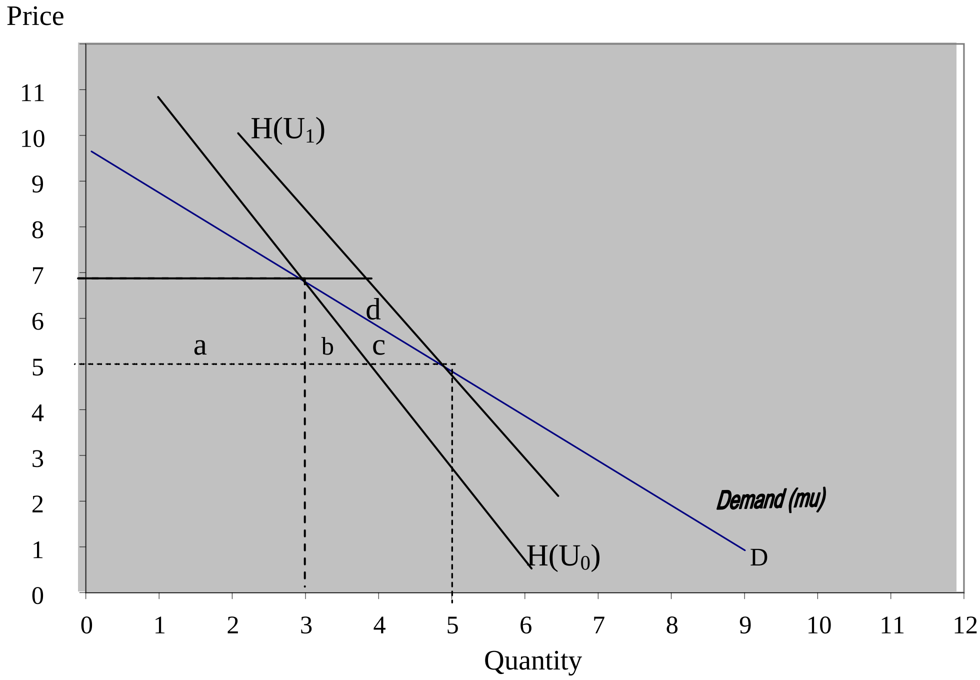

Figure 2.3 Compensating variation, equivalent variation and the Marshallian consumer surplus

Source: Perman *et al*. (2003)

Figure 2.3 illustrates the welfare effects of a policy change that reduces the price of the environmental good or service. The demand curve D represents the Marshallian or ordinary demand curve, $H(U_0)$ and $H(U_1)$ represent the Hicksian compensated demand curves corresponding to the original and subsequent utility levels respectively. A fall in price from \$7 to \$5 increases the Marshallian consumer surplus (MCS) by the area bounded by the two price lines and D which is equal to (a + b + c). The Marshallian consumer surplus measure is calculated from the market demand curve, which describes the relationship between the price and the quantity demanded. The MCS arises as a result of the difference between the market price and the maximum amount of money the individual is willing to pay for each unit. The market price ($5) paid for a given quantity (5 units) corresponds to the last unit (the marginal unit – 5^{th} unit) yet the consumer would have paid higher prices on all previous units because of diminishing marginal utility.

CV is measured using the original utility level as the reference point but valued at the new price. Its value is represented by the area bounded by the two price lines and $H(U_0)$, and is equal to (a + b). This value represents the maximum amount an individual would be willing to pay (WTP_{MAX}) to secure the change and still remain at the original welfare level. EV is measured with reference to the subsequent utility (welfare) level but valued at the old price and is equal to the area (a + b + c + d). This represents the minimum amount of money an individual would be willing to accept as compensation (WTA) for not having the price fall and still attain the same welfare level that he would have had if the price fall had occurred. Using the above estimates of MCS, CV, and EV, their differences may be made apparent in the following equations:

$$CV = (a + b) = \int_5^7 H(U_0)\, dP = 7$$

$$MCS = (a + b + c) = \int_5^7 D\, dP = 8$$

$$EV = (a + b + c + d) = \int_5^7 H(U_1)\, dP = 9$$

$$CV < MCS < EV$$

From the above it follows that WTP < MCS < WTA for a price fall. If the above analysis is repeated for a price increase, CV and EV become WTA and WTP respectively, with CV > MCS > EV meaning that WTA > MCS > WTP. Table 2.1 shows the relationship between WTP/WTA and the four welfare measures – CV, CS, EV, and ES.

MCS may approximate WTP where the income effect of the price change is very small (Perman *et al*., 2003). Policy analysts often use MCS as a proxy for either WTP or WTA arguing that the portion of income spent on the good or service in question is likely to be very small resulting in little or no income effects. Willig (1976) contends that in most cases the error involved in using MCS instead of CV or EV is 5% or less. For a good whose income elasticity is zero, the Hicksian demand functions are identical to the Marshallian demand function so CV, EV, and MCS are equal. However, where income effects are large, differences between the measures may be significant and it becomes important to identify the correct measure to be estimated. The challenge for the policy analyst is selecting the correct welfare measure under different conditions depending on the circumstances and purpose of the analysis. Table 2.1 provides a guide for selecting the correct welfare measure.

Table 2.1 Monetary measures for: (a) price change effects (CV and EV), and (b) environmental quality changes (CS and ES)**

	Compensating measure	Equivalent measure
(a)	CV	EV
Price fall (utility increase)	WTP *(WTP^C)** for the change occurring	WTA *(WTA^E)* compensation for the change not occurring
Price rise (utility decrease)	WTA *(WTA^C)* for the change occurring	WTP *(WTP^E)* for the change not to occur
(b)	CS	ES
Improvement (utility increase)	WTP (WTP^C) for the change occurring	WTA (WTA^E) for the change not occurring
Deterioration (utility decrease)	WTA (WTA^C) compensation for the change occurring	WTP (WTP^E) for the change not to occur

* Superscripts C and E denote compensating and equivalent measure respectively.
** CS and ES are compensating and equivalent surpluses respectively.

Source: Perman, Ma, McGilvary, and Common, (2003); and Haab and McConnell, (2003)

The analysis of the welfare effects of a price change assumes that the commodity or service is divisible so that individual consumers decide on the quantity consumed given the price change. Environmental services are lumpy, non-exclusive and generally non-divisible implying that consumers are constrained to experience the level of environmental quality brought about by the policy change. CV and EV are not the appropriate measures to use under these circumstances. The theoretically correct measures of welfare change resulting from environmental quality improvement are the CS and the ES as indicated in Table 2.1 above.

The following analysis assumes a well-behaved utility function (Perman et al., 2003):

$U = U(Y, X)$ Where Y is the composite good whose price is assumed to be \$1. X is the environmental service.

Welfare changes due to environmental quality or quantity improvement are analysed in a somewhat similar fashion to that of a market price change except that, as pointed out above, the relevant welfare measures are the CS and the ES. Figure 2.4 illustrates these measures. U_0 and U_1 represent the original and subsequent welfare levels before and after the improvement assuming that the improvement is beneficial and preferred to the status quo. A policy delivering this change will result in the individual moving from his original equilibrium point ‘a’, where the original price ratio lineY_0A is tangent to U_0, to a new equilibrium such as point ‘b’ where the new price ratio line Y_0B, implicit in an environmental improvement, is tangent to U_1. The corresponding consumption levels of the service (X) are X_0 and X_1.

To estimate the individual’s WTP for this improvement, we must find an amount of money which, when taken away from the individual, will leave him in his original welfare position U_0 whilst consuming X_1 at the new price implicit in the environmental improvement. To achieve this, Y_1B_1 parallel to Y_0B, is drawn to pass through the points ‘a’ and ‘c’ on U_0. The distance ‘cb’ (which is equal to Y_0Y_1) is the CS. Empirically this can be measured using stated preference methods by simply asking individuals to state their maximum willingness to pay (WTP) that will make the ex post subjective utility equal to the ex ante utility level.

The equivalent measure (ES) is obtained by drawing Y_2A_1 parallel to Y_0A and passing through ‘d’ and ‘b’ on U_1. ES is represented by the distance ‘ad’ and is equal to Y_2Y_1. This is the minimum amount of money an individual is prepared to accept (WTA) to forego the improvement in order to attain the same level of satisfaction they would have achieved if the change had occurred. The difference between CS and ES is clear from Figure 2.4. CS is measured with reference to the new consumption level X_1 valued at the new price whilst ES is measured with reference to the original consumption level X_0 valued at the old price.

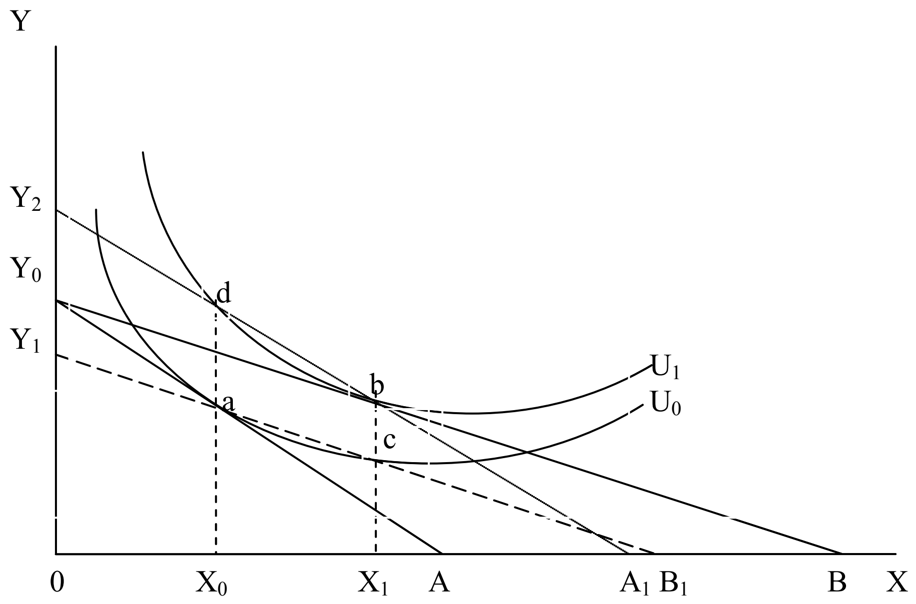

Figure 2.4 Compensating surplus and Equivalent surplus measures

Source: Perman *et al*. (2003)

So far the theoretical expose of the welfare measures accounts for the differences between WTP and WTA and indicates the conditions under which the two measures may be equal. For example conventional economic theory predicts that WTP and WTA measures should be equivalent as long as income and wealth effects are small, and different in all other cases. Empirical evidence from non-market valuation studies reveals a disparity between WTP and WTA. Anderson, Vadnjal, and Uhlin (2000) refer to differences ranging by a factor of between 2 and 16. Brown and Gregory (1999) list 23 studies, spanning over the period 1974 to 1999, that compared WTA and WTP and found disparities between the two ranging by factors between 1.4 and 61.0.

A study by Knetsch and Sinden (1984), confronting respondents with actual money payments and cash compensations, revealed unexpectedly large disparities between WTP to avoid a lose and WTA compensation for the same lose that may not be explained sufficiently by standard economic theory. Similar results were obtained by Hammack and Brown (1974) where a sample of duck hunters indicated, on average, that they would pay $247 to secure hunting at the existing level but demanded compensation of at least $1,044 to forego it. A review of 45 previous WTP - WTA studies by Horowitz and McConnell (2002), found the WTA/WTP ratio to be larger for non-market goods (7.17 times) than for private goods (2.92 times) and conclude that "the further a good is from being an 'ordinary private good,' the higher the ratio" (Horowitz & McConnell, p. 442)

The disparity between these measures has for a long time created problems for economists in terms of which measure to use for a specific policy change. For example, Sinden (1978) observes that some researchers tend to confuse the four welfare measures in their studies and gives Gluck (1975) as an example of a study where the concepts of CV and CS are confused in one of the policy changes. Sinden points out that Gluck used CV as a surplus measure for two policy changes, namely, continued fishing and withdrawal of rights to fish yet the correct measures were CV for the former and CS for the later. However, Sinden argues that Gluck's survey questionnaire was appropriately framed and correctly captured CS.

The general consensus among economic analysts is that, to correctly measure the welfare effects of a given policy change, WTP should be used for gains and WTA for losses. For example using WTP to avoid policy changes that impose losses or results in mitigation, or reductions is likely to seriously understate the true economic value of the effect (Brown & Gregory, 1999; Knetsch, 2007). Despite this agreement, most researchers prefer to use WTP even where WTA would have been more appropriate because it is easier to measure and estimate (Knetsch, 2007).

A number of reasons have been advanced in attempts to explain the disparity between WTP and WTA observed in empirical studies. The fundamental difference in value between WTP and WTA lies in the constraint income imposes on WTP and the perceived property rights (Mitchell & Carson, 1989; Brown & Gregory, 1999). A consumer's WTP is subject to a budget constraint whilst WTA is not. The disparity can also be explained in terms of people's attitudes when valuing current possessions compared to what they can potentially have. People place higher values on their possessions (endowment effect) and resist any losses hence higher values of WTA for any losses compared to WTP to acquire additional possessions (Thaler, 1980).

In their Prospect Theory, Kahneman, and Tversky (1979) provide an alternative descriptive framework for analyzing preferences in a manner that is theoretically consistent with observed empirical disparities between WTP and WTA. Their theory differs from the expected utility theory (standard economic theory) in that it assigns value to changes (gains and losses), rather than final assets, based on a reference point such as the status quo. They contend that changes that bring about gains and losses are valued from this reference point and the value function, defined on deviations from this point, is steeper for losses than for gains, and generally concave for gains and convex for losses. Figure 2.5 illustrates a typical value function.

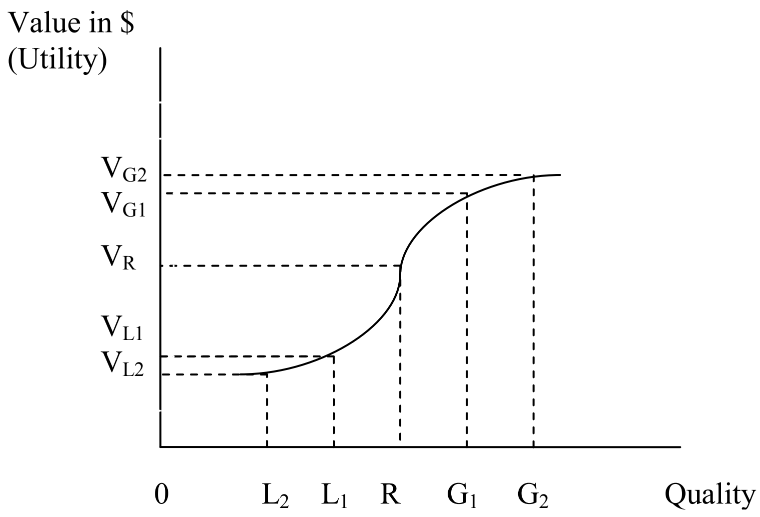

Figure 2.5 The hypothetical value function and value of gains and losses
Source: Knetsch (2007)

It is evident from the Figure 2.5 that equal gains and losses measured from the reference point R are valued differently. For example gains of G_1 and G_2 are valued at $\$(V_{G1}-V_R)$ and $\$(V_{G2}-V_R)$ respectively, while losses of L_1 and L_2 are valued at $\$(V_R-V_{L1})$ and $\$(V_R-V_{L2})$ respectively with the losses valued more than the corresponding commensurate gains [$\$(V_R-V_{L1}) > \$(V_{G1}-V_R)$ and $\$(V_R-V_{L2}) > \$(V_{G2}-V_R)$]. Also clear from Figure 2.5 is that people experience diminishing marginal effects of both gains and losses. Knetsch (2007) states that the correct welfare measure for any quality changes taking place to the left of R (the domain of losses), whether improvements or deterioration, is WTA. For example it would be incorrect to use WTP for an improvement from L_2 or L_1 to R as this would provide an under-estimate of value. Similarly all changes taking place to the right of R (the domain of gains) should employ WTP as an appropriate measure.

2.1.5 Methods of Measuring Welfare Changes

Currently a number of techniques are available for valuing environmental goods or non-market goods in general (Mitchell & Carson, 1989; Garrod & Willis, 1999; Bateman *et al*., 2002; Ward, 2006). Empirical techniques based on underlying economic theory are employed to measure the economic value of a resource or ecosystem using welfare changes associated with environmental or ecosystem quality changes. These techniques can be classified into two groups; direct and indirect techniques. The direct methods are also referred to as Revealed Preference (RP) methods such as the Travel Cost Method (TCM), Hedonic Pricing Method (HPM), and Averting Behaviour (AB); whilst the indirect methods are referred to as Stated Preference (SP) methods and examples are: Contingent Valuation Method (CVM), Conjoint Analysis (CA), Choice Experiments, Choice Ranking, and Contingent Rating (Madureira, Rambonilaza, & Karpinski, 2007). The next chapter looks at non-market valuation techniques.

CHAPTER 3

Non-Market Valuation Techniques

3.1 Introduction

In this chapter an overview of non-market valuation is provided and broad areas of non-market valuation application are highlighted. Non-market valuation techniques are described and discussed with the main emphasis placed on the two most commonly used techniques, the CVM and the TCM representing direct (or stated) and indirect (or revealed) preference methods respectively.

3.2 Non-market Valuation and Decision-Making

Non-market valuation is a process of estimating a monetary value for goods and services that have no market, or limited market, or 'incomplete' market (Bateman *et al*., 2002). Mainly, it employs analytical tools from microeconomics, welfare economics, and econometrics (Haab & McConnell, 2003). The need to value environmental goods and services arose from the desire to incorporate the natural environment in cost-benefit analysis of public policy (Boyer & Polasky, 2004). Faber and Costanza (1987) argue that the increased threat on the world's limited resources dictates increased importance of accurate valuation of non-marketed natural resources as these resources become scarcer. Comprehensive cost-benefit analysis of policy impacts should bring the environment into the picture in order to reflect, as far as possible, the total costs and benefits of the policy to society. Without a monetary value of environmental goods and services, policy decision making may not be optimal as it would be impossible to fully assess the trade-offs implied by alternative policies. Non-market valuation techniques play an important role of providing monetary value estimates of environmental goods and services which would otherwise be given a zero monetary value if the normal market system is used.

Over the years, a rapidly growing world population, urbanization, and increased agricultural activity to feed this growing population have exerted and continue to exert pressure on natural and environmental resources which requires increasingly harder trade-off decisions (Faber & Costanza 1987). For example serious conflicts have emerged concerning development of land on one hand and conservation on the other (Carson, Wilks, & Imber, 1994). Wetlands and rainforest have been converted to agricultural land or urban land. Over the same period non-market valuation studies have increased rapidly with marked increases observed during the 1990's (see Figure 3.1). The increase in non-market valuation studies in the US in the 1980's and 1990's seems to have been spurred by the debate surrounding the controversy of using non-use value estimates from contingent valuation surveys as a basis for legal claims for environmental damages under the 1980 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the 1990 Oil Pollution Act (Cummings & Harrison, 1995). The main debate revolved around the claim resulting from the 1989 Exxon Valdez oil spill (Smith & Osborne, 1996). The Exxon Valdez oil spill occurred in March 1989 coinciding with the publication of Mitchell and Carson's (1989) highly referenced book, "Using Surveys to Value Public Goods: The Contingent Valuation Method" (Adamowicz, 2004).

In the United Kingdom, the 1995 Environment Act established the Environment Agency (EA) which was mandated to take into account environmental costs and benefits arising from its policies (Bateman *et al.*, 2000a). This may partly explain the increased interest in non-market valuation studies in the UK during the 1990's. In a study of non-market valuations in New Zealand covering the period 1974 to 2005, Yao and Kaval (2007, p. 7) conclude that the 1991 RMA transformed non-market valuation applications "from mainly an academic exercise,… into a government decision support tool for policy decision making..." and increased the number of studies conducted.

Figure 3.1 shows trends in annual non-market valuation studies[4] during the period 1960 to 2007. The contingent valuation method appears to have been the most popular non-market valuation technique as illustrated in Figure 3.1 and Figure 3.2. Stated preference (SP) methods (CVM and CA) account for about 63% of the valuation studies whilst revealed preference (RP) methods account for about 25%. Benefits transfer/secondary studies (BT/Sec) account for 12% highlighting the increase in importance of these studies over the years.

[4] Studies involving the five main techniques were analyzed to highlight the general trend in non-market valuations

Care should, however, be exercised in interpreting Figures 3.1 through to 3.5 as the data used to construct them comes from a single source – EVRI (Environmental Valuation Reference Inventory, nd) database. EVRI is currently the single most comprehensive international database of non-market valuation studies with just over 2100 studies (Bateman *et al.*, 2000b; Bateman *et al.*, 2002; Freeman III, 2003). The numbers of studies from 2005 onwards is low which may be explained by the fact that some journal databases update publications according to a "moving wall" policy, agreed on by publishers, with most coverage usually spanning from the first issue of the journal up until 2 to 5 years ago (JSTOR, nd).

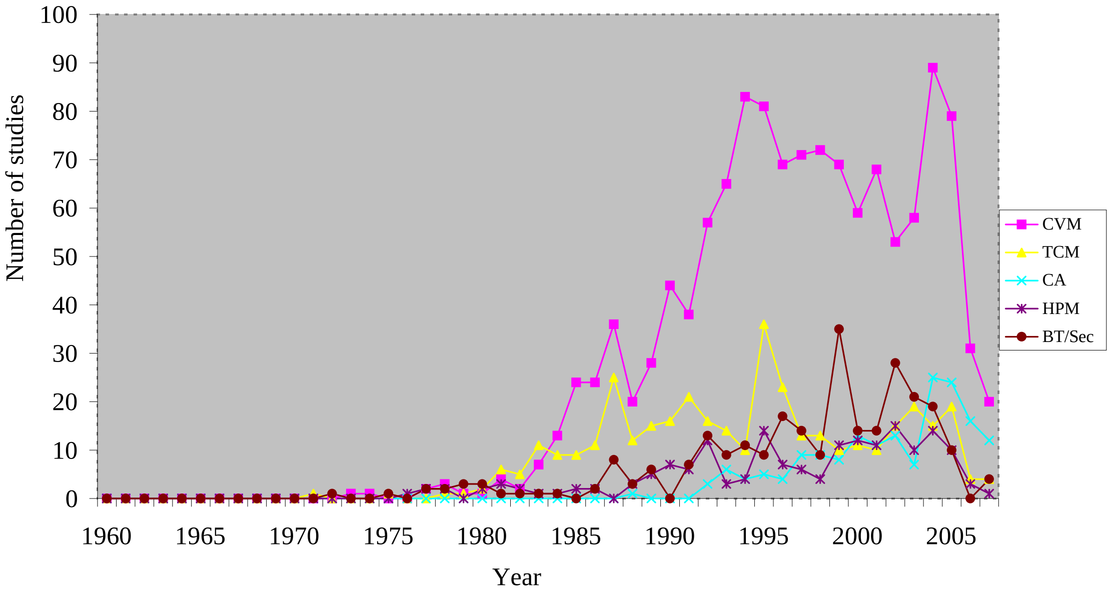

Figure 3.1 Non-market valuation studies: 1960 - 2007

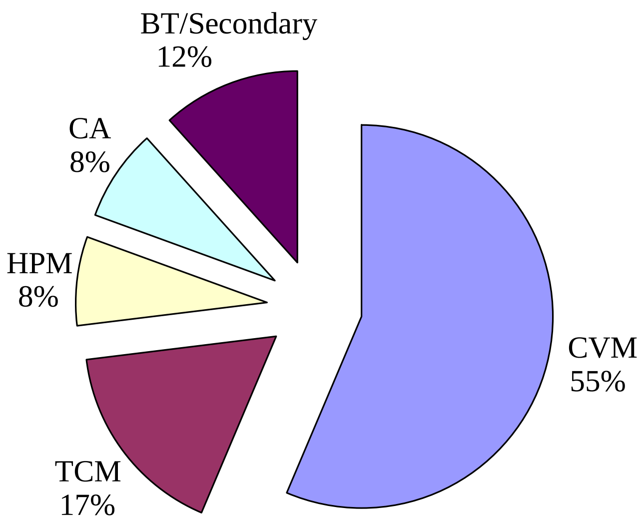

Figure 3.2 Non-market valuation studies by technique

Figure 3.3 shows the USA as the leader in non-market valuations accounting for about 46% of non-market valuation studies currently held in the EVRI database.

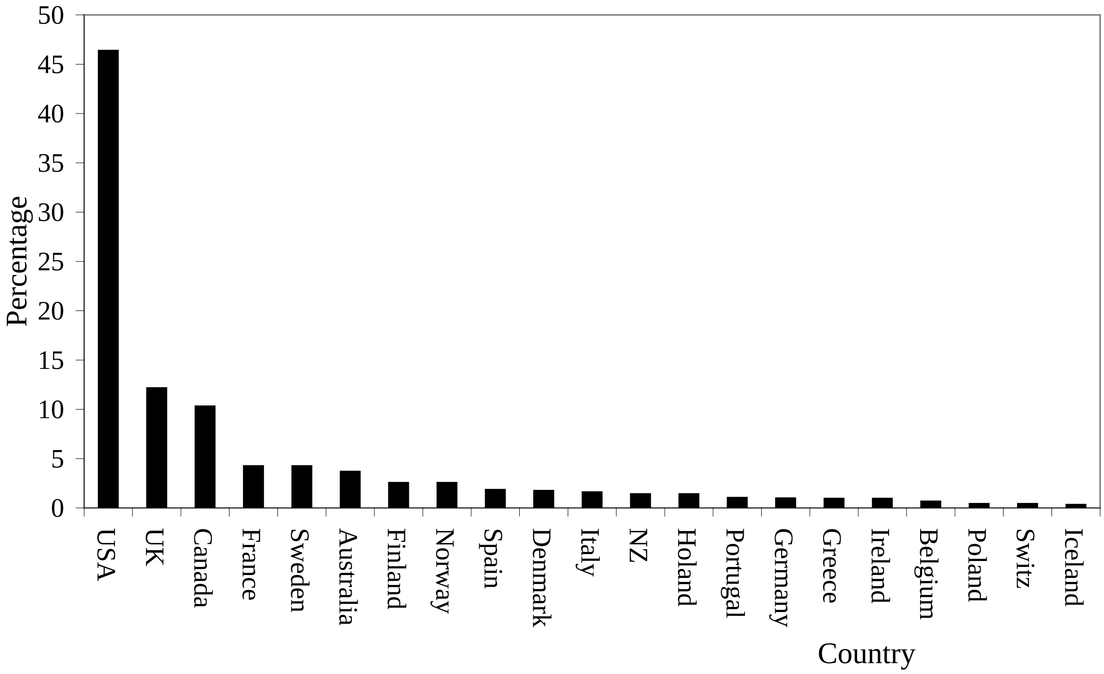

Figure 3.3 Distribution of Non-market valuation studies by country

The predominance of valuation studies among high income countries is not surprising as poorer countries' main primary concern is poverty alleviation with environmental issues way down their priority list. Figure 3.4 shows the distribution of studies by country income group with the high income countries accounting for 84% of the valuation studies suggesting strong environmental management policy by the rich countries. Low income countries do not appear to be taking advantage of the benefits of the input from non-market valuation studies in cost-benefit analysis. The share of low and middle income countries may be higher than the figure reported here because of publication and country bias[5]. There may be a substantial number of unpublished reports and valuation studies from these countries which have not made it to the EVRI database and are unlikely to ever make it there because they are either not searchable, or private and confidential or both.

[5] A New Zealand study by Yao and Kaval (2007) compiled 92 non-market valuation studies carried out in New Zealand during the period 1974 to 2005 and contend that this number accounts for over 90% of the valuation studies ever conducted in NZ. Of these valuation studies, 57% were project reports, 24% were postgraduate theses, and 18% (about 17 articles) were refereed journal articles. Currently the EVRI database holds 30 NZ articles suggesting that the bulk of project reports and postgraduate theses have not made it to the EVRI database.

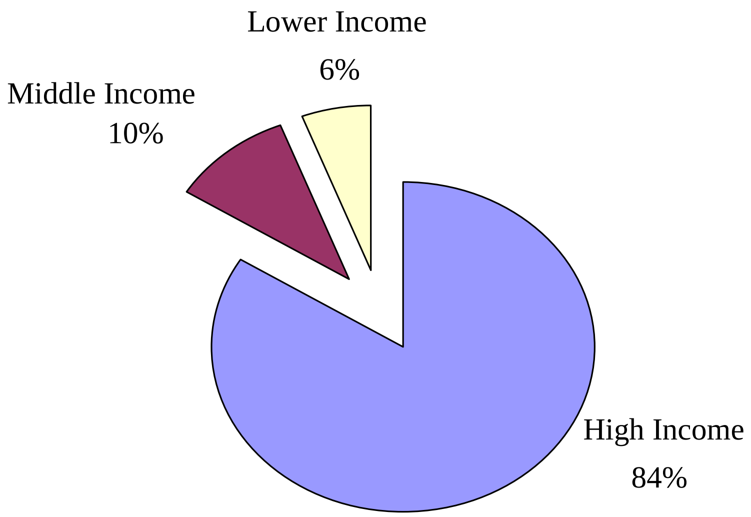

Figure 3.4 Distribution of studies by country income group

At a continental level North America tops the list with 54% followed by Europe with 28%. South America and Africa are at the bottom with 2% each. In Europe, the UK, Sweden, France, Norway and Finland are the main contributors, with New Zealand and Australia leading the pack in the Australasian region.

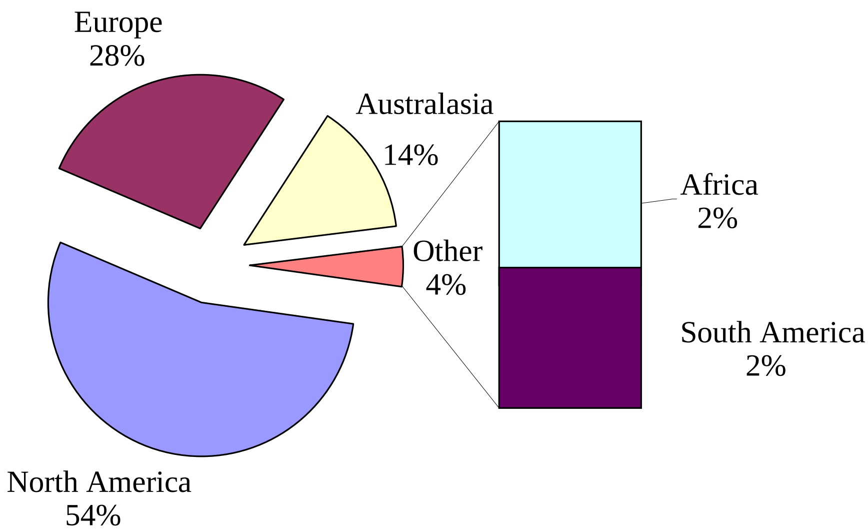

Figure 3.5 Distribution of studies by continent

3.3 The Contingent Valuation Method (CVM)

The Contingent Valuation (CV) technique is an approach based on the direct elicitation of value from individual respondents through the use of carefully designed and administered sample surveys (Arrow *et al*., 1993; Hanemann *et al*., 1991; Venkatachalam, 2004). The CVM may be administered through mail surveys, personal and telephone interviews. Amirnejad *et al*. (2006), Venkatachalam (2004), and Mitchell and Carson (1989) trace the origins of the CV technique to Ciriacy-Wantrup (1947), who originally proposed the method, and Davis (1963), whose early work used questionnaires to estimate the value of outdoor recreational benefits.

3.3.1 Historical Background of the CVM

The Contingent Valuation technique was developed as a result of realisation of the growing importance of benefits from environmental goods and services, and the need to incorporate the costs and benefits of non-market goods and services associated with a particular policy change or project to achieve optimal resource allocation. The standard process was to carry out cost-benefit (B-C) analysis of public policy purely on the basis of costs and benefits as evaluated in terms of market prices and quantities. Public goods such as environmental goods and services are not, in general, provided via a market despite the fact that they provide substantial benefits to the public (Costanza *et al*., 1997). Cost-benefit analysis of public policy that does not incorporate the costs and benefits of non-market goods and services implies a zero valuation for these goods and services. Ciriacy-Wantrup (1947) identified the essential problem in valuing public goods as that of obtaining a demand schedule for these goods. He suggested that individuals in a sample could be asked how much they were willing to pay for additional quantities of collective non-market goods; but noted the potential biases and problems inherent in such a method.

Ciriacy-Wantrup’s (1947) suggestion was not developed further until Davis (1963), unaware of this suggestion, used questionnaires to estimate the value of outdoor recreational benefits. In Davis’ study, the Maine backwoods constituted the ecosystem and the recreational benefits the ecosystem service. To validate his findings, Davis compared estimates from the new technique (CVM) with those of a travel cost method and found the results to be similar. The results of Davis' studies generated interest in the CVM. Ridker and Henning (1967) included a willingness to pay (WTP) question in their study of the effects of air pollution on property prices. Cicchetti and Smith (1973) applied the contingent valuation technique in a study to estimate the wilderness hikers' WTP for wilderness experiences. This study is similar to that of Davis in that it estimated the value of recreation, an ecosystem service, provided by a wilderness (ecosystem). Darling (1973) used an econometric approach (Hedonic Pricing Method) and a WTP questionnaire to estimate the value of three urban water parks capitalized in property (values) prices. Hammack and Brown (1974) used the CV technique (mail format) on waterfowl hunters to estimate waterfowl benefits from wetlands. This was the first major study to report both WTP and WTA estimates from the same survey (Mitchell & Carson, 1989). Randall, Ives and Eastman (1974) introduced a bidding game CV format to estimate the economic value of air visibility establishing the CVM as the only known method capable of valuing such a good. These studies and other earlier works laid a foundation for the continued use of the CVM as a tool for valuing environmental non-market goods and services.

Most of the early studies sought to legitimize the CVM (a direct method) by comparing their findings with those obtained for the same amenities by other techniques which had already reached widespread acceptance in estimating non-market benefits such as the Travel Cost and the Hedonic Price methods (Mitchell & Carson, 1989; Bishop, Heberlein & Kealy, 1983). Smith, Desvousges, and Fisher (1986) state that comparisons between direct and indirect methods were intended to enhance the acceptability of the direct methods.

3.3.2 Methodological Procedure of the CVM

3.3.2.1 Hypothetical Scenario: Depiction of the Good and the Appropriate General Context in Which the Good Would be Provided

In a typical contingent valuation survey, respondents are presented with detailed information about a hypothetical scenario that would reduce or increase the quantity or quality of an environmental good, service, or resource. The environmental entity, the goods or services it provides, and the change in quantity or quality of that environmental entity or goods and services need to be clearly defined using maps, pictures, diagrams and literary descriptions to provide sufficient information about the 'product' the respondent is required to evaluate. Haab and McConnell (2003) assert that the service or good must be meaningful, limited geographically and temporally, and defined in terms of characteristics that can reasonably enter a respondent's preference function. A suitable payment vehicle[6] for the elicitation of WTP/WTA values is also described in detail clearly specifying the nature and time frame for the payment and linking such payment to the provision of the benefit – 'no payment, no benefit'.

The hypothetical scenario simulates a market situation in which the respondent's behaviour is 'observed'. The design of the questionnaire and survey procedure form the 'heart and soul' of a CV analysis. Careful data handling and econometric analysis can not correct for a poorly designed questionnaire (Mitchell & Carson 1989; Haab & McConnell, 2003). The hypothetical scenario must be credible and respondents should believe that such a program is possible (Beasley, Workman & Williams, 1986) otherwise respondents will not take the survey seriously.

A willingness to pay/accept (WTP/WTA) question is then posed within the survey setting asking respondents to state their maximum/minimum WTP/WTA for the given change in the quantity or quality of the environmental good, service, or resource.

The technique then proceeds by confronting respondents with further questions to validate their previous responses to the WTP/WTA question and to extract socio-economic, attitudinal and behavioural indicators such as age, sex, education, income, membership to environmental groups, preferred outdoor activities, and views towards the environment, which may influence the individual's preferences, and help to explain WTP (Lienhoop & MacMillan, 2007).

According to Carson, Groves and Machina (2000), a survey questionnaire must meet two basic conditions in order for it to produce results that are consistent with economic theory. These conditions are:

[6] The payment vehicle may be in the form of rates or taxes, entrance fees (user-pays), membership fees, donations to a special fund, and increased prices. The payment vehicle selected must be appropriate to the contingent scenario and should be least objectionable to reduce strategic bidding and protests.

i. The respondent must see the results of the survey as potentially influencing the actions of the authorities.
ii. The respondent must care about the outcome of the action taken by the authorities.

If these two conditions are satisfied, a respondent is likely to treat the survey question as an opportunity to influence the actions of the authorities in a way that maximizes his/her welfare by either true-telling, or behaving strategically (free-riding, over/under bidding). Survey questions meeting the above conditions are said to be consequential (Carson, Groves & Machina, 2000). Where these conditions are not met, the survey questions are said to be inconsequential and economic theory cannot make any predictions about the nature of the responses to such questions.

3.3.2.2 Value or Willingness to Pay (WTP) Elicitation Methods

WTP/WTA may be defined as the maximum/minimum amount an individual is willing to pay/accept for a given gain /loss in the quality or quantity of a good or service. The WTP/WTA questionnaire may be formulated in a number of ways described below, depending on the problem and the researcher’s preferences.

i. Open-ended question format

An open-ended question such as “what is the maximum/minimum amount your household would be willing to pay/accept as compensation for...?” may be use to elicit WTP/WTA responses from respondents. Bateman *et al*. (1995), Lienhoop and MacMillan (2007) used an open-ended questionnaire in their CV studies. Literature suggests that respondents often find it difficult to formulate a value spontaneously for a non-market good, without some form of assistance, because they lack experience in valuing such goods (Bishop & Heberlein, 1979; Cameron & Huppert, 1989; Mitchell & Carson, 1989). As a result, many open-ended CV formats tend to produce unacceptably high non response rates or protest zeros to the WTP questions (Mitchell & Carson, 1989). Arrow *et al*., 1993 contend that asking respondents to formulate monetary values in response to an open-ended CV question presents them with an extremely difficult task. Prices in ordinary markets, unlike in open-ended CV scenarios, are given and the consumers respond to these prices.

ii. Referendum format

This approach may take the form of a hypothetical referendum as developed by Bishop and Heberlein (1979) and recommended by Mitchell and Carson (1989), in which respondents are advised how much each would have to contribute if the measure passed and are then asked to cast a simple "yes" or "no" vote.[7] This may be implemented through, mail, telephone, or in-person interviews. Bergstrom *et al*. (1990) used a dichotomous choice (DC) valuation question to estimate expenditures and consumer's surplus associated with on-site recreational use of a wetland and argued that research suggested that DC questions were incentive-compatible in that the questions gave proper incentives for the revelation of 'true' values. Hoehn and Randall (1987) suggest that the DC format appears to have the most satisfactory characteristics. Herriges and Shogren (1996) state that one advantage of this format is that it mimics the decision making task that individuals face in everyday market transactions. This method of elicitation is also known as discrete choice, dichotomous choice, and take-it-or-leave-it. Only the closed-ended type of questions can be used in the dichotomous choice format.

This DC approach uses a list of predetermined prices (bids) selected to envelop expected maximum WTP amounts of respondents. The range and dispersion of these bit amounts must be set in such a manner that they map out the entire response curve of the respondents. These prices are usually obtained from focus group meetings and pilot studies (pre-tests) carried out before hand. For best results Arrow *et al*. (1993) recommend the use of a dichotomous question that asks respondents to cast a "yes" or "no" vote for a given level of taxation like in most real referenda. Carson, Wilks and Imber (1994, p. 733) used a double bounded dichotomous choice format to elicit WTP for the preservation of Australia's Kakadu Conservation Zone and argue that it "obtains more information about where respondents' WTP amounts lie than does the simple binary discrete choice approach".

[7] The approach is referred to as single- bounded dichotomous choice if the amount is a specific amount; or double- bounded dichotomous choice if a range is specified i.e. if a respondent's answer is 'Yes' to the first bid amount, a predetermined higher bid is offered and the respondent is asked to respond. If the first response is a "No" a lower amount is offered. In a one-and-one-half bound dichotomous choice the respondents are advised in advance of the range covered by the programme costs (say the programme will cost between $X and $Y with X and Y varied across the sample). They are then asked if they would pay $X; if the answer is "No" nothing further follows but if it is "Yes", they are asked if they will pay Y.

iii. Bidding game

The procedure involves a series of “yes” or “no” answer questions, administered through personal interviews, where respondents are presented with progressively higher or lower prices (bids) depending on their answer until they answer differently (an iterative bidding game). The first bidding game was introduced by Davis (1963). Brookshire, Randall, and Stoll (1980) used an iterative bidding technique to estimate WTP for elk hunting. Brookshire, Ives, and Schulze (1976) used a bidding game to estimate the damage from possible construction of a power plant. The argument in favour of this technique is that the bidding process helps respondents to evaluate their preferences whilst its main weakness is that the initial bid can influence the respondents’ final valuation (starting point bias) (Boyle & Bishop, 1988). The final bid amount is a measure of the Hicksian compensating or equivalent surplus for the item being valued depending on the design of the contingent market (Boyle & Bishop, 1988).

iv. The payment card or checklist method

The payment card or checklist method was first developed by Mitchell and Carson (1981 and 1984 as cited in Mitchell & Carson, 1989) as an alternative to the bidding game to eliminate starting point bias. The method retains the essential properties of the direct question approach and increases the response rate to WTP questions by providing respondents with a visual aid (Mitchell & Carson, 1989). The question may be open-ended where the respondents select their maximum WTP bids from a list of amounts specified on the card, with the selected bid representing a point on the underlying demand curve. The card consists of dollar values starting from zero and increasing at fixed intervals. Each card presents estimates (anchors) of what people in certain income bands paid for selected public goods during the past 12 months. Before the interviewer can show the card to a respondent the good to be valued and the market is described in detail and the respondent’s income obtained. The closed-ended format provides a “yes” or “no” answer to a question specifying both the precise quantity or quality of the non-market good to be gained or lost and the exact amount of money to be paid or received. Mitchell and Carson (1989) criticise this method because of its potential vulnerability to biases associated with the ranges used on the cards and the location of the benchmark.

3.3.2.3 Administration of the Survey

The main methods used for administering the survey instrument are mail, telephone, and personal interview (in-person) (Dillman, 1978). The decision on which method to use depends on how the valuation question is framed and the cost associated with each method. Bradburn (1983, p. 294 as cited by Mitchell & Carson, 1989) points out that "contrary to the common belief favouring face-to-face interviews, there is no clearly superior method that yields better results for all types of questions". However, the advantage of the mail survey method over the telephone and other methods is that it is cheaper and still permits the use of visuals aids. The mail method may suffer from non-response bias as those who do not respond are likely to be the least interested in the project (Mitchell & Carson, 1989). The interview method provides more information by way of explanations by the interviewer but comes at a high cost and may also result in interviewer bias.

3.3.2.4 Models for Analyzing Contingent Valuation Responses

3.3.2.4.1 Open Ended Responses

Responses to open ended questions are straight forward to analyze as each bid amount (maximum WTP) may be taken to correspond to a point on the demand curve. The mean and median of the sample are computed mathematically from the sample data. The sample is assumed to be representative of the population and the distribution of WTP values in the sample is assumed to be similar to that of the population so that the expected sample mean and median are good estimates of the population mean and median.

To obtain the aggregate population WTP, the sample mean or median is multiplied by the population size. This is equivalent to the horizontal summation of individual WTP across all individuals who constitute the population. For private goods, individual demand curves are horizontally summed to obtain the market demand curve. For public goods, theory suggests that the summation of the individual demand curves should be vertical (Bradford, 1970; Mitchell & Carson, 1989). The WTP estimates may be reported as; mean WTP per household (or per person), aggregate WTP per year, or as a net present value[8], depending on how the valuation question is framed and the researcher's requirements.

3.3.2.4.2 Binary Choice Responses

Binary choice responses cannot be processed in the same way as responses to open-ended questions. "The mean and median WTP measures for [dichotomous choice] responses are inferred from the underlying statistical distribution of the probability that respondents say yes or no to the different bid amounts used" (Brouwer & Bateman 2005, p. 3). Pate and Loomis (1997) state that, the dichotomous structure of the dependent variable (yes/no responses) requires the use of a non-linear probability model such as the logit model which is most commonly used in CV studies. Hanemann (1984) developed the first economic-theoretic framework for the calculation of the mean and median WTP estimates from dichotomous choice response data.

Literature suggests two utility theoretic approaches for dichotomous choice models; the 'utility difference' and 'tolerance approach' (Duffield & Patterson, 1991). The utility difference theoretic model which allows for the specification of an indirect utility function was developed by Hanemman (1984). Cameron (1988) adopted the tolerance approach which involves specifying a functional form for the expenditure function.

The tolerance approach assumes that each individual has a maximum amount they are willing to pay (WTP) for a particular change in environmental quality improvement and would answer "yes" to a valuation question if presented with a bid amount less that WTP or "no" otherwise. The probability that an individual will say "yes" to the bid amount 'x' [Pr(yes|x)] is modelled as a function of the bid amount 'x'. Pr(yes|x) is given by the formula (Duffield & Patterson, 1991):

$$\Pr(yes|x) = \Pr[WTP > x] = 1 - F(x) \qquad (1a)$$

Where F(.) is the distribution function of WTP values in the population. F(.) usually belongs to a parametric family such as the logistic CDFs (which give the logit model) or

[8] The values may also be per person or household per year or some other units such as cubic meters, square meters, hectares etc.

normal CDFs (which give the probit model). Duffield & Patterson estimate mean WTP using the formula:

$$E(WTP) = X_{\max} - \int_{0}^{X_{\max}} \frac{1}{1+e^{-(\ln\alpha+\beta\ln X)}}\,dX \qquad (1b)$$

Boyle, Welsh and Bishop (1988) argue that using an equation that truncates the expected value of WTP is not correct as this under estimates the value of expected WTP_{MAX} because truncating the integration at X_{MAX} violates the condition that the area under the probability density function (pdf) is exactly equal to one. The area under the (pdf) over the range of integration truncated at X_{MAX} is less than 1. They suggest that the correct range of integration should be from -∞ to ∞.

The <u>utility difference approach</u> starts by specifying indirect utility functions for the status quo and the environmental improvement, and assumes that the individual knows for sure which choice maximizes his/her utility (Hanemann, 1984) and will select a choice that reveals his/her true preferences as a rational agent. The probability that the respondent will say "Yes" to a given bid amount $A is given by the formula of the form (Hanemann, 1984; Lee & Han, 2002; Amirnejad *et al*., 2006):

$$\Pr(\text{Yes}|\ \$A) = \Pr[V(q_1, Y\text{-}A, \mathbf{z}, \varepsilon_1) \geq V(q_0, Y, \mathbf{z}, \varepsilon_0)] \qquad (1c)$$

Where $V(q_1, Y\text{-}A, \mathbf{z}, \varepsilon_1)$ and $V(q_0, Y, \mathbf{z}, \varepsilon_0)$ are the indirect utilities associated with the environmental improvement and the status quo respectively.

Pate and Loomis (1997) use a logistic regression model developed to analyze their data as follows:

$$log\{prob(yes)/1 - prob(yes)\} = C_0(constant) - C_1(log\ D) - C_2(bid) + C_3(know) - C_4(substitutes) + C_5(SpRec) + C_6(member) + C_7(age) + C_8(sex) + C_9(angler) \qquad (1d)$$

The dependent variable is the log of odds or logit, and the C_i's are the slope coefficients including the intercept. The variables in parentheses are those hypothesised to influence the respondents' responses to the bid offered. Each coefficient was interpreted as the change in the log odds (*log{prob(yes)/1 - prob(yes)})* or logit associated with a one-unit change in the independent variable. The logit coefficients were then transformed into WTP coefficients using the method of Cameron (1988) which allows the researcher to rescale the logit equation into the more familiar WTP function (Pate & Loomis' 1997). The transformation is accomplished by dividing the constant term (intercept) and all of the slope coefficients in the model (other than the bid amount) by the absolute value of the coefficient on the bid amount variable. "This transforms the coefficients in the equation into coefficients with ordinary least squares interpretation, insofar as the estimation of the impact on WTP" (Pate & Loomis, 1997, p. 203). WTP is then estimated using the equation:

$$WTP = \sum\{(\text{mean } X_i)*(C_i/C_2))\} + C_1/C_2 (\log D) \quad (1e)$$

Bishop, Heberlein, and Kealy (1983) analyzed their data with a logit model of the form:

$$\pi_i = (1 + e^{\beta Y_i})^{-1} \quad (1f)$$

Where π_I is the probability that the i^{th} hunter will say yes to the offered bid; Y_i is a vector of explanatory variables; and β is a vector of regression coefficients. In their model (1) the natural logarithm of the bid amount (lnbid) was used as the only explanatory variable in the model.

3.3.3 Legitimization of the Contingent Valuation Method

CVM has been employed by courts and government agencies such as the US Environmental Protection Agency, the National Oceanographic and Atmospheric Administration, and the US Fish and Wildlife Service to assess the benefits of policies impacting the environment and damages from environmental disasters (Aadland & Caplan, 2006). The Exxon Valdez oil spill report to the Attorney General of the State of Alaska used the contingent valuation method in the assessment of passive-use loss incurred by the oil spill (Carson *et al*., 2003). The US Department of Interior used the CVM to assess natural resource damages under the "Superfund" legislation (Duffield & Patterson, 1991). In circa 1979, the US Water Resources Council endorsed the CVM as an acceptable procedure for estimating economic value of recreational and environmental resources (Walsh *et al.*, 1984; Duffield & Patterson, 1991).

In New Zealand, a comprehensive environmental law - the Resource Management Act (RMA) of 1991 provides for government intervention in promoting the sustainable management of natural and physical resources. Yao and Kaval, 2007 highlight the requirements under section 32 and section 88 of RMA 1991 which make it mandatory for all valuations to take into account benefits and costs (of any kind whether monetary or non-monetary) of policies, rules or other methods. The requirements under these sections promote the use of non-market valuation techniques which include the contingent valuation method.

3.3.4 Issues Surrounding the Use of the CVM

The CV technique has been in use for thirty five years or so to estimate passive-use values. Arrow *et al*. (1993) observe a dramatic increase in the number of academic papers and presentations related to the contingent valuation technique resulting from the growing interest both nationally and internationally in environmental problems and policies due to global warming, controversy surrounding the validity of the technique, and the growing use of the contingent valuation technique in estimating lost passive-use values in litigation arising from American state and federal statutes designed to protect natural resources. Arrow *et al*. (1993) further assert that the appeal of the CVM lies in its potential to estimate lost passive-use values in damage assessments where there appears to be no behavioural trails to be followed.

The value estimates obtained using the CVM do not only depend on the scenario presented to the respondents but also on how the respondents perceive it, the payment vehicle used, the method of conducting the survey (mail, telephone, in-person interview), and the bidding (elicitation) method (Carson, Groves & Machina, 2000). Different elicitation formats yield different results. For example, results from independent studies by Gibbard, (1973) and Satterthwaite, (1975) suggest that it is impossible to formulate a continuous response question that has the same incentive and informational properties as an incentive-compatible binary discrete-choice question. However, Bateman *et al*. (1995) contend that differences in value estimates from different elicitation formats can be explained by economic theory and psychology.

The CV technique has been criticized on the basis of unreliable results (Diamond & Hausman, 1994; Cummings *et al*., 1995; Arrow *et al*., 1993) which arise from:

i. Its reliance on answers to hypothetical questions rather than observed economic choices, resulting in hypothetical bias. "Ask a hypothetical question and you get a hypothetical answer" (Seller, Stoll, & Chavas, 1985, p. 158). Taylor and Douglas (1999) define hypothetical bias as observed difference between people's responses to hypothetical referenda and real referenda. Stated values tend to over estimate the "true" values they are supposed to measure (positive hypothetical bias). Harrison *et al*. (2008) state that hypothetical bias arises as a result of strategic over-bidding when respondents do not expect any actual payments to be made for the provision of the good.
ii. Respondents' answers that may be inconsistent with the tenets of rational choice. For example a respondent may express a zero value (zero WTP) for required environmental goods and services because they do not agree with some aspect of the proposed program for religious or cultural reasons or they just cannot be bothered to formulate a true or realistic value for the service or good. For example, in New Zealand, a Maori respondent may refuse to place a value on a wetland because he believes that it is wrong, according to their cultural norms, to put a monetary value on any natural resource.
iii. Respondents' lack of understanding regarding what it is they are being asked to value due to inexperience in valuing non-use benefits and public goods. Respondents may, as a result, value something different from what the researcher is trying to measure (Mitchell & Carson, 1989; Carson, Groves & Machina, 2000).
iv. Poorly designed survey (Mitchell & Carson, 1989; Haab & McConnell, 2003). Responses to a poorly designed survey questionnaire may not be consistent with expectation and the results from data analysis may not have economic interpretation.
v. Respondents' failure to take contingent valuation questions seriously because of the hypothetical nature of the whole exercise and the non-binding nature of the results of the surveys. Where there is no incentive to state the true preference,

respondents are tempted to just state any large amount since their response is not binding.

vi. Strategic Bias / Over and Under Bidding. Respondents may either overstate or understate their WTP in an attempt to influence the outcome or results in their favour. A simple test for strategic bias is the analysis of the distribution of WTP responses. A bimodal distribution or the existence of fat tails may be an indication of significant strategic bias. Schultze, d'Arge and Brookshire (1981) conclude, from a review of six contingent valuation studies, that strategic bias in revealing consumer preferences is not likely to be a major problem. This conclusion is also supported by Smith (1977); Grether and Plott (1979); and Bishop, Heberlein and Kealy (1983).

vii. Anchoring and Starting Point Bias

Starting point bias is mainly associated with the use of iterative bidding in CV surveys. Mitchell and Carson (1989) contend that respondents may interpret the initial bid amount as being indicative of the value which the interviewer or questionnaire expects from them. If the starting bid is too high or too low in relation to the respondent's true WTP value, respondents may change their responses prematurely to get over the question quickly and save their time. For single bounded DC formats respondents may exhibit a tendency to agree regardless of the bid level (O'Conor *et al*., 1999). This is an extreme form of anchoring (100%) which Mitchell and Carson (1989) refer to as "yea-saying".

viii. Truncation and Endogenous Stratification effects

Where onsite samples are taken, non-users of the sites are excluded from the sample so that the observations are truncated at positive site demand. The likelihood of an individual being sampled depends on the frequency of visiting the site so that those who frequent the site most (who have similar characteristics or interests) are most likely to be selected. This is referred to as endogenous stratification (Shaw, 1988; Englin & Shonkwiler, 1995).

ix. Embedding effects

Respondents may fail to separate aspects of the programme from the overall national or regional environmental policy and state maximum WTP reflecting the overall valuation of the environmental issues instead of the proposed programme. Where a resource is valued as part of a larger programme or package, WTP is lower than when it is valued alone (Loomis, Lockwood, & DeLacy, 1993; Brown, Barro, Manfredo, & Peterson, 1995).

x. Warm Glow / Moral satisfaction

When respondents are asked to state their maximum WTP for a given programme, the stated values may not be based entirely on the demand for the goods and services delivered by the program as assumed in the survey. Respondents instead may feel good about contributing to a worthy cause; i.e. respondents may derive satisfaction from giving per se (Andreoni, 1989; Arrow *et al.*, 1993).

xi. Scope

Responses may not always be sensitive to the quantity and quality of the proposed change (Diamond & Hausman, 1994; Ready, Berger, & Blomquist, 1997). In a study by Boyle *et al*. (1994), respondents' mean WTP to avoid the loss of 2000, 20000 and 200000 migratory birds was found not to differ significantly. Arrow *et al*. (1993) suggest that studies finding such insensitivity to scope may be defective in that the choices may not have been clearly presented to the respondents so that they view the alternatives as being essentially the same. Scope sensitivity may be tested for, ex-post, by estimating a value function from the CV data and assuring that it has a positive slope – indicating sensitivity to the scope of the change (Ready, Berger, & Blomquist, 1997).

xii. Free Ridding

Respondents may find it in their best interest to state zero values if they suspect that the commitment is binding and expect others to commit so that the programme is implemented (Mitchell & Carson, 1989). Once the service or good is available they will not be excluded from consuming it.

xiii. Zero protest bids

Zero protest bids have been treated differently in contingent valuation studies as the majority of researchers discard them (Bennett *et al.*, 1998; Bowker & Didychuk, 1994; Colombo, Calatrava-Requena, & Hanley, 2006) while others include these as genuine zeros in the analysis (Jorgensen & Syme, 2000; Bateman *et al*., 2006a). Those who discard protest bids specifically test for these in their surveys through a follow up question on zero bids to determine if the individual is in fact protesting or not.

xiv. Outliers or extreme tails

Carson, Wilks, and Imber (1994) state that, in the binary discrete choice and double bounded discrete choice methods, extreme values are avoided. Where an open ended question is posed, respondents may state high values where they know that their responses are not binding

xv. Mean or median estimates. Where sample data is normally distributed, the mean and median may coincide or be very close to each other so that selecting either does not influence the end result. However where the sample is skewed to one side or the distribution has fat tail(s), the mean and median will take on significantly different values. In these cases the median is the preferred measure of central tendency (Hanemann, 1984) as it gives the value that applies to at least 50% of the sample. In a study by Streever *et al*. (1998) the median was selected as the more appropriate measure of central tendency since the sample WTP distribution was skewed to the right. The median gave more conservative results than the mean as the mean was higher than the median.

xvi. Inequivalance between WTA and WTP for the same environmental change. A detailed discussion of this issue was presented in Chapter 2.

xvii. Self-selection bias or non-response bias. The decision to respond to a survey questionnaire depends on the importance, or lack of it, the respondent attaches to the service, good or resource being valued. Individuals who value the service, good or resource highly are most likely to respond as opposed to those individuals who value the good less. The majority of the responses may therefore reflect a high valuation from a particular stratum of the population. Applying estimates from such survey responses to obtain aggregate values over the entire population may result in serious overestimates of value (Bateman *et al*., 2000a).

3.3.4.1 Suggested Solutions to Some of the Problems Associated with the CVM

Table 3.1 provides a summary of suggested solutions to some of the problems associated with the CVM. The objective of these solutions was to make the results of CVM more acceptable buy resolving some of the major areas of contention.

Table 3.1 Summary of problems and suggested solutions

Study	Problem	Suggested Solution or Action
Bishop and Heberlein (1979)	Strategic bias Non-response bias Extreme values	Use of referendum contingent valuation format. This method is recommended by NOAA (1993); Mitchell & Carson (1989).
Schulze *et al*. (1981)	Strategic bias	A review of six studies revealed that strategic bias is not likely to be a major problem. Suggest an ex-ante visual inspection of the frequency distribution of the WTP responses to find out if a bi-modal clustering of values at abnormally high and/or low levels exists.
Mitchell and Carson (1981, 1984 as cited in Mitchell & Carson, 1989)	Starting point bias	Used anchored payment cards and tested their results for the effects of anchoring on final bids and found no evidence of any influence.[9]
Walsh *et al*. (1984)	Self-selection or non-response bias	Urging all to respond. Financial incentive may be used to motivate responses.
Stevens *et al*. (1991, p. 393)	Free rider effects	The use of a payment vehicle “such as taxes, which exact payment from everyone” reduces free riding.
Carson, Wilks & Imber (1994)	Extreme values (outliers)	In the binary discrete choice and double bounded discrete choice methods, extreme values are avoided.
NOAA (1994, 1996)	Hypothetical bias	Blue ribbon panel recommended that hypothetical bids be deflated using a ‘divide by 2’ rule unless these bids can be calibrated using actual market data.

[9] Boyle and Bishop (1988) cite a study by Randall, Hoehn and Tolley (1981) which found that anchored payment cards generated fewer protest bids than did the other questioning formats. They also found evidence of strong influence of anchors on the final bids.

Carson, Wilks, and Imber (1994)	Strategic bias	Used double bounded, discrete-choice elicitation format and argued that it gives respondents little opportunity to bias their answers.
Ready, Berger, and Blomquist (1997)	Scope and non-zero intercept	Estimated a flexible value function from contingent valuation data that allowed for statistical test for positive slope and for non-zero intercept.
Streever *et al*. (1998)	Starting point bias	Used a range of randomly generated starting bids (seed values) to prevent any systematic bias upwards or downwards.
List and Shogren (1998)	Hypothetical bias	Estimated a calibration function to correct for the exaggeration in the WTP (calibrated the welfare estimates ex post).
Cummings and Taylor (1999); List (2001); Harrison and Rutström. (1999)	Hypothetical bias	Advocated the use of "cheap talk" to mitigate ex ante the effects of hypothetical bias in CVM.
Bateman *et al*. (2000a)	Self-selection or non-response bias.	Aggregate benefits should only be obtained by scaling the sample estimates over the proportion of the population that reflects this selection bias. For example statistics may be available on household usage or visitation to a site.

3.3.5 The CVM Debate

In 1992 the Exxon Company commissioned a number of contingent valuation studies and organized a public seminar which heavily criticized the validity and reliability of the CVM (Bateman *et al.*, 1995). In response, the National Oceanic and Atmospheric Administration (NOAA) set up a "blue ribbon" panel, consisting of eminent persons in the social science field, co-chaired by Nobel Prize winners Kenneth Arrow and Robert Solow, to advise on the use of the CVM in natural resource damage assessments for oil spills. The panel endorsed the CVM and recommended guidelines[10] to be followed in contingent valuation studies to ensure that the results are reliable enough to be used as a starting point in a judicial or administrative determination of natural resource damage.

Diamond and Hausman (1994) and McFadden (1994) argue that estimates from CVM should be rejected on the basis of unreliability of responses to the hypothetical contingent valuation questions. However, proponents of the CVM argue that despite all the problems cited above, they believe that more recent and comprehensive studies based on new survey design techniques and test methods have already or soon will be able to deal with these objections (Schulze, d'Arge & Brookshire, 1981; Arrow *et al*., 1993 Bateman *et al*., 2002). Hanemann (1994) and Smith (1994) argue that most of the biases may be traced to inadequate survey design, while Mitchell and Carson (1989) contend that carefully designed contingent valuation studies may control for most of the biases.

Aadland and Caplan (2006), observe that the reliability and validity of information obtained from CVM has been the subject of lively debate by Diamond and Hausman (1994) and Hanemann (1994). Proponents of CVM have attempted to develop new methodologies that either: (1) mitigate ex ante any hypothetical bias (i.e., bias associated with the respondent miss-stating maximum willingness to pay (WTP) due to the hypothetical nature of the good and payment method) or; (2) calibrate the welfare estimates ex post (List & Shogren, 1998; Harrison & Rutstrom, 1999).

Haab and McConnell (2003) believe that the debate about the validity of value estimates obtained using the CVM is over, with the possible exception of its use in eliciting existence values. Despite the impossibility of validating contingent valuation results externally, the CVM and other stated preference methods remain the only methods currently capable of providing information on passive-use values. Cummings and Harrison (1995) accept the existence of non-use value but question the capability of the CVM to measure non-use values.

Studies investigating the temporal reliability of value estimates from contingent valuations have come up with mixed results. Reiling *et al*. (1990), Bateman and

[10] See Appendix 3 for complete list of NOAA guidelines.

Langford (1996), and Carson *et al.* (1997) found no sensitivity of the contingent valuation estimates to the timing of interviews, but Brouwer and Bateman (2005) found significant sensitivity of contingent valuation estimates to time. The Brouwer and Bateman's study involved a five year gap between the samples whilst the other two studies involved short time gaps which may explain the differences in the findings. For short time gaps the respondents may be conditioned by the first survey if the same sample is used while for long time gaps, socio-economic and demographic factors that influence WTP may change over time thereby influencing the results such as those of Brouwer and Bateman (2005).

3.3.6 Validity and Reliability of Contingent Valuation Estimates

Early attempts to validate the contingent valuation method may be classified into two categories (Kealy, Dovidio, & Rockel, 1988; O'Conor *et al*., 1999): (1) comparison of value estimates obtained using the CVM with those from indirect methods (convergent validity) such as TCM and HPM (Bishop & Heberlein, 1979; Thayer, 1981; Brookshire *et al*., 1982; Seller, Stoll, & Chavas, 1985; Smith, Desvousges, & Fisher, 1986), and (2) those from simulated markets (Bohm, 1972; Bishop, Heberlein, & Kealy, 1983). Bohm (1972) and Bishop and Heberlein (1979) compared estimates from the CVM to real payments for quasi-private goods such as television-viewing and hunting permits respectively.

Bjornstad and Kahn (1996, as cited by Madureira, Rambonilaza, & Karpinski, 2007) suggest that an ideal test to establish the validity of stated preference (SP) estimates would be to compare these estimates to a standard obtained with the revealed preference (RP) methods. One way of doing this is testing convergent validity between estimates from SP and RP methods (see Appendix 1). However this is limited to use value only (Madureira, Rambonilaza, & Karpinski, 2007) because RP methods do not measure non-use values. Convergent validity can be tested when different valuation methods are applied to value the same object. Carson *et al*. (1996) evaluate the convergent validity of RP methods and CVM for more than 616 estimate comparisons from 83 studies, and their tests provide support for the convergence validity hypothesis. They also find that estimates from SP methods are generally smaller than those obtained from RP methods for the same good. Results from a study by Bishop, Heberlein, and Kealy (1983), involving the estimation of the value of goose hunting permits from several contingent valuation formats and a travel cost model, show that contingent values could easily be in error by as much as 50% or more. Brookshire *et al.* (1982) show that CVM and Hedonic models yield similar magnitudes for WTP for improved air quality in Los Angeles.

Diamond and Hausman (1994) suggest that the internal validity of the CVM may be tested by comparing the WTP functions estimated with the contingent valuation surveys with specific, observable properties that economic theory implies WTP should follow. For example, economic theory predicts that WTP estimates should be responsive to the amount or scope of the environmental amenity being offered, and that, for an improvement in environmental quality, the bid level should have an inverse relationship with the probability of accepting the bid. Smith and Osborne (1996) tested contingent valuation estimates of WTP for visibility improvement from five different studies in the US and concluded that the estimates had a positive and statistically significant relationship with percentage improvement in visibility range.

Carson *et al*. (2001) argue that, for contingent valuation estimates to be valid and reliable the good to be valued must be clearly explained, its delivery to the public made plausible, and a realistic expectation of payment must be created.

3.3.7 WTP and WTA Inequivalance in Contingent Valuation Studies

Contingent valuation researchers have avoided asking WTA questions primarily because of problems with protesting, strategic over-bidding and inequivalance between WTA and WTP for the same environmental change (Mitchell & Carson, 1989). For example, Knetsch and Sinden (1984), and Anderson, Vadnjal, and Uhlin (2000) found that WTA measures yield considerably higher values than those obtained from WTP. These empirical findings conflict with conventional economic theory which states that WTP and WTA measures should be equivalent as long as income and wealth effects are small (Willig, 1976; Randall & Stoll, 1980; Freeman III, 2003). As a consequence of these unresolved issues the influential NOAA blue ribbon panel report recommends the use of WTP questions only as a conservative estimate of welfare loss (Arrow *et al.*, 1993). However, as noted by Brown and Gregory (1999), the use of WTP for environmental losses is, in fact, incorrect and may well underestimate the environmental costs of a project, especially when the good to be valued is unique and not substitutable or when it is an important component of the respondents' endowment. Since the choice of welfare measure depends on respondents' perceived property rights, an important task of CV researchers should be to investigate the perceived entitlement structures, as these do not always coincide with the legal situation (Mitchell & Carson, 1989).

Respondents may provide higher minimum WTA values because they reject the property rights implied by the willingness-to-accept format (Mitchell & Carson, 1989). A second explanation for the high minimum WTA values is irreversibility of preference, so-called 'endowment effects' or 'loss aversion' (Kahneman & Tversky, 1979; Knetsch, 1989; Kahneman, Knetsch, & Thaler, 1990; Tversky & Kahneman, 1992). People ask for more compensation when losing goods than they are willing to pay to obtain them. This is because people are attached to goods once they have ownership or become familiar with how to use the goods (Stigler & Becker, 1977). Knetsch (1989, 2007) says that the evaluation varies depending on our reference point in judging gains and losses. Theoretical work in Hanemann (1991) reveals that the lack of substitutes and larger income elasticity creates a larger disparity between maximum WTP and minimum WTA.

3.3.8 Justification for the Continued Use of the CVM

Bishop, Heberlein, and Kealy (1983) state that the CVM has gained credibility from comparisons with estimates from TC models, costs and prices of substitutes, and property values. Ready, Berger, and Blomquist (1997) found a 12% difference between WTP estimates from CVM and HPM for the same loss of one farm and attributed this difference to the non-use benefits that may be captured in CVM estimates but not in HPM estimates. Statistical tests revealed that the difference between the two estimates was not statistically significant and may be due to random error. Comparisons of estimates obtained from CVM with those obtained from RP methods are problematic in that contingent valuation estimates may capture non-use value which is not captured by RP methods so that even where convergent validity is not achieved, the CVM may not be dismissed altogether as unreliable.

3.3.9 Milestones in the Development of the CVM

i. Ciriacy-Wantrup (1947) suggested that it would be possible to estimate the value of non-market goods and services by asking individuals to state their willingness to pay.

ii. Davis (1963) carried out the first CV survey (bidding game) to estimate the benefits of outdoor recreation in the Maine.

iii. Hammack and Brown (1974) study was the first to report both WTP and WTA values from a CV survey.

iv. Randall, Ives and Eastman (1974) introduced the bidding game CV format to measure air visibility establishing the CVM as the only known method capable of measuring passive-use values.

v. Bishop and Heberlein (1979) introduced the referendum CV format in an effort to avoid biases associated with the open-ended format.

vi. Hanemann (1984) developed a model for calculating the mean and median from binary WTP response data. He developed a utility difference model, for dichotomous choice data, consistent with utility maximisation theory and illustrated how the compensating and equivalent surplus should be derived from the fitted model. The model allows for the specification of the indirect utility function.

vii. Mitchell and Carson (1981 and 1984) introduced the payment card.

viii. Seller Stoll and Chavas (1985) compare TC and CVM estimated and pointed out that the TCM estimates the Marshallian consumer surplus whereas the CVM estimates the Hicksian equivalent measure. This may partly explain the differences in value of the same amenity obtained from the two methods.

ix. Exxon Company organised public workshops ‘Cambridge Economics, 1993’ to challenge the validity and reliability of the CVM in assessing the lost passive-use value from the Exxon-Valdez oil spill. NOAA responded by setting up a blue ribbon panel to investigate the validity and reliability of the CVM in measuring lost passive-use value.

x. Arrow *et al.* (1993) endorse the validity of the CVM as an acceptable method of assessing environmental damages and issue the NOAA guidelines on contingent valuation studies.

3.4 The Travel Cost Method (TCM)

3.4.1 The Travel Cost Model

The travel cost method is one of the oldest non-market valuation techniques used to value environmental goods and services (English & Bowker, 1996) and has been used extensively in the valuation of recreational sites (Seller, Stoll, & Chavas, 1985; Smith, Desvousges, & Fisher, 1986). The original theoretical foundation of the Travel Cost Method is attributed to Hottelling's (1947) suggestion, in a two-page letter to the US National Park Service, that the benefits from outdoor recreation sites could be estimated by calculating individual recreationists' cost of travel to the site (Smith, 1989; Kahn, 2005; Yao & Kaval, 2007). Hottelling's theory was first applied in TCM studies involving water-based recreation by Trice and Wood (1958), and Clawson (1959).

The TC technique involves using travel cost as a proxy for the price of visiting outdoor recreational sites (Trice and Wood, 1958; Perman *et al.*, 2003). The rational is that, a recreationist undertakes a visit to a recreational site if the recreational benefits or utility from such a visit is at least equal to the cost of the visit to that site i.e. marginal benefit is at least equal to marginal cost. Travel cost is therefore used as a proxy for the price of the recreational experience on the visit since most recreational sites have zero (or nominal) entry fees (Smith, Desvousges, & Fisher, 1986). In this case, the cost (associated with the trip) incurred in the private goods and services market is used to infer the per-trip value (WTP) for the site visited. The visit to the site is treated as a single transaction and travel cost as the price for that transaction (Wilson & Carpenter, 1999) just like what happens in a market for a private good. When travel costs to a site change, economic theory predicts that individuals or households respond to this change by either increasing (for a reduction in travel cost or entrance fees) or reducing (for an increase in travel cost or entrance fees) the number of trips to the site until the marginal value of the last trip is just equal to travel cost.[11] A statistical relationship (trip generating function - TGF) between the observed visits and the cost of visiting is derived and used as a surrogate demand curve from which consumers' surplus per visit-day can be measured by integrating under this curve (Ribaudo & Epp, 1984; Bowker,

[11] This follows from the assumption of a rational economic agent and constrained optimization (utility maximization).

English, & Donovan, 1996).

Data on distances travelled to site, mode of transport, travel time, costs directly related to the trip; socio-economic and demographic factors such as household income, age and education; site characteristics; and individual attitudes towards the environment may be collected through carefully designed questionnaires (Champ, Boyle & Brown, 2003). The most popular method of collecting this data is through on-site surveys where a random sample of site users is taken and the questionnaire administered through personal interviews or the individuals may be allowed to take the questionnaire away for completion later. On-site sampling introduces endogenous stratification, truncation, and over-dispersion in travel cost analysis (Shaw, 1988; Smith, 1989; Martinez-Espineira & Amoako-Tuffour, 2005). These concepts will be defined later.

The TC technique assumes weak complementarity between the non-market good or service and consumption expenditure on a complementary market good (Ribaudo & Epp, 1984; Perman *et al*., 2003). This implies that, when consumption expenditure on the market good is zero, the marginal utility of the non-market good or service is also zero (Cocheba & Langford, 1978; Bouwes & Schneider, 1979). Cocheba and Langford assert that the TCM is only useful for measuring consumers' surplus when the theoretically correct welfare measure is the Hicksian compensating variation or WTP. Seller, Stoll, and Chavas (1985) correctly point out that the TCM provides estimates of the Marshallian consumer surplus. If the correct welfare measure is the Hicksian equivalent variation or willingness to sell (WTA), the TCM would yield underestimates of value (Hammack & Brown, 1974 as cited by Cocheba & Langford, 1978 p. 494).

Since the Travel Cost Method is based on ex-post travel cost, it cannot be used to estimate values where very little or no travel cost is involved, implying that it cannot be used to estimate non-use values (Krutilla, 1967; Smith, 1989) such as option, existence and bequest values. The value of a recreational activity at a particular site is produced by a set of attributes associated with the site. For example the value of a recreational experience of an individual at the site may depend on a combination of scenic beauty, air quality, diversity of wildlife and fauna. The basic TCM may not effectively isolate the value of, say, wildlife from the value of the other inputs which are combined to produce the recreational experience (Cocheba & Langford, 1978). In other words the basic TCM is unable to isolate the value of an ecosystem service from the ecosystem functions and other services. However advanced models of the TCM are now able to isolate and measure the importance of individual site attributes in terms of site choice (Smith 1989).

The travel cost method has been used to estimate non-market values of goods and services of a number of ecosystems. For example, Everitt (1983) used the TCM to estimate the value of recreational benefits of a forest ecosystem - the Coromandel State Forest Park in New Zealand. Smith, Desvousges and Fisher (1986) estimated the value of recreational benefits from increased water quality of a freshwater ecosystem. Wilson and Carpenter (1999) reviewed TCM valuation studies of fresh water ecosystem services in the US during the period 1971 and 1997 and observed that the studies focused on recreation demand as a proxy for non-market demand for water quality or water level of lakes, reservoirs and rivers.

3.4.2 Theoretical Illustration of Welfare Changes Associated with an Environmental Quality Improvement

The diagram below illustrates the effect of an improvement in environmental quality on an individual recreationist's welfare.

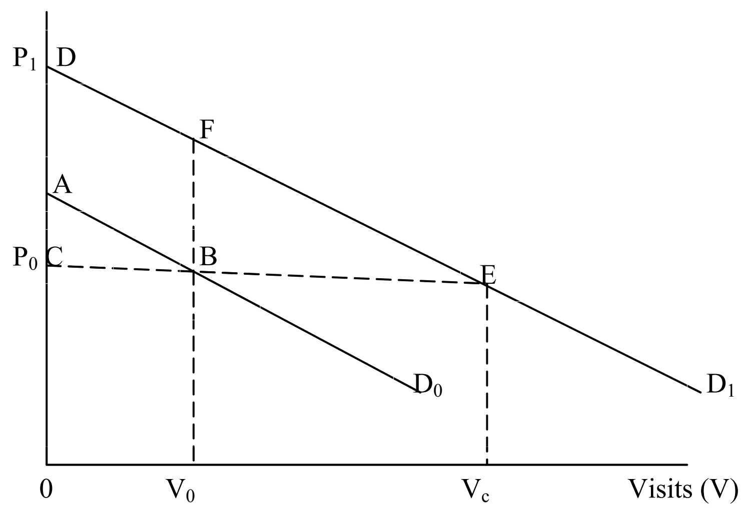

Figure 3.6 Welfare benefits associated with an environmental quality improvement

Source: Bouwes & Schneider (1979)

Suppose that, in the diagram above, D_0 represents an individual's income compensated demand curve for current recreation (visits) at a particular site and V is the number of visits per year or season. An improvement in the quality of the site will shift the demand curve outwards to D_1.[12] Site quality improvement enhances the recreational experience at the site. For example if angling is the recreational activity, improved water quality at the site will improve the bag rate at any given effort since improved water quality promotes larger numbers of fish at the site (Bouwes & Schneider, 1979). Therefore marginal utility per trip is assumed to increase (Bouwes & Schneider). At the original price (travel cost), the individual now visits the site more than before - his annual visits increase from V_0 to V_c. The area (BADE) bound by the two demand curves and the cost line (P_0) represents the individual's welfare gain (annual benefit) from the site quality improvement (Ribaudo and Epp, 1984; Smith, 1989; Perman *et al*., 2003; Kahn, 2005). BADE is the CV[13] associated with an increase in consumption from V_0 to V_c due to the shift in the compensated demand curve**.** The individual could pay an amount up to BADE dollars (WTP) for the improvement in site quality before becoming indifferent between paying this extra amount, to obtain the improvement, and status quo which does not involve paying any extra amount. The area of triangle ABC representing the individual's original annual consumer surplus, corresponding to V_0 visits, price P_0, and demand curve D_0, is less than the new consumer surplus represented by the area of triangle DEC. DEC minus BADE equals ABC indicating that the change in the quality of the environmental entity at a cost equal to BADE does not leave the individual recreator worse off. If however, the individual is restricted to his original level of site visits V_0, the benefit from site quality improvement is reduced to BADF. The actual annual benefit to the recreator is between BADE and BADF (Bouwes & Schneider, 1979). BADE assumes that there are no substitute sites. With substitute sites the number of visits will be less than V_c and at least equal to V_0.

The above analysis covers current users only. Aggregating benefits across these users underestimates the total benefits of the environmental quality improvement as new

[12] Site quality or quantity is a parameter of the Hicksian demand function. Any change in site quality or quantity results in a shift in the Hicksian demand function (Perman *et al*., 2003)

[13] For an environmental improvement the appropriate measure is the CS (see Table 2.1). CV and CS are equal only when the environmental service is non-essential and weak complementarity exists between the consumption of the service and the level of environmental quality (Perman *et al*., 2003). Complementarity between consumption and environmental quality is weak if individuals who are not currently consuming the service do not care about the environmental quality improvement that affects this service as their utility is unaffected.

visitors attracted to the site for the first time and some former users returning to the site after the improvement are excluded in the above analysis (Ribaudo & Epp, 1984). The benefit (consumer surplus) from site quality improvement for such recreators is represented by the area bound by their individual demand curves and the cost (price) line. Their individual demand curves before the improvement lie below the current cost of a visit (Ribaudo & Epp).

3.4.3 The Value of Travel Time

The value of travel time has been a contentious element of the travel cost method as researchers' views differ on what value to attach to travel time. Cesario (1976) reported that an approximate measure of the value of leisure time is one-third the hourly wage rate. Some researchers have argued that the selection of one-third, one-half, one-quarter, two-thirds, three-quarters and full wage rates as a measure of the value of leisure time is arbitrary (Ribaudo & Epp, 1984; Smith, 1989; Champ, Boyle & Brown, 2003). According to Walsh, Loomis, and Gillman (1984), the US Water Resources Council (1979) guidelines recommended the use of US$3 per hour as the value of travel time. Champ, Boyle & Brown, (2003, p. 285) suggests that one-third and full hourly rates have been accepted in recreation literature as lower and upper bounds respectively "but neither is on firm footing." Farber and Costanza (1987) used variations which included the full wage, 0.6 and 0.3 full wage and obtained results that indicated sensitivity to the rate used to measure the value of travel time. However, a model specification using 10% of the hourly wage rate as a basis for the travel time cost estimation proved to be better than the others. Seller, Stoll, and Chavas (1985) used zero as the value of travel time because this value provided the best fit for their model, and argued that since most people visit recreational sites on weekends, their opportunity cost of time is nearly zero.

Results from a study by Bowker, English, and Donovan (1996) seem to suggest that the consumer surplus estimates from guided white-water rafting increased more than proportionally to wage fraction increases making the value estimates sensitive to the wage rate fraction used. Smith (1989) argues that using a fraction of the wage rate to estimate the value of travel time is not consistent with reality as some people are able to adjust their working hours while others work a fixed number of hours per given period and may not be able to adjust their working time. Furthermore, some recreationist may be on paid leave while others are on unpaid leave. For some recreationists the journey may be enjoyable and form part of the total recreational experience of the trip (Smith, 1989). In estimating the value of travel time these differences should be taken into account by incorporating appropriate questions in the questionnaire to collect the relevant information.

The basic TCM omits on-site time on the assumption that all recreators spend the same time per visit to a recreational site. In reality on-site time may vary across individuals. Omitting this information from the model may affect the parameter estimates. Another simplifying assumption of the basic TCM is that recreationists undertake single purpose trips. In the main recreationists incur travel costs for multiple purposes involving multiple site visits. The challenge for the researcher is to apportion the travel cost among the sites visited. One way of achieving this is to ask the respondents to state the number of days spent at each site or to rank the importance of the site and apportion the cost accordingly. If this information is not available the rule of thumb is to divide the travel cost equally between the sites visited.

3.4.4 Over-dispersion, Truncation and Endogenous Stratification in TCM

Onsite sampling introduces truncation and endogenous stratification. The onsite sample only includes individuals who have at least visited the site once and excludes non-users. There will be no zero visit observations in the sample as the sample is truncated at zero. Those who frequent the site most are likely to be sampled so that the sample contains individuals who have similar tastes or similar attitudes towards the site use (Shaw, 1988; Smith, 1989; Martinez-Espineira & Amoako-Tuffour, 2005). Data from onsite sampling often exhibit over-dispersion where the variance is greater than the mean because a few visitors make many trips and most make only a few (Haab & McConnell, 2003; Martinez-Espineira & Amoako-Tuffour, 2005).

The dependent variable in an individual travel cost model is a count calculated on the basis of the visits to the site and can therefore only take on values that are non-negative integers (Shaw, 1988). Englin and Shonkwiler (1995) developed and empirically applied a truncated, endogenously stratified negative binomial model to take into account these problems.

3.4.5 Travel Cost Models

Literature identifies four main variants of the travel cost model based on the conventional theory underlying the travel cost demand model (Smith, 1989; Haab & McConnell, 2003). These are described briefly below.

3.4.5.1 The Individual Travel Cost Demand Model (ITCM)

The individual TC demand model is the simplest and may be specified as follows (Bowker, English, & Donovan, 1996):

$TRIPS_i = f(TCOST_i, INC_i, SUB_i, OTH_i) + u_i$

Where; $TRIPS_i$ is the number of trips undertaken by the i^{th} individual

$TCOST_i$ is the travel cost

INC_i is the budget constraint (income)

SUB_i is the price of alternative sites

OTH_i is a vector of other socio-economic and site attributes

u_i is the random error term

The model estimates the number of trips a typical individual with a given set of characteristics would undertake to the site at different levels of travel cost. A number of functional forms (e.g. linear, semi-log double log, quadratic) of the model have been used to estimate the individual's consumer surplus or access value (Ziemer, Musser, & Hill, 1980; Farber & Costanza, 1987; Adamowicz, Fletcher, & Graham-Tomasi, 1989; Champ, Boyle, & Brown, 2003) depending on researcher's preferences and how the data fits the model.

3.4.5.2 The Zonal Travel Cost Method (ZTCM)

The ZTCM uses macro data (average zonal data on income, age, distance, substitutes, etc.) instead of micro data used in the ITCM (Bowker, English, & Donovan, 1996). It divides the origins of recreationists into zones on the basis of a number of criteria such as countries, counties, provinces, towns/cities, or concentric rings drawn with the site as the central point (Smith, 1989; Haab & McConnell, 2003; Perman *et al*., 2003; Chen *et* *al*., 2004). Individuals from the same zone are assumed to have the same characteristics (Smith, 1989; Haab & McConnell, 2003) and face the same travel cost and therefore respond to changes in travel cost or entrance fees in the same way. The dependent variable is estimated as a visitation rate per 1000 population of each zone (Perman *et al., 2003*; Chen *et al., 2004*). The visitation rates are scaled up by the zonal population and summed across all the zones to obtain the site's demand curve (total visits to the site at different levels of travel cost) (Smith, 1989; Bowker, English, & Donovan, 1996; Perman *et al*., 2003). Since the ZTCM uses aggregate data it is statistically less efficient than the ITCM but less costly to implement (English & Bowker, 1996).

3.4.5.3 The Hedonic Travel Cost Method (HTCM)

The HTCM models the behaviour of recreationists in terms of their WTP for individual characteristics of outdoor recreational sites (Haab & McConnell, 2003). The technique involves regressing travel costs on "the bundles of characteristics associated with each of several potential destination sites" (Brown & Mendelsohn, 1984, p. 427) to estimate the prices of recreation attributes. The coefficients from this regression may be interpreted as representing the change (increase) in travel cost which the recreationist is prepared to pay for a unit change in the attribute under the ceteris paribus condition (Brown & Mendelsohn, 1984).

3.4.5.4 The Random Utility Model (RUM)

The RUM describes the probability that an individual will choose any one of the available sites for a particular trip (Smith, 1989; Haab & McConnell, 2003; Champ *et al*, 2003) The specification of the model assumes the probability of choosing a particular site in comparison with another depends on the attribute and prices of these alternatives and not on the other available alternatives [independence of irrelevant alternatives (IIA)] (Smith, 1989).

3.4.6 Advantages and Disadvantages of the TCM

The main advantage of the TCM is that it is based on revealed preferences (observable data from actual behaviour and choices) and is relatively inexpensive especially where the zonal method is used and data can be collected from official sources. This advantage has been recognised in valuation literature especially where the validation of the CVM has been tested against estimates from the TCM and HPM (Bishop & Heberlein, 1979; Thayer, 1981; Brookshire *et al*., 1982; Seller, Stoll, & Chavas, 1985; Smith, Desvousges, & Fisher, 1986; Sanders, Walsh, & McKean, 1991).

The TCM works best when visitors travel from a wide range of distances to the site so that there is considerable variability in terms of travel cost (Dwyer, Kelly, and Bowes, 1977 as cited by Seller, Stoll, and Chavas, 1985; Smith, 1989). However, problems exist involving the proper allocation of costs between the activities where visitors undertake multiple purpose trips and/or where they enjoy a scenic drive to the site (Seller, Stoll, and Chavas, 1985). This is not an issue where individual recreationists visit only one site during their trip.

The application of the TCM is limited to use values (Bowker, English & Donovan, 1996). Onsite sampling only covers site users so that the value estimates from TCM do not include non-user value of the site.

Although the TCM is directly linked to actual behaviour, some ‘art’ is still required to manipulate the revealed information on trips and costs into consumer surplus (Smith, 1989). The TCM may be of limited use in providing information for ex-ante policy analysis.

3.4.6.1 Advantages of ITCM over the ZTCM

i. Statistical efficiency
ii. Theoretical consistency in modelling individual behaviour
iii. Avoidance of arbitrary zone definitions, and
iv. Increased heterogeneity among populations within zones.

3.4.6.2 Why the TCM is Not Suitable for the Case Study

The restoration and preservation of the Pekapeka Swamp is an example of an environmental quality improvement. The welfare benefits of this environmental quality improvement may not be estimated using the TCM as illustrated in section 3.42. The travel cost method is not appropriate for the estimation of WTP for the restoration and preservation of the Pekapeka Swamp for two reasons. Firstly, the WTP value estimate for the restoration and preservation of the Pekapeka Swamp includes non-use value which the TCM cannot measure as pointed out earlier. Secondly, The Pekapeka Swamp is currently in a state of degradation, offers very little recreational opportunity, and there are hardly any visitors at the site at any given point in time so that on-site sampling is not possible. Off-site sampling may not be appropriate as most respondents would express zero visitations. An alternative methodology is therefore required for the case study.

3.5 Hedonic Pricing Method (HPM)

The HPM is "based on the hedonic hypothesis that goods are valued for their utility-bearing attributes or characteristics" (Rosen, 1974, p. 34). This assumes that consumers view commodities as bundles of attributes and are willing to pay prices that take into account the combined benefits that may be derived from the individual attributes. For example, the range of prices which people are prepared to pay for different houses depends on a number of factors (attributes of the house) such as, size and number of bedrooms, acreage, design and quality of construction, and location (Rosen, 1974; Palmquist, 1988; Champ *et al.*, 2003; Kahn, 2005). People are prepared to pay more for a house located in a healthy environment than a similar house located in a polluted environment. The premium paid on the house located in a healthy environment reflects the value of environmental quality capitalized in the price of the house (Freeman III, 2003).

The HPM employs statistics to estimate the implicit price or hedonic price of the individual attributes by regressing the observed prices of differentiated goods against the attributes of the good (Rosen, 1974; Wilson & Carpenter, 1999). Since the HPM is based on revealed preferences it avoids the criticisms associated with stated preference methods. Data required for the analysis may be readily available from official sources at relatively low cost.

3.6 Choice Modelling (CM) or Attribute Based Valuation Methods (ABVM)

Choice Modelling or Attribute Based Valuation Method (ABVM) is a family of stated preference methods (Conjoint Analysis and Choice Analysis) (Hanley, Mourato, & Wright, 2001). Like the CVM, CM relies on survey questionnaires for data collection and elicitation of preferences. The ABVMs value several attributes (or treatments levels) of a good or several goods simultaneously (Brey, Riera, & Mogas, 2007; Hensher, Rose, & Greene, 2005). Conjoint Analysis involves respondents rating or ranking each of the treatment combinations consisting of different levels of different attributes and predetermined price levels (Hanley, Mourato, & Wright, 2001), while Choice Analysis involves respondents making specific choices between alternatives with different levels of the same attributes or with different attributes (Hensher, Rose, & Greene, 2005). Kahn, (2005) contends that Conjoint Analysis may be viewed as a HPM where hypothetical prices take the place of market prices. Analysis of the data provides estimates of implicit prices of key attributes.

Hanley, Mourato, & Wright, (2001) list four main choice modelling alternatives described in the Table 3.2 below. They cast doubt on the ability of Contingent Rating and Paired Comparisons in providing estimates that are consistent with welfare.

Table 3.2 Main Choice Modelling Alternatives

Approach	Tasks	Welfare Consistent Estimates?
Choice Experiments	Choose between two or more alternatives (where one of the alternatives is the status quo)	Yes
Contingent Ranking	Rank a series of alternatives	Depends
Contingent Rating	Score alternative Scenarios on a scale of 1 - 10	Doubtful
Paired Comparisons	Score pairs of scenarios on similar scale	Doubtful

Source: Hanley, Mourato, & Wright (2001)

3.7 Benefits Transfer (BT)

Benefits Transfer is a methodology that uses available information from existing non-market valuation studies to generate value estimates for valuation problems at hand. For example information from a valuation study of wetland recreation in Australia may be used to generate value estimates for a similar wetland in New Zealand by directly applying the unit value (either adjusted or unadjusted) from the Australian study to the policy site in New Zealand, or by transferring a value function (WTP function) where site specific variables are used to estimate a value for the policy site (Bateman *et al*., 2000b; Bateman *et al*., 2002; Champ, Boyle, & Brown, 2003; Freeman III, 2003).

The main appeal of this method is that it can reduce both the time and resources needed to develop original value estimates for the policy site (Bateman *et al*., 2002). These estimates may be used to evaluate the attractiveness of potential public policies, to assess the value of policies implemented in the past, and to identify the compensation required where for example toxic substances such as oil are released to the environment (Desvousges, Dunford, & Mathews, 1992). However, the process of benefits transfer is complex and more research is needed to evaluate the extent to which these estimates are transferable across societies where preferences, constraints, and institutions differ (Bateman *et al*., 2000b; Champ, Boyle, & Brown, 2003). Furthermore, a number of problems associated with BT have been highlighted such as, finding good quality studies of similar situations; potential for characteristics to change over space and time; no new impacts are measured as we can only measure what the previous studies measured (Turner *et al*., 2003); and existence of substantial transfer errors (Brouwer, 1998; Bateman *et al*., 2000b).

3.8 Advantages and Disadvantages of Selected Valuation Methods

Table 3.3 summarises the main advantages and disadvantages of non-market valuation techniques discussed in this chapter.

Table 3.3 Advantages and disadvantages of selected valuation methods

Method	Advantages	Disadvantages
Contingent valuation method (CVM)	Ex ante technique: it can be used to measure the value of anything without need for observable behaviour (data). Until the mid 90s, when ABVMs were introduced, it was the only method available to measure existence or bequest values. Technique is not generally difficult to understand. Enables both ex-ante and ex-post valuation.	Since hypothetical, not actual market transactions or decisions are the focus of CVM, various sources of errors (i.e., incentives to misrepresent values, implied value cues, and scenario misrepresentation) may be introduced. Subject to various biases such as; interviewing bias, starting point bias, non-response bias, strategic bias, yea-saying, scope and embedding effects, payment vehicle bias, information bias. Expensive due to the need for thorough survey development and pre-testing. Concerns about reliability for calculating non-use values (particularly for such calculations to support natural resource damage assessments for use in litigation). Controversial, especially for non-use value applications.
Travel cost method (TCM)	Based on observable data from actual behaviour and choices. Relatively inexpensive.	Need for easily observable behaviour. Limited to in situ resource use situations including travel. Analysis is limited to the assessment of the current situation. Does not measure non-use values. Possible sample selection problems and other complications related to estimating consumer surplus.
Hedonic pricing method (HPM)	Based on observable and readily available data from actual behaviour and choices.	Difficulty in detecting small or insignificant effects of environmental-quality factors on

		housing prices. Connection between implicit prices and value measures is technically complex and sometimes empirically unobtainable. Ex-post valuation and does not measure non-use values.
Choice Modelling/Conjoint Analysis (CJ)/Choice Analysis (CA). *Choice experiment* *Contingent ranking* *Contingent rating* *Paired comparisons*	Can be used to measure the value of any environmental resource without need for observable behaviour (data), as well as the values of their multiple attributes. It can measure non-use values. Eliminates several biases of the CVM. Enables ex-ante and ex-post valuation.	Controversial for non-use value applications. Technique can be difficult to understand. Expensive due to the need for thorough survey development and pre-testing. Doubt as to whether Contingent ranking, Contingent rating, and Paired comparisons satisfy conditions of utility theory.
Benefits Transfer	Can be used for rapid assessments, less time required, relatively inexpensive.	Reliability depends on the quality of the primary studies. Cannot be applied to something new as it relies on estimates from previous studies.

Source: Adopted from Birol, Karousakis & Koundouri (2006).

CHAPTER 4

The Case Study: Pekapeka Swamp

4.1 Background

We want to estimate the economic value, to the Hawke's Bay community, of the restoration and preservation of Pekapeka Swamp using the CVM. The advantages and disadvantages of employing this technique and the reasons for its selection were discussed fully in Chapter 3. The task involves designing and implementing an appropriate survey questionnaire that will enable us to collect the necessary data required to compute a value estimate. In Chapter 2 we discussed in detail the disparity between WTP and WTA measures when used to provide estimates of the same underlying value. Before a contingent valuation methodology for the case study can be developed, we need to resolve two important issues, namely, (1) which of the two measures (WTP and WTA) should be use, and (2) should the services be evaluated individually and then aggregated to obtain a total value?

It is conceivable to estimate the restoration and preservation value of the swamp using WTP to secure the improvement or WTA compensation to forego the improvement. The underlying value to be estimated is the same but as discussed before, theory predicts these two estimates would be the same under certain conditions yet empirical evidence points otherwise. Based on empirical evidence of the disparity between these measures (see Knetsch & Sinden, 1984; Brown & Gregory, 1999; Anderson, Vadnjal, & Uhlin, 2000; Horowitz & McConnell, 2002), we expect the WTA estimate to be significantly higher than WTP. If actual compensation were to be paid out, we expect almost all households to express non-zero valuations as it would be in the best interest of each household to be paid something even if they do not care about the services provided by the swamp. This contrasts sharply with the WTP situation where a sizable number of households are expected to express genuine zero WTP values and those who express non-zero values do so under income constraints. The overall effect is that the WTA estimate would over-estimate the underlying value we are trying to measure. Bateman *et al*. (2000c) found that the median value estimates of WTA compensation had very large confidence intervals, and concluded that these value estimates were not credible. WTP will be used in this study as it provides a conservative lower bound of the value (Arrow *et al*., 1993) and the valuation question will be framed appropriately.

Valuing individual services and adding up the value estimates may result in double counting (Loomis *et al*., 2000). It may be difficult for individuals who enjoy a number of benefits from the same resource to attach specific values to each service. For example an individual who goes fishing at a swamp may also enjoy the aesthetic views whilst fishing so that an estimate of the value of fishing for this individual will include an element of aesthetic value of the swamp. If a separate aesthetic value of the swamp is estimated and added to the value estimate for fishing, the total will over-estimate the combined value of the two services. Loomis *et al*. (2000, p. 104) points that “there could be potentially more than double counting when adding up independently derived estimates of WTP, as substitution effects and budget constraints are often incompletely accounted for, leading to over-valuation even in absence of double counting.” To avoid this problem we elicit a total value for a set of ecosystem services that could potentially be provided by a fully functional wetland.

4.2 Case Study Site

Located adjacent to State Highway 2 (SH2) and Palmerston North - Gisborne railway, approximately 12 km south west of Hastings (see figure 4.1), the Pekapeka Swamp is a site of national and regional interest because of its ecosystem and its unique Maori cultural and social significance (HBRC, 1999). Pekapeka Swamp is 4.5km long, 0.8km wide at its widest point and covers 90.7ha. According to HBRC, it is the second most important wetland system and one of the few remaining swamps in the Hawke’s Bay region. The Department of Conservation (DoC) has identified Pekapeka Swamp as a Recommended Area for Protection (RAP) under the Heretaunga Ecological District, and ranks it as a high priority for restoration (HBRC, 1999). Historically, the site was an important source of livelihood for the local Maori before the arrival of the early settlers (HBRC, 1999).

Figure 4.1 Map showing the location of Pekapeka Swamp adjacent to SH2 (Source: Google Earth)

At the present time, Pekapeka Swamp is environmentally degraded due to commercial over-fishing, agricultural run-off from the surrounding farmlands, livestock grazing, drainage, dumping of waste materials, invasion and over-growth of the pussy and crack willows (HBRC, 1999, 2005). Biodiversity is endangered; fish, plant and bird species have been reduced dramatically. The site currently offers very limited recreational opportunities because of its degraded state, with duck shooting as the only significant local recreational activity (HBRC, 2005). The Pekapeka Swamp provides a classic example of the tragedy of the commons – a dilemma in which many rational individuals acting independently in their own self-interest can ultimately destroy a shared limited resource even when it is clear that it is not in anyone's long term interest for this to happen (Hardin, 1968).

A public programme by the Hawke's Bay Regional Council (HBRC) is currently under way to restore and preserve the environmental balance of the swamp through fencing out livestock, chemical and physical eradication of the invasive willows, replanting of native plant species, construction of a weir to ensure adequate water levels all year round without restricting the movement of fish up and down the stream, and management of activities to permit the system to regenerate itself with minimal negative impacts from the surrounding farming activities and public access (HBRC, 1999, 2005). According to the HBRC, a restored and protected Pekapeka Swamp would support increased plant, fish and bird species; and offer, to the local and regional community, increased recreational opportunities such as waterfowl hunting, fishing, camping, picnicking and walking.

Previous public policy seems to demonstrate failure to appreciate the full value of the beneficial functions provided by a fully functional wetland system by allowing the degradation and loss of Pekapeka Swamp to progress unchecked. It would appear that the acquisition of half the area of the swamp by the authorities in 1968 under the Public Works Act was primarily for soil conservation and river control purposes (HBRC, 1999) as; drainage, dumping and over-fishing were allowed to continue unabated after the acquisition. No particular action seems to have been taken at that time to preserve the integrity of the swamp as an ecosystem that generates goods and services that enhance the welfare of the community (HBRC, 1999; Kathy Webb in Hawke's Bay Today, 15.04.2006).

The Pekapeka Swamp Management Plan 1998 – 2003 and Pekapeka Wetland Management Plan 2005 – 2010 include budget estimates summarised in Tables 4.1 and 4.2 respectively. The total budget estimates for the two plan periods are NZ$843,278 and NZ$630,900 ± $25,000 respectively. Actual budget expenditure during the first plan period was NZ$518,000 with approximately 40.3% of this amount spent on willow control, 15.4% on land acquisition and fencing, and 17.2% on staff time. The average annual expenditure during the 1997/8 – 2003/4 period was NZ$64,750. No reasons are provided in the 2005 – 2010 plan, for under budget expenditure during the previous plan period but HBRC states that the process of protecting and rehabilitating the swamp during that period had not been cheap.

Table 4.1 1997/8 - 2003 Budget plan for the Restoration and preservation of Pekapeka

Year	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03
Estimated Cost ($)	116,589	112,660	53,900	194,057	232,623	133,440

Table 4.2 2005 – 2010 Budget plan for the Restoration and preservation of Pekapeka

Year	2005/06	2006/07	2007/08	2008/09	2009/10
Estimated Cost ($)	121,960	134,360	109,460	121,460	143,660

4.3 Ownership of Pekapeka Swamp

Since 1968, acquisition of land area near the swamp has seen the gradual transfer of land ownership from private hands to the HBRC. By the end of 1998, approximately 90.1ha had been purchased with most purchases occurring in 1998. In June 2004, the last parcel of land measuring 1.45ha was purchased bringing total ownership of the wetland under the HBRC (HBRC, 1999, 2004).

4.4 Landform

The swamp lies in a sediment filled depression "surrounded by ridges of Te Mata limestone ranging between 300 – 400 metres above sea level" (HBRC, 1999, p.3) (see Figure 4.2 below). The swamp has a total fall, from north to south, of 3.57m and lies at 20.2m above sea level. HBRC (1999) describe the typical soil type in the swamp as 250mm black peaty loam on a soft loamy peat. The area acts as a natural flood soak during heavy rain.

Figure 4.2 An aerial view of Pekapeka Swamp
Source: Google Earth

4.5 Rainfall and Vegetation

Pekapeka swamp lies within a region that experiences dry hot summers and fairly mild winters with varying annual rainfall. According to the National Institute of Water and Atmospheric Research (NIWA), the mean annual rainfall for the period 1971 - 2000, in the region where the swamp lies, ranged between 750 and 1000mm. The swamp usually suffers water shortages during summer/autumn months due to evaporation and low rainfall.

Eight main vegetation categories have been identified in past surveys (HBRC, 1999). These include willow, raupo, and small areas of sedges and rushes, grassland, and open water. The two dominant categories are willow (crack willow, pussy willow, and weeping willow) and raupo. Raupo is native and grows naturally in the swamp while the willow species (crack and pussy) are invasive and are considered pests. The weeping willow does not pose a threat to the swamp as it does not spread and provides habitat for wildlife. The crack and pussy willow varieties are targeted for eradication from the swamp.

4.6 Wildlife and Aquatic Life

Pekapeka Swamp is considered to be of local, regional and national wildlife significance. The swamp provides habitat to a variety of resident and migratory (native and exotic) bird species, some of which are extremely rare. For example, the swamp is believed to provide a breeding place for the Australasian Bittern which has become rare in Hawke’s Bay (HBRC, 1999). A few sightings of the Mash Crake have been made, and a number of Spotless Crake has been identified in the area. HBRC (1999) identified the following four main categories of wildfowl at the Pekapeka Swamp: (a) 7 game species which include Black Swan, Mallard, and Pheasant; (b) 17 unprotected species which include Rock Pigeon, Blackbird, and Feral Goose; (c) 17 fully protected species which include NZ Dabchick, Little Shag, and White-faced Heron; and (d) 2 partially protected species, Black Shag and Australian Harrier.

By providing a passage for fish up the Poukawa stream to Lake Poukawa, Pekapeka Swamp is an important part of the Poukawa fishery. The long finned eel, short finned eel and inanga used to be the dominant fish species before the swamp was degraded and over-fished HBRC, 1999).

4.7 Population of the Survey Region

According to the 2006 census statistics, Hawke's Bay has a multi ethnic population[14] of 144,783 consisting of the following ethnic groups: European (79.9%), Maori (23.5%), Pacific (3.7%), Asian (2.5%), and Other (0.4%). The proportion of Maori in Hawke's Bay is higher than that of New Zealand overall. Males (females) constitute 48.56% (51.44%) of the population and the average household size is 2.6. Unemployment rate stands at 4.6% and is lower than the national average of 5.1%. The median income for those aged 15 years and over is NZ$22600 per annum.

Napier city and Hastings district account for 85% of the population, with the balance distributed among smaller urban areas, rural service towns and rural villages. The majority of the population has access to the telephone and is serviced by an efficient postal system. The target survey population consisted of all households in the Hawke's Bay Region calling areas[15] since our sample was drawn from the white pages of the current 2007/08 Hawke's Bay telephone directory.

Figure 4.3 shows the age distribution of the population of Hawke's Bay compared to the national population. According to the 2006 census statistics, about 63% of the population in Hawke's Bay is aged between 15 and 64 years. This is an important age group as it provides a large pool of labour and Hawke's Bay is below national average. Figure 4.3 suggest that the age distribution of the Hawke's Bay population is slightly different from that of New Zealand as a whole with more older and younger people. About 72.5% of the population aged 15 years and above has at least a school qualification, but 27.5% have no qualifications compared to 22.4% for New Zealand. The large number of individuals aged 15 years and over with no qualifications has

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[14] Recent population estimates put the population of Hawke's Bay at about 152,700 (Ministry of Social Development: http://www.socialreport.msd.govt.nz/regional/r-councils/hawkes-bay.html#ethnicity-age. Accessed 04/07/09)

[15] The local calling areas are Wairoa, Napier/Hastings, Waipukurau, and Dannevirke. Dannevirke falls outside the Hawke's Bay Regional Council boundary but is included because of its proximity to the site. Residents of Dannevirke are closer to the site than residents of Wairoa and are expected to benefit from the restoration and preservation programme.

important implications for the contingent valuation survey design if non-response is to be minimised.

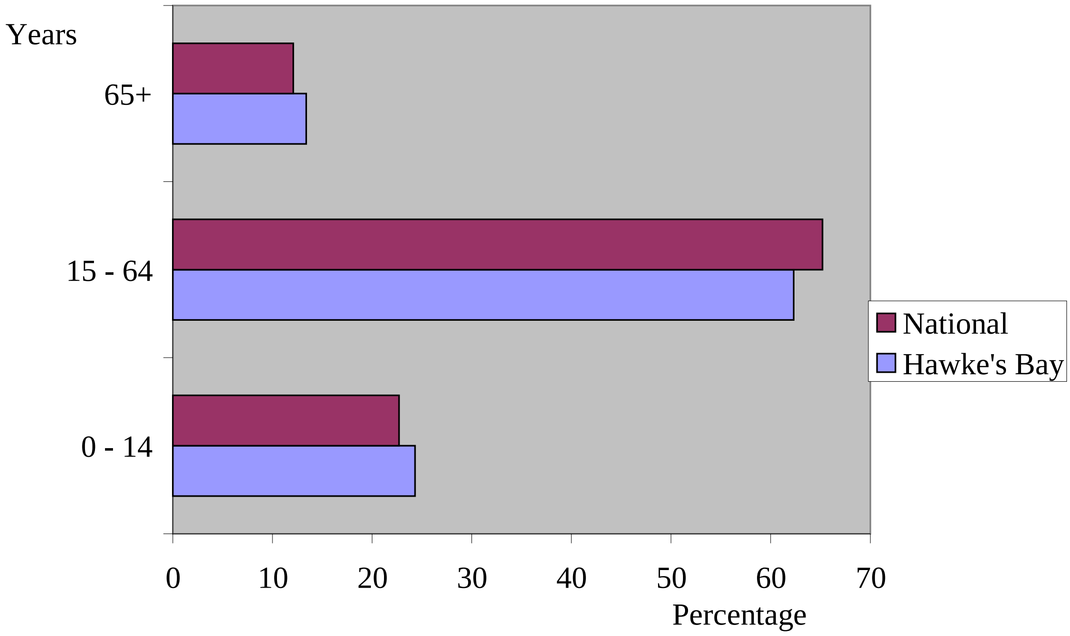

Figure 4.3 Age Distribution

4.8 Estimating the Total Economic Value of the Wetland

The survey questionnaire was be designed to mirror the long term objectives of the HBRC's restoration and preservation programme and capture an estimate of total value that is consistent with economic theory. The scenarios presented in the survey questionnaire (see Appendix 2.2b) attempt to depict as clearly as possible the alternatives to enable respondents to 'cast their votes' in a manner that reflects their true preferences.

A number of studies reviewed show that the CVM can be used to estimate total economic values of wetlands. Zhongmin *et al*. (2003), employing in-person interviews, applied the CVM (payment card format) in rural China to estimate the total economic value of restoring ecosystem services in the Ejina region and obtained a present value of aggregate WTP of 55.33 million RMB (US$6.67 million). The results demonstrate that households in the region place considerable value on Ejina ecosystem services. Wattage and Mardle (2007) estimated the total economic value of Sri Lankan coastal wetlands in the Muthurajawela Marsh and Negombo Lagoon (MMNL) area using the one-and-one-half bound (OOHB) CVM format and report an aggregate household WTP value of Rs.107,223,700 (US$ 1,072,237) per month for the conservation of MMNL.

Oglethorpe & Miliadou (2000) used the CVM (iterative bidding) to estimate the total economic value of Lake Kerkini in northern Greece and concluded that the sustainable management of the lake is justified on the basis of respondents' WTP. Respondents were willing to donate, on average, 6906.2 Gdr (£15.24) per person per year for the protection of the lake, generating an aggregate value of 12.8 billion Gdr (£28.3 million) per year. Loomis *et al*. (2000) applied a dichotomous choice CVM to estimate the total economic value of restoring ecosystem services in an impaired river basin. Results from this study put household mean WTP estimate at $21 ($252) per month (year) and aggregate annual value between $19 million and $70 million.

The results of these studies clearly indicate considerable total economic value for wetlands. It is hoped that the proper application of the CVM to the case study will produce results that demonstrate value for the Pekapeka Swamp that may be taken into account in future policy decisions concerning the restoration and preservation of the swamp.

CHAPTER 5

Methodology

5.1 Introduction

In this chapter, we develop a survey methodology to estimate a dollar value for the restoration and preservation of the Pekapeka Swamp, explore the potential use of the restored Pekapeka Swamp by households in the Hawke's Bay Region, and identify the socio-economic and demographic factors that influence household WTP. Literature on method selection and application, survey design, payment vehicle, sample size, socio-economic and demographic factors is discussed.

The research procedure adopted follows a sequence of clearly defined processes as indicated in the flow chart below. The objective of the survey, as clearly defined in the objectives of the case study, is to apply the CVM to estimate Hawke's Bay Region households' maximum WTP (WTP_{max}) for the restoration and preservation of Pekapeka Swamp. The selection and justification of the CVM format used in the survey is outlined in detail in the next section.

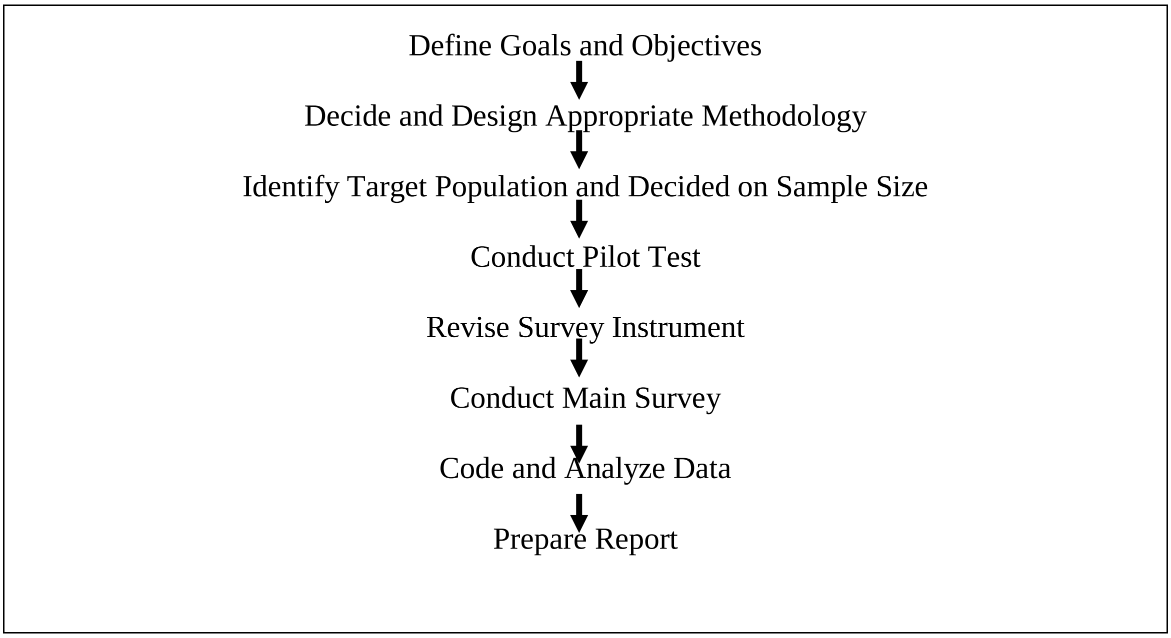

Figure 5.1 Flow chart showing the research process

5.2 CVM Survey Design

In Chapter 3, various non-market techniques were explored, compared, and their relative strengths and weaknesses were discussed as was their application suitability under different conditions. The contingent valuation method (CVM) was selected as the most appropriate approach for this study because, apart from Choice Analysis or Conjoint Analysis and their variants (which are more complex and more expensive to administer than the CVM), it is the only method that is capable of capturing total economic value which includes passive or non-use values such as bequest, existence, and option values (Bateman *et al*., 2002). In this section, a detailed discussion of the process of designing and implementing the CVM to the case study is presented.

5.2.1 Key Design Issues

The key design issues in this study include the selection of the elicitation method, contingent scenario, sample size, bid selection and sub-sample allocation, the type of payment vehicle and the period over which the payments will be collected, how the funds will be administered, selection of the relevant aggregation population, and administration of the survey instrument.

<u>a. Selection of the Elicitation Method and Sample Size</u>

The dichotomous choice format was selected because it is the recommended elicitation format by the National Oceanic and Atmospheric Administration (NOAA) "blue ribbon" panel (Arrow *et al*, 1993) who contend that this method is less stressful to the respondents; reduces strategic bias; and non-responses - a view also shared by Cameron (1988). Duffield and Patterson (1991) state that the dichotomous choice (DC) format is low cost (therefore feasible) as it can be administered through a mail survey, successfully elicits participation, and is free of starting bid bias. Further, the DC approach allows for analysis which is consistent with utility theory (Hanemann, 1984; Bowker & Stoll, 1988; Cameron, 1988). However, despite the appeal of the DC method in reducing or eliminating a number of biases such as interviewer bias (for mail surveys), stating point bias, and non-response bias, Cameron and Quiggin (1994) state that the method can be highly statistically inefficient in that large numbers of observations are required to map out the underlying distribution of resource values with any given degree of accuracy. Herriges and Shogren (1996) argue that the key disadvantage of the DC format is that the resulting survey responses reveal little about an individual's willingness to pay. The NOAA panel overcomes this problem by recommending a sample size of at least 1000. The Pekapeka Swamp case study adopts this recommendation.

Following Bishop and Heberlein (1979), the CVM survey for the Pekapeka Swamp employed a dichotomous choice format where the bid amount was systematically varied across the sample. The sample was divided into a number of sub-samples with each sub-sample receiving a different bid amount (Kristrom, 1990; Bennett, Morrison, & 1998; Brouwer & Bateman, 2005). Brouwer and Bateman (2005), and Bateman and Brouwer (2006) used as many as 15 and 11 bid amounts respectively in their surveys. The issue concerning the number of bid levels (number of sub-samples) and the bid levels will be discussed later. The dichotomous choice question was followed by an open-ended value question. Amirnejad *et al.* (2006) and O'Connor *et al*. (1999) used a dichotomous choice question followed by an open ended question which requires the respondents to give their perception on maximum WTP (WTPOE). Boyle and Bishop (1988); Seller, Stoll, and Chavas (1985); Smith, Desvousges, and Fisher (1986); and Stevens *et al*. (1991) used similar methods in their studies in which two elicitation methods were used on the same sample. This study adopts a similar framework. The information elicited through the open ended question, apart from providing an alternative value estimate of WTP, is also useful for later analysis dealing with range and anchoring effects. O'Connor *et al*. (1999) state that the anchoring effects in the open-ended follow-up WTP response take the form of starting point bias in which the open-ended values are affected by the bids offered. Literature acknowledges that question ordering may influence valuation (Bateman & Langford, 1996; Powe & Bateman, 2003) but in this case study it may be argued that it is irrelevant since the same amenity is being valued and the open ended question is merely a follow up to the dichotomous choice question, and only requires the respondent to pin point his 'exact' maximum WTP (Amirnejad *et al*., 2006).

Furthermore, the open ended question is employed to test the hypothesis that the dichotomous choice format is superior to the open-ended format[16] and also to test for construct validity[17] and consistency in the respondent's valuation of the good. For example a respondent may answer "no" to the dichotomous choice question when presented with a bid amount of, say, $10 yet under the open ended question he states a maximum willingness to pay of, say, $50. Such valuation is inconsistent with economic theory and will be excluded from the dataset used to estimate the model. The results of the open ended question will also be used to make inferences as to the existence of starting bid bias[18] in the dichotomous choice format. To check for starting point bias we will estimate the mean of the open-ended responses at each of the different DC bid levels and test for significant differences in the means, and regress WTPOE on the bid to yield an estimate of the marginal effect of the bid on the follow-up value (Mitchell & Carson, 1989; Green *et al*., 1998; O'Connor *et al*., 1999). The open ended question has been used in previous studies that have produced valid and reliable value estimates (Cicchetti & Smith, 1973; Hammack & Brown, 1974; Bishop & Heberlein, 1979; Walsh, Loomis & Gillman, 1984; Mitchell & Carson, 1986). For example, the open ended elicitation format used by Mitchell and Carson (1986) worked well because the respondents were familiar with the concept of paying for clean water through their water bills.

b. Method of Administering the Survey Instrument.

A dichotomous choice CVM may be administered using three different approaches; the mail questionnaire, telephone interviews, and personal interviews (Dillman, 1978; Mitchell & Carson, 1989). The personal interview approach is favoured where in-depth information gathering is involved and where the contingent scenario is complex and will require explanation by the interviewer. However, this approach is expensive especially where the population is scattered over a large geographical area such as the Hawke's Bay Region which covers an area of 21,399 km^2. Where the information required is less detailed and the interviewer does not have to explain details to the respondents, the telephone interview may be more appropriate especially with small

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[16] A comparison will be made of how well the data fits the models; the significance of the coefficients; whether they have the expected signs; and whether the parameter estimates are statistically different for the two models.
[17] Mean value estimates of WTP_{max} from the two elicitation methods will be compared and tested to see if they are significantly different.
[18] A simple correlation between the bid offered and the WTPOE value will provide preliminary information as to the existence starting bid bias.

target populations (Dillman, 1978). The advantage of the telephone and personal interviews is that they provide immediate responses to questions. The telephone interview approach was not appropriate for this study as detailed information on the contingent scenario which required maps and pictures needed to be conveyed to the respondents to enable them to respond appropriately to the valuation question.

For this study, the mail survey questionnaire was used as it was less costly and more appropriate than both the telephone and personal interview approaches. This approach provides fairly rapid responses and is detailed enough to provide the respondents with enough information to elicit value formulation. It is also convenient to the respondents as it allows adequate time for the respondents to think about their responses and complete the forms at their leisure.

c. Selection of the Relevant Aggregation Population

The selection of the relevant aggregation population (national or regional) for the estimation of the aggregate value depends on the status of the wetland i.e. whether the wetland is generally viewed as a local resource or as a resource of national character. Pate and Loomis (1997) argue that limiting the geographic extent of a public good to one political jurisdiction leads to underestimates of aggregate WTP. On the other hand, limiting the geographic extent of a public good to the immediate environs may result in higher average WTP per household as the effects of distance decay on WTP are minimised. For popular national sites, the distance decay effect on WTP is insignificant as reported by Schulze, Brookshire, and Thayer (1981). They reported that respondents from as far away as Chicago stated WTP values, for the preservation of visual air quality at the Grand Canyon, as high as those of respondents leaving in states close to the site.

The Pekapeka Swamp is not a resource of international or national significance. It is however, significant within the Hawke’s Bay Region. According to the Hawke’s Bay Regional Council (HBRC), it is the second most important wetland system in the region (HRBC, 1999, 2005). The target population for the study is therefore households in the Hawke’s Bay Region, as people in other regions in New Zealand may not have information about the existence of the wetland and are likely to express zero values or simple not respond to the survey. Sutherland and Walsh (1985) suggest an empirical estimation of the boundary where expected WTP values change from positive to zero. However, this can only be done ex-post the regression analysis of the responses. They further suggest that sample proportion should increase with the distance so that a reasonable number of responses are obtained from respondents who reside further and further away. The hypothesis behind the ‘negative WTP value-distance’ relationship is that respondents who reside far from the study site are likely to have less knowledge and information about the study site and are unlikely to have visited it before hence their lower WTP. This hypothesis will be tested in this study by including the distance (log of distance) as one of the independent variables in the model used to estimate WTP and examining the sign and significance of the coefficient on distance (log of distance). Google Earth will be used to estimate distances from the site to the respondents’ homes.

d. Contingent Scenario

The contingent scenario will provide a clear description of the good ‘wetland’ to be valued. The benefits derived from wetlands will be highlighted (aesthetic, recreation, and non-use values). Visual aids in the form of pictures will be used to represent both the status quo and the future with or without the restoration programme (see Appendix 2.2b). Respondents are likely to view the survey questionnaire as plausible and credible as it was designed to represent a possible and potential response or solution to the current problem of the wetland degradation (Haab & McConnell, 2003). Furthermore, the success of the current restoration programme should give respondents confidence that a similar programme can be a success. Strategic bias is unlikely to be a major problem as the survey will be cast as a hypothetical and academic exercise. Free-rider effects will be minimised by the provision that the programme would be implemented only if all people contribute to the special fund (Oglethorpe & Miliadou, 2000).

In this study, it can be argued that respondents are likely to be familiar with fully functional wetlands as there are many wetland areas in New Zealand that are protected by the Department of Conservation (DOC) under the Ramsar Accord. Three of New Zealand’s six internationally recognised wetlands, the Whangamarino, Kopuatai Peat Dome, and the Firth of Thames are located in the Waikato region of the north island and are within reasonable distance from Hawke’s Bay. Within the Hawke’s Bay region, wetland systems such as lakes Tutira, Poukawa, and Hamita, Ahuriri Estuary, Waitangi Estuary, and Poranga Estuary are available to the locals. A number of restoration efforts are currently under way in some wetlands throughout New Zealand. Therefore some respondents will have experience with both wetlands under restoration and fully functional ones. The hypothetical information provided within the context of the contingent market may be argued to be sufficiently close to the experiences of the individuals to allow them to provide realistic values. In addition, people in New Zealand are used to the funding of public projects at regional and national level through taxes and levies of some sort.

e. Selection of a Payment Vehicle

Payment vehicle bias will be mitigated by using a relatively neutral payment vehicle which is expected to minimise the incidence of zero responses as protests against the payment vehicle (Sutherland & Walsh, 1985; Oglethorpe & Miliadou, 2000). A familiar payment vehicle considered to reduce protest bids will be suggested to the respondents. A special levy collected via regular power bills seems to be a more neutral payment vehicle than rates and taxes as New Zealanders are currently reeling under a heavy tax burden and are expecting government to reduce taxes. An increase in rates or collecting the levy through an instrument associated with council may be met with resistance and increased protest against the payment vehicle. Some households live in rental properties so that funding the programme through rates would not affect them financially and they could behave strategically by stating large WTP amounts which would commit landlords only. There is also the risk that land lords may protest against the proposed rate increase as they realise that non-property owners would benefit from the programme free of charge.

f. Administration of the fund and the period over which Payments are to be made

A fund associated with the Hawke’s Bay Regional Council may be met with resistance and protest from respondents as there will be no guarantee that the money, once in the council’s coffers, is used for the specific purpose of restoring and preserving Pekapeka Swamp. A special fund to be administered by an independent committee elected by the residents of the region seems to make more sense because individuals will be able to hold the elected members of the committee accountable for the funds raised. Individuals may also feel that this arrangement is more transparent than via the council. If the public is not happy with the way the fund is administered, they will be able to dismiss the committee and elect new members.

Project periods vary in time span depending on the nature of the project and the availability of funding. The restoration of Pekapeka Swamp requires a long time frame to allow the wetland system to regenerate itself (HBRC, 1999). This cannot be achieved in one or two years. Financial commitment over a long period of say 10 to 20 years is risky as the horizon is so far people may not be able to predict with some degree of accuracy what their income levels will be. Suggesting such a long period may result in higher non response rates and protests. A period of 5 years appears reasonable for such a project and allows for any reviews and adjustments to be made to the level of required funds at the end of the five year period. The Hawke's Bay Regional Council has adopted a similar time frame for the Pekapeka Swamp management plans (1998 - 2003, and 2005 - 2010).

g. Bid (Seed) selection and sub-sample allocation

Literature suggests a number of methods which may be used to construct a bid vector (bid levels and the number of bids) and a sub-sample vector (number of respondents allocated to each bid level) in order to estimate a reliable welfare measure from a given sample size. The basic consideration in all the methods is that the bid range and number of bids should be sufficiently large to identify the response curve (Duffield & Patterson, 1991). Eulalia (2001) contends that the efficiency of the estimates depends crucially on the survey design, especially the set of bids that are offered to the respondents during the valuation exercise.

In a pioneering DC CVM study by Bishop and Heberlein (1979), the upper end of the bid distribution was set *a priori* and bid offers from $1 to $200 were set at roughly equal log-linear intervals. Boyle, Welsh, and Bishop (1988) suggest obtaining a preliminary estimate of the population distribution of WTP values using an open ended pre-test survey and then allocating bids to cover the entire distribution. Duffield and Patterson (1991) propose and test a model for determining the optimal allocation of the sample over a given set of bid amounts. With a loosely chosen bid vector, a given total sample size, and results from the open-ended pre-test survey, the Duffield and Patterson (1991) method proceeds by finding a solution (the number of bids, bid levels, and sub-sample allocation) that minimise the variance of the expected value of WTP. Cooper (1993) criticises the Duffield and Patterson model as it does not address how the individual bid amount levels should be set. Cooper suggests that, since the estimate of the true population mean is estimated as an integral under the curve [1 – F(A)] across the entire range of respondents' WTP values, the entire range of the bid distribution should be utilised as fully as possible (Cooper, 1993).

The Cooper method for optimal design takes the sample size as given and constructs, through an iterative two-stage procedure, the bid and sub-sample vectors which minimise the mean square error (MSE) of the WTP estimate as opposed to the minimum variance criterion of Duffield and Patterson (1991). Minimising the MSE of the WTP estimate ensures the minimisation of the probability that the distribution of the bids is different from the true WTP distribution (Cooper, 1993). In the model, the following logit cumulative density function (cdf) is rearranged;

$$\Pr(WTP \leq A_i) = \hat{P}_i = \{1 + \exp[-(\alpha + \beta A_i)]\}^{-1}$$

$\hat{P}_i$ is the number of "No" responses to the bid A_i divided by the number of respondents offered bid A_i, so that;

$$\ln(\hat{P}_i / 1 - \hat{P}_i) = \alpha + \beta A_i + \varepsilon_i$$ (ε_i is an error term added to the equation).

It is expected that larger sub-sample sizes per bid level would push $\hat{P}_i$ closer to P_i (the true probability) and improve the consistency of the parameter estimates. Increasing the number of bids would increase the model's degrees of freedom which improves the efficiency of the model (Cooper, 1993).

Another method recommended by Cooper (1993) is the Distribution With Equal Area Bid Selection (DWEABS) which is an iterative two-step model. It starts with a given number of unique bid values (m), a total sample size (N), and a prior probability distribution for WTP. Then it proceeds by dividing the area under the WTP probability distribution curve into equal area segments and then selecting (m) bid amounts corresponding to the borders between the areas. This ensures that the bids are set at equal probability increments. The selected bids are then used with the available information to determine the variance minimising sub-sample allocation on the (m) bid amounts. The above steps are repeated to find (m) and sub-sample allocation that minimise the mean square error (MSE). Bateman and Brouwer (2006) allocated the sample equally to the 11 bid amounts obtained through a pilot study.

In this study we adopt a two-step experimental structure with multiple point designs as suggested in the literature reviewed above. A multiple point design is preferred despite its known disadvantage of providing some points that are not informative because it is not known *a priori* which points will be informative and which ones will be not. One-point or two point designs (where the total sample is allocated to one or two bid amounts respectively) are problematic in that they could potentially miss the mark entirely and provide very little information about the asymptotic distribution of WTP (Cooper, 1993).

Results of a CV pre-test survey were used to empirically define a bid range of NZ$1 to NZ$200 for the main survey. In the pre-test survey, an open ended question was posed and respondents were asked to state their maximum willingness to pay for the restoration and preservation of Pekapeka Swamp. It is assumed that the results of the pre-test provide important information about the characteristics of the population which include the range of WTP values, and the mean. With this information, it is possible to design a bid vector and sub-sample vector which will provide the maximum possible information about the parameters of the WTP distribution.

The first step taken in setting the bid levels was to list, on an excel spread sheet, in ascending order, bid amounts in popular denominations from $1 to $200 and a few above the $200 upper limit of the range. The log of these bid amounts was taken and the log interval between successive bids was calculated. Consecutive amounts that have roughly equal log-linear intervals were selected and taken as the basis on which the final bid vector would be based (see Table 5.1) (Bishop & Heberlein, 1979).

Table 5.1 Bid amounts with roughly equal log-linear intervals

Bid amount	log(Bid)	Interval
1	0	-
2	0.30103	0.30103
5	0.69897	0.39794
10	1	0.30103
20	1.30103	0.30103
40	1.60206	0.30103
80	1.90309	0.30103
160	2.20412	0.30103
320	2.50515	0.30103

The next step was to modify the list by eliminating bid amounts that are likely to provide less informative points on the estimated WTP distribution. For example, the $1, $2, and $5 bid amounts lie on the lower end of the bid range and are likely to be below a threshold bid for which the probability of respondents answering “yes” (“no”) to the DC question is the same and close to 1 (0), so that including all three bid amounts in our set would not provide better information than just one of them. The $2 and $5 bids were therefore dropped from the list. Since the upper limit of the bid range was set empirically at $200, the $320 bid was taken as a likely outlier and replaced with the $200 amount.

The pre-test sample mean and standard deviation were used to construct a logistic cumulative distribution function (cdf) of the estimated mean WTP using the formula:

$$Logistic\ cdf\ \ of\ \ mean\, WTP = \frac{1}{1+e^{-(A_i-\mu)/s}}\,.$$

Where, A_i, μ, and s are the bid amount, pre-test sample mean, and standard deviation respectively. The bid list from Table 5.1 (excluding $2 and $320 bids) was used for the A_i’s. Additional bid amounts within the $1 to $200 range ($30, $50, $60, $70, $90, $100, $120, $140, and $180), and negative values (-$1, -$2, -$5, -$10, -$20, -$30, -$40, -$50, -$60, -$70, -$80, -$90, -$100, and -$110), were introduced to produce a smooth cdf curve depicted in Figure 5.2. Increasing the number of bids improves the efficiency of our model by increasing the model’s degrees of freedom (Cooper, 1993) and also enables the cdf to be clearly mapped out. In a New Zealand study of the value of recreational fishing, Wheeler and Damania (2001) used as many as 19 bid amounts.

In selecting the final list of bid amounts, all negative bid values listed earlier were omitted because the study assumed that the restoration and preservation of the Pekapeka Swamp was viewed as desirable by the respondents. Negative values reflect the need for compensation (WTA) which is not the focus of this study. Respondents with negative valuations could protest, refuse to participate or indicate a zero value and those who respond, their responses would be identified as protests.

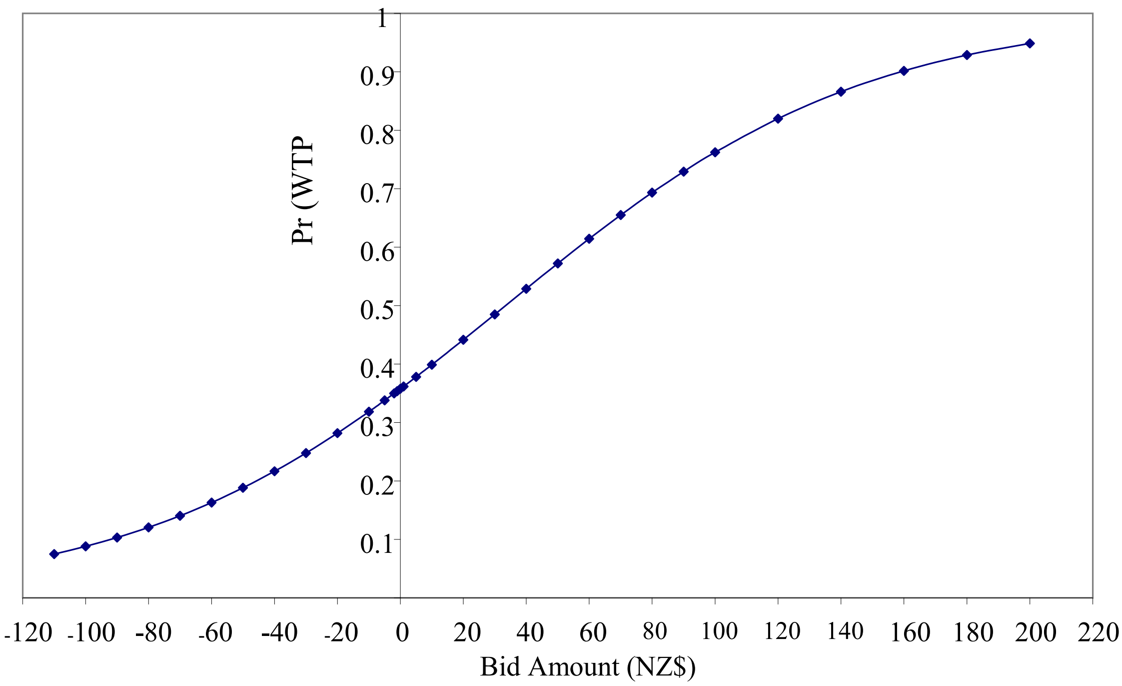

Figure 5.2 Logistic Cumulative Distribution Function (cdf)

We were able to increase the number of bids because of the large sample size of nearly 1000 compared to the sample sizes of between 237 and 353 used by Bishop and Heberlein (1979). The final bid vector was $1, $10, $20, $30, $40, $50, $60, $70, $80, $90, $100, $120, $140, $160, $180, and $200. With a large sample size and 16 bid levels, the number of respondents allocated to each bid amount is still large enough to provide consistent parameter estimates. The allocation of the sample among the final bid levels was done in such a way that the distribution of respondents was concentrated within one standard deviation of the pre-test sample mean WTP.

h Sampling Procedure

Three possible sample sources were considered – buying a mailing list from a professional firm, sampling from the voters roll, and sampling from the white pages of the Hawke's Bay telephone directory. Budgetary considerations eliminated buying a mailing list as an option. The voters roll was potentially the best option but the logistics of obtaining an electronic copy or sampling from the public copy of the register held at the electoral offices in the Hawke's Bay region reduced its attractiveness as an option leaving the telephone directory as the obvious choice despite its disadvantages. The main disadvantage of the telephone directory is that it is not up to-date. Changes that occur during the year are not reflected until the following year, names of deceased people may be included, and some people do not bother correcting their details once they move so that their old addresses still appear. The telephone directory lists only those who want to be listed. Sampling from the directory automatically excludes all unlisted people and those who have no access to the telephone. According to NZ Statistics, about 80% of the households in the Hawke's Bay region have access to the telephone providing a fairly good representation of the population in that region.

Respondents for the survey were selected from the Hawke's Bay 2007/2008 telephone directory using a systematic random sampling technique. Omwenga (1995) and Kirkland (1988) provide local examples of previous studies that drew samples from telephone directories. The sampling technique used gives all listed households in the Hawke's Bay calling area an equal chance of being selected.

The Hawke's Bay telephone directory has 227 white pages. Each page consists of 4 columns listing both individual and company names[19]. A random sample of 10 columns, from 10 randomly selected pages, was drawn and the number of entries (both individual and company) in each column was counted. These entries were added up and

[19] Company names occupy bigger spaces compared to individual person names. To come up with the number of "equivalent" company entries we estimated the number of individual entries that would fit in each company entry.

an average number per column was calculated at about 73. The process was repeated for company names giving an average of about 21 entries per column. To estimate the total number of individual entries in the Hawke's Bay calling area we preceded as follows:

Total number of entries = 4(73 – 21)*227 = 47,126

We proceeded by assuming that each telephone directory entry is equivalent to a household. According to the 2006 NZ Census, The Hawke's Bay region has a total of 54,618 households of which about 80% (43,694) have access to the phone. Our estimate is higher than the census figure because it includes households in the Dannevirke[20] area which lies outside the Hawke's Bay Regional Council boundary. With a minimum sample size of 1000 in mind, we estimated the number of entries to be drawn from each page by dividing the sample size by the number of pages (1,000÷227 = 4.4). To allow for the pre-test sub-sample and extras, we sampled 5 entries from each page by randomly selecting one name from each of the 4 columns on each page of the directory. The fifth name was then picked randomly from any of the 4 columns. This process resulted in a total sample size of 1,135 (5 x 227 = 1,135). After dropping out names with incomplete addresses, we achieved a final sample size of 1,117.

5.2.2 The Survey Instrument

The design of the survey instrument follows, as far as possible, the Total Design Method (TDM) of Dillman (1978) and incorporates recommendations of influential literature such as Mitchell and Carson (1989); Heberlein and Baumgartner (1978); and Bateman *et al*. (2002). It consists of a cover letter, a survey questionnaire booklet, and two reminders (See Appendix 2.1a to 2.2d). The questionnaire, in booklet form, was produced on high quality white paper in A5 format to make it appear smaller and appealing to respondents. This was also done to convey the seriousness and importance of the research. The layout of the booklet pages was individually designed to avoid blank pages, unnecessary clutter, and ensure that questions fit properly on each without extending to the next page. Question ordering was carefully thought out to provide a logical flow through the document. The combined effect of a logical question ordering

[20] Dannevirke area is included in our survey because of its proximity to the site. Some of the residents in this area could benefit from the restoration programme.

and well designed page layout was to encourage respondents to continue filling out the form and reduce unintended omissions.

Heberlein and Baumgartner (1978) contend that lowering the respondents’ costs involved in completing and returning the questionnaire encourages high response rates. These costs may be lowered by providing postage-paid return envelops, designing a questionnaire that is easy to complete within a reasonable time frame, and motivating respondents by increasing the perceived importance of the study and their input.

1. Cover Letter

The cover letter was designed to have four key components.

a. Introduce the survey, explain its purpose, and convince the respondent that it is useful.
b. Convince respondent that his/her response is important to the success of the study
c. Assure the respondent that the questionnaire is easy and will take a short time to complete, responses will be treated confidentially, and their participation will be anonymous.
d. Convey the time frame of the survey (when responses are expected - due date).

The cover letter was printed on Massey University official letterhead to lend weight to the survey; appropriately dated to make it appear important; and correctly addressed (including name and appropriate salutation) and individually signed for personalisation as recommended by Dillman, 1978, and Mitchell and Carson, 1989.

2. Front Cover of Questionnaire Booklet

Respondents are likely to examine the front cover first before any other part of the survey questionnaire. It is important to design the front cover in such a way that it makes good first impression and generates interest. The front cover was designed to consist of:

a. The title of the study

   The title is neutral, simple to understand, and conveys the objective of the study.

b. A statement conveying the social utility argument

   The statement portrays completing the questionnaire as a socially useful activity and makes the respondent feel important and that he is being consulted on an issue that directly or indirectly affects him, his household or his community (Dillman, 1978; Bishop, Heberlein & Kealy, 1983; Mitchell & Carson, 1989).

c. Name and address of the study sponsor

   This is important to give weight to the survey so that it is taken seriously especially where the researcher is little known or unknown to the majority of respondents. The other advantage of this is that where questionnaires are separated from the return envelope, respondents are still able to return the questionnaire.

d. A reference number

   The reference number on the front cover is for mailing and administration of the survey instrument only. This is conveyed to the respondents in the cover letter. The reference number was placed on the top right hand corner where it is clearly visible. Placing it where it is not clearly visible may raise suspicion and reduce the element of trust created by the promise of complete anonymity and confidentiality (Dillman, 1978).

3. Part I: Introduction and background information

This section develops from the social utility argument raised on the front cover. The background and stresses the importance of Pekapeka Swamp to the Hawke's Bay community and the fact that proper management of the resource is only possible if the Hawke's Bay Regional Council has information on the community's preferences. A definition of a wetland is given and ecosystem services provided by a fully functional wetland system are listed. Providing respondents with such a list of benefits will assist in the value formulation process and will ensure uniformity in terms of the whole range of wetland benefits being valued. A map, in colour, clearly showing the location of the study site was provided in order to inform those not familiar with the site. The location of the site is important to respondents in terms of establishing which benefits are relevant and how the wetland is likely to impact on them in future.

Instructions on how to complete the questionnaire are given before any questions are posed.

4. Part II: Awareness and use of wetlands in general

This section collects information on awareness of the existence of Pekapeka Swamp prior to this survey. It is expected that respondents with prior knowledge of the existence of the swamp are likely to have visited the swamp, are familiar with its current state, can readily express their views about the problem and its solution, and are therefore more likely to respond immediately. Furthermore, their previous knowledge and possible experience with the site would positively influence their valuation compared to those who have no knowledge and previous experience with the site. Awareness of the existence of Pekapeka Swamp is likely to influence the response time and willingness to pay. The validity of this statement will be tested in the model where "Awareness" will be included as one of the explanatory variables. A qualitative analysis of responses should show the effect of "Awareness" on response time.

The respondent's recreational utilisation of wetlands is also explored. A list of wetland activities is provided and the respondent is asked to indicate, by a tick, the activities they consider as important; as their main wetland activity; and what their future wetland activities might be. The information provides a profile for the respondent in terms of current and future consumption of recreational services of wetlands. Higher consumption of wetland recreational services may encourage, in the absence of close substitutes, respondents to state higher WTP for the restoration and preservation of the Pekapeka Swamp.

5. Part III: Valuing Pekapeka Swamp

The first part of this section builds on the previous section by providing a list of reasons for valuing existing wetlands. Respondents are asked to indicate, by a tick, the importance of each reason on a five-point scale from "No Opinion" (0) to "Extremely Important" (4). The reasons listed include protecting wildlife and wildlife habitat; providing scenic beauty, commercial income, recreational opportunities, flood control, water purification; and the non-use values such as option, existence and bequest values. Space is provided for respondents to specify other reasons they feel are important.

The main objectives of this section are: (a) to prepare respondents for the value formulation stage by presenting them with important wetland services and initiating a thought process that highlights the importance of these services to the individual as the respondents ponder over them and try to place each of these on the scale, and (b) to determine whether or not the respondents demonstrate intrinsic value for the environment and non-use values. By rating these services, the respondents are communicating their preferences to the researcher. The way a respondents rates the services provides a profile for the respondent and insight into his willingness to pay for the restoration and preservation of Pekapeka Swamp. For example respondents who rate all or most of the services lowly are likely to have zero or low WTP_{max} whereas those respondents who rate the services highly are expected to have higher WTP_{max} values.

The second part of this section tests respondents' attitude towards environmental protection by presenting them with conflicting land uses for the site – agricultural development versus preservation of ecosystem services, and asking them if they would support an environmental programme that seeks to restore and preserve the site at no direct cost to themselves. Three possible answers "YES", "NO", and "NOT SURE", are provided and the respondents are asked to tick the relevant answer and state their reasons.

The hypothetical or contingent scenario for the valuation of the restoration and preservation of Pekapeka Swamp is then outlined. Respondents are presented with a familiar payment vehicle considered to reduce protest. Three scenarios are presented with the aid of colourful pictures (see Figure 5.3). The 'Status quo scenario' shows how the wetland currently looks like and is based on photos that were taken by the researcher at the site in September 2008; 'Future scenario 1' depicts how the site would look if the restoration and preservation programme is not voted for and the site is converted to agricultural use; and 'Future scenario 2' shows how the site could potentially look if the programme is voted for. All three scenarios are presented in colour to attract attention and generate respondent interest.

Before respondents are presented with the valuation question, their potential use of the restored Pekapeka Swamp is explored. This gives respondents an opportunity to consider and reflect on the potential benefits that they may derive from the restored wetland without the burden of placing a value on these benefits. By the time the valuation question is posed, it is expected that the individual would have had enough information and considerable forethought on the value of the benefits of the programme.

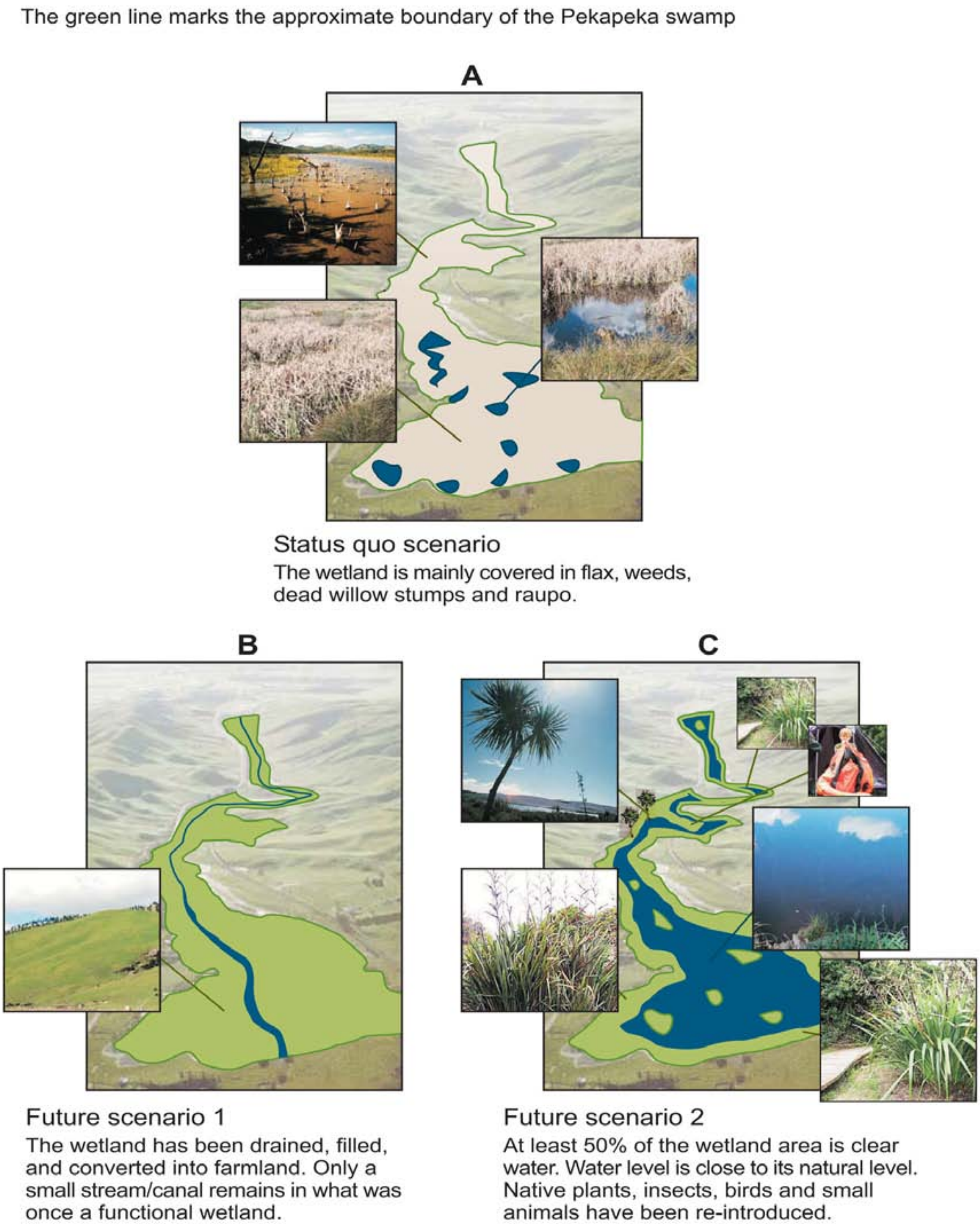

Figure 5.3 Contingent scenarios for the valuation of Pekapeka Swamp

The valuation question is posed within the contingent scenario with one of the sixteen bid amounts presented to each respondent. Respondents are reminded, before answering the valuation question: to consider their income and other financial commitments (budget constraint); of the benefits they could derive from the restored site (total value); that alternative sites may exist (substitution); and to discuss their answers amongst the household members (consensus). It is important to remind respondents in this manner to ensure that realistic valuations that conform to the utility theoretic are stated. The valuation question consists of a DC and open-ended (OE) question. OE questions have been used in previous CV surveys of waterfowl hunting (Hammack & Brown, 1974; Bishop & Heberlein, 1979) and wilderness recreation and preservation (Cicchetti & Smith, 1973; Walsh, Loomis & Gillman, 1984)

Four possible answers to the valuation question are provided. The first option provides for a “YES” answer to the DC question and a provision for the respondent to state a maximum annual amount at which they would still support the programme. If the respondent selects this option, the open ended WTP amount is expected to be at least the same or more than the bid offer. A lesser amount would indicate inconsistent valuation or a selection error (i.e. placing a tick in the wrong box). The second option provides for a “NO” answer to the bid offer and a provision to state the highest possible amount, below the bid offered, at which the respondent would support the programme. The third option provides for zero valuation and is structured to identify genuine zeros from protest. The fourth option allows respondents to express “NO OPINION” and select possible reasons for this answer from a suggested list or inset the reason in the space provided.

6. PART IV: Information about the household

This section collects a personal profile for the respondent. Information on socio-economic and demographic characteristics such as age, education, gender, occupation, household income, family size, and ethnicity is collected (Lienhoop & MacMillan, 2007). The question on household income is presented last because it is likely to be the most objectionable. Presenting this question early may result in high non response rates as respondents would stop completing the questionnaire as soon as they get to this question. Information collected under this section will be used to explain the respondents’ WTP.

7. Back Cover of the Questionnaire Booklet

The back cover of the questionnaire booklet was left blank to avoid drawing attention to it. Dillman (1978) advises that questions printed at the back face an increased chance of item non-response as some respondents may over look them. A blank back cover also provides additional space for respondents' comments.

8. First Reminder

The first reminder in the form of a reminder/thank you postcard was sent to respondents who did not respond by the due date to encourage them to respond and thank those who had already done so. The importance of the respondents' response to the success of the study was emphasised.

9. Second Reminder

The second reminder was in the form of a letter appealing to respondents to complete the survey questionnaire and mail it as soon as possible. The social utility argument is reiterated and respondents supplied with another copy of the questionnaire in case they had disposed of or misplaced the original one.

5.3 Survey Procedure

5.3.1 Focus Group

A preliminary questionnaire, cover letter and reminders were prepared after a review of relevant literature (Dillman, 1978; Heberlein & Baumgartner, 1978; Seller, Stoll & Chavas, 1985; Sutherland & Walsh, 1985; Mitchell & Carson, 1989; Stevens *et al*., 1991; Arrow *et al*., 1993; Amirnejad *et al*., 2006; Wattage & Mardle, 2007). These were then given to a focus group consisting of 6 staff members at the New Zealand Centre for Ecological Economics (NZCEE) for their expert evaluation. Each member was asked to do the following:

a. Read the cover letter and complete the questionnaire as would a normal respondent and record the time they took to complete the survey.

b. Go through the cover letter and questionnaire again in detail, this time analyzing the structure and content of the two documents and the reminders to see if they adequately address the needs of the study and ensure they are straight-forward enough for an average New Zealander to handle without any serious difficulty.
c. Comment and suggest any changes that need to be made to the documents before a pre-test is carried out.

Comments from the focus group indicated that the questionnaire adequately addressed the research question and that it was logically structured. The language was viewed as clear enough for an average person to handle and the time required to complete the survey was reasonable at between 15 and 20 minutes. A copy of the survey questionnaire was also sent to HBRC for their comments especially on how well the study captures the important aspects of the current restoration programme. Their response was that overall they were satisfied with the survey questionnaire but advised against including income as some respondents may object to disclosing their incomes.

5.3.2 Pre-test

A sub-sample of 159 was randomly drawn from the main sample of 1,117 households, originally drawn from the Hawke's Bay Region, to test the survey instrument. Details of the sampling technique will be provided later. The main objectives of the pre-test questionnaire were to provide feedback on the content and structure of the instrument, provide an insight into the distribution of WTP values, and provide an indication of the extent of problems associated with value formulation. In this regard the pre-test questionnaire differed from the draft final survey in three ways: (1) it contained a question requesting respondents to comment on the structure and composition of the questionnaire; (2) an open ended question was used to elicit WTP values; and (3) a question requesting respondents to comment on the WTP amount they stated was posed.

Because of time constraints it was decided from the onset that there would be no follow-ups to respondents on the pre-test survey. To ensure a reasonable number of responses are obtained, a fairly large pre-test sample was employed. Kirkland (1988) and Omwenga (1995) used pre-test sample sizes of 40 and 75 respectively. Some pertinent results of the pre-test are presented in Tables 5.2 and 5.3.

Table 5.2 Pre-test Survey Responses

Number of questionnaires mailed out	Number of questionnaires returned undelivered	Number of questionnaires assumed delivered	Number of responses	No-Response
159	16	143	25 (17.48%)*	118 (82.52%)*

* Calculated as a percentage of the number of questionnaires assumed delivered.

The pre-test survey results may be affected by self selection bias if non-respondents differ from respondents significantly in terms of socio-economic, demographic, behavioural, and attitudinal attributes. Results from a study by Wellman *et al.* (1980) suggest that there is no important difference between early respondents and the reluctant respondents who are reined in through follow-ups to increase the response rate.

Table 5.3 Summary of responses to the questionnaire structure and content

Issue	Agree (%)	Disagree (%)	No-opinion (%)
Some of the questions were hard to understand.	14.3	71.4	14.3
Some parts of the questionnaire were hard to follow.	20.0	70.0	10.0
The questionnaire was too long.	25.0	75.0	0.0

Respondents' comments were reviewed before the final survey questionnaire was produced. At least 70% of the respondents disagreed with the statements listed in Table 5.3 with about a quarter of the respondents indicating that the questionnaire was too long. The comments on the length of the questionnaire did not affect the length of the final draft as the 10 page questionnaire complies with the requirements of the Total Design Method (TDM) of Dillman (1978).

Question 25 (see Appendix 2.2b) concerns value formulation. Mitchell and Carson (1989), Bishop and Heberlein (1979), and Arrow *et al.* (1993) contend that asking respondents to formulate monetary values in response to an open-ended CV question presents them with an extremely difficult task. Results in Table 5.4 seem to support this view as only 42.11% of the respondents indicated that they were quite certain with their valuation. It is interesting to note that the majority of respondents who stated that they were quite certain about their valuation reported zero WTP values. The results are pleasing as they indicate that those who responded took the survey seriously.

Table 5.4 Responses to the WTP value formulation

Response	Percentage
Quite certain	42.11%
There is no way we can be certain about the amount	15.79%
Just a guess	36.84%
Not sure what to think	0%
Other	5.26%

5.3.3 Main Survey

The Pekapeka Swamp contingent valuation survey was administered to a sample of 958 households in the Hawke's Bay Region, from November 2008 through to January 2009 using a mail survey questionnaire as discussed earlier. The cover letters were personalized with the name and address of the respondent; the salutation was "Dear Householder"; and the letters were individually signed. The first mail out was on November 7, 2008 and consisted of a cover letter, survey questionnaire and an addressed postage-paid return envelop. Two reminders were mailed out at approximately three week intervals. The first follow-up was a reminder/thank-you post card to all non-respondents encouraging them to respond. The second reminder consisted of a replacement questionnaire with a more emphatic cover letter and an addressed postage-paid return envelop.

The follow-up procedure adopted in this study differs slightly from the TDM of Dillman (1978) by using only two follow-ups instead of three, and different timings of the mailings. Our objective in taking this approach was to achieve an acceptable response rate within a given budget and time frame. The three stage follow-up as recommended by Dillman is to increase the response rate by reigning in the reluctant respondents. Apart from time and budget constraints, we considered the findings of Wellman *et al*. (1980), cited earlier, in adopting the two stage follow-up. Bennett, Morrison and Blamey (1998) used a two stage follow-up in their study using a reminder card and a complete re-mail of the questionnaire to stimulate responses.

Concern was expressed at the timing of the last mail out as it was only six days prior to Christmas. The alternative was to wait until the third week of January 2009 which could have prolonged the length of the study. Advice from Dillman (1978, p. 180) is to "avoid mailing close to holidays and the entire month of December" because of increased mail during this period and increased likelihood that a lot of people will be holidaying away from their homes.

The cut-off date was January 23, 2009, exactly 11 weeks after the first mail-out. Non-response checks were not made as a two-stage follow-up was adopted as explained earlier. Responses were categorized as indicated in Table 5.5.

Table 5.5 Response categories for the Pekapeka Swamp Survey, 2008

Response details	Response category (code)
Questionnaire returned undelivered	0
First time response (Early)	1
Response after first reminder (Middle)	2
Response after second reminder (Late)	3
No response	4

All the information capture by the survey instrument was carefully coded[21] (see Appendix 2.3) before being captured electronically on an excel spread sheet.

5.4 The Model

The qualitative nature of the responses to dichotomous choice questions requires the employment of more sophisticated estimation techniques to analyse the data. Fortunately, several software applications such as SPSS, SAS, STATA, and EViews are available to process and analyse this type of data. In this study, SAS was used to analyse the data for reasons of familiarity.

[21] A code sheet indicating variable number, variable name, description of the variable, response details and response code was produced to capture all the information provided by respondents.

Two models were used to analyze and estimate WTP functions and values from responses to the survey questionnaire. A simple OLS regression model was used on responses to the open ended question while a logit model was employed to analyze responses to the dichotomous choice question. In both models we hypothesize that socioeconomic and demographic variables are important explanatory variables. We have no theoretical basis to pre-select the variables that provide the best model. To address this problem, stepwise regression was employed to select among the possible variables.

The logit model is selected because it is formulated to be consistent with both the hypothesis of utility maximization and the Random Utility Model (RUM). The methodology proceeds by formulating a logit model that is consistent with utility maximizing behaviour, correlating the “Yes” and “No” responses to the contingent valuation question using the formulated logit model, and deriving an estimate of WTP of an average household in the Hawke’s Bay region.

5.4.1 The Logit Model for Analyzing DC Responses

The logit model adopted in this study is based on a WTP framework along the lines developed by Hanemann (1984) from which the Hicksian compensating and equivalent welfare measures may be obtained from dichotomous choice, discrete response data (Bowker and Stoll, 1988). In this case study we attempt to obtain a measure of household compensating surplus from dichotomous choice, discrete response data (see Table 2.1). Recall that the contingent scenario and the DC valuation question present the household with a given improvement in environmental quality at a stated price (bid amount) and then ask them to cast a vote in favour of, or against, the programme. The respondent takes the environmental quality as given but is free to decide on the value or the price to pay. The estimated WTP therefore refers to a specific and fixed environmental improvement.

Suppose that a household (j) in the Hawke’s Bay region is presented with the possibility of obtaining a change in the quality of an environmental good q (the Pekapeka Swamp) from q_0 (the status quo or base case) to q_1 (restored and preserved Pekapeka Swamp); where q_1 is better than or is a preferred state to q_0, namely $q_1 > q_0$. The indirect utility function of the jth household for the base case can be expressed as (Hanemann, 1984; Lee & Han, 2002; Haab & McConnell, 2003; Amirnejad *et al*., 2006):

$$V_j\ (q_0, Y_j, \mathbf{z_j}, \varepsilon_{0j}) \tag{1a}$$

Where Y is income, **z** is a vector of market commodities, prices, and characteristics of the household or individual, and ε is some stochastic component - known to the individual respondent, influenced by his/her taste and preferences but unobservable to the researcher. ε_0 and ε_1 are identically, independently distributed (i.i.d) random variables with zero means (Hanemann, 1984; Lee & Han, 2002; Haab & McConnell, 2003; Amirnejad *et al*., 2006). The subscript of ε indicates status quo if it is zero and the alternative state if it is 1. In the following equation the subscript 'j' identifying the indirect utility function with the jth household is omitted from the function to avoid clutter but will be brought in whenever it is convenient to do so. Equation (1a) then becomes;

$$V\ (q_0, Y, \mathbf{z}, \varepsilon_0) \tag{1b}$$

Since the restoration and preservation of the Pekapeka Swamp is assumed to be viewed by the individual/household as an improvement, the indirect utility function associated with this improvement may be expressed as (Hanemann, 1984; Lee & Han, 2002; Haab & McConnell, 2003; Amirnejad *et al*., 2006):

$$V\ (q_1, Y, \mathbf{z}, \varepsilon_1) \tag{2}$$

If the restoration and preservation of the Pekapeka Swamp represents an improvement, as assumed earlier, then (Hanemann, 1984; Lee & Han, 2002; Haab & McConnell, 2003; Amirnejad *et al*., 2006):

$$V\ (q_1, Y, \mathbf{z}, \varepsilon_1) \geq V\ (q_0, Y, \mathbf{z}, \varepsilon_0) \tag{3}$$

This means that the indirect utility associated with the restoration and preservation programme is equal to or greater than the base case. Assuming that the individual is rational and maximizes utility (rational agent assumption), the restoration and preservation programme is preferred to the base case and its selection maximizes individual/household utility.

However, if the individual/household is told that the restoration and preservation programme will cost his/her household \$A (the bid amount), the indirect utility associated with the improvement in the wetland system becomes (Hanemann, 1984; Lee & Han, 2002; Haab & McConnell, 2003; Amirnejad *et al*., 2006):

$$V\ (q_1, Y-A, \mathbf{z}, \varepsilon_1) \quad (4)$$

If the individual is presented with the bid amount \$A and is asked to cast a vote in favour of, or against, the programme, he will compare $V\ (q_1, Y\text{-}A, \mathbf{z}, \varepsilon_1)$ with $V\ (q_0, Y, \mathbf{z}, \varepsilon_0)$ and vote "Yes" only if $V\ (q_1, Y\text{-}A, \mathbf{z}, \varepsilon_1) \geq V\ (q_0, Y, \mathbf{z}, \varepsilon_0)$ and "No" otherwise, assuming that the individual is a utility miximizer. It is assumed that the individual/household knows his/her utility function (Hanemann, 1984), is able to formulate value from a given set of information (Mitchell & Carson, 1989; Carson, Groves & Machina, 2000), and will reveal their true preferences when presented with a choice. The condition for voting "Yes" may be expressed as (Hanemann, 1984; Johansson, Kristrom, & Maler, 1989; Lee & Han, 2002; Haab & McConnell, 2003; Amirnejad *et al*., 2006):

$$V\ (q_1, Y-A, \mathbf{z}, \varepsilon_1) \geq V\ (q_0, Y, \mathbf{z}, \varepsilon_0) \quad (5)$$

To measure the compensating surplus (CS) we ask the question; "How much income should be taken away from the household or individual so that they remain at their initial level of satisfaction (welfare) given the environmental improvement?" In other words, what income adjustment is necessary to bring equality between equations (1b) and (2)? The answer to this question provides a value for the compensating surplus. If, for convenience, we represent CS with the letter C, then the necessary condition for equality between (1b) and (2) is:

$$\Delta V\ (C, q_1, q_0, Y, \mathbf{z}, \varepsilon) = V\ (q_1, Y-C, \mathbf{z}, \varepsilon_1) - V\ (q_0, Y, \mathbf{z}, \varepsilon_0) = 0 \quad (6)$$

Where ΔV represents utility difference. The above equation means that the utility difference – the change in utility between the base case and the improvement, after taking away \$C from the individual/household, is equal to zero. Therefore C = C (q_1, $q_{0,}$ Y, z, ε) is the maximum WTP for the environmental change from q_0 to q_1. Both C and ΔV are random variables since their functions contain the random component (ε). Since 'ε', the stochastic or random component of the utility function is unknown to the researcher, the statements about "Yes" and "No" can only be probabilistic ones (Hanemann, 1984). The probability of a "Yes" response is the probability that the respondent thinks that he is better off in the proposed scenario, even with the required payment (see equation 5). This conditional probability may be represented as;

$$\Pr(Yes|X) = \Pr[V(q_1, Y\text{-}A, \mathbf{z}, \varepsilon_1) \geq V(q_0, Y, \mathbf{z}, \varepsilon_0)] \quad (7)$$

X is a vector of explanatory variables for the respondent. Although equation (7) may be used as a starting point for non-parametric estimation, it is too general for parametric estimation (Haab & McConnell, 2003). To derive a suitable functional form, equations (1b) and (2) are restated by specifying utility as separable into two components, deterministic and stochastic components which are additive as indicated below (Haab & McConnell, 2003).

$$V(q_0, Y, \mathbf{z}, \varepsilon_0) = V(q_0, Y, \mathbf{z}) + \varepsilon_0 \quad (8)$$

$$V(q_1, Y, \mathbf{z}, \varepsilon_1) = V(q_1, Y, \mathbf{z}) + \varepsilon_1 \quad (9)$$

The contingent valuation scenario is designed to capture the deterministic element of the utility function (Haab & McConnell, 2003), which has as its arguments q_1, q_0, Y, A, and **z**. Equation (7) may now be restated as:

$$\Pr(Yes| X) = \Pr[V(q_1, Y\text{-}A, \mathbf{z}) + \varepsilon_1 \geq V(q_0, Y\ \mathbf{z},) + \varepsilon_0] \quad (10)$$

The right hand side of equation (10) may be rewritten, after subtracting ε_0 from both sides of the inequality sign, as:

$$\Pr(Yes| X) = \Pr[V(q_1, Y\text{-}A, \mathbf{z}) + \varepsilon_1 - \varepsilon_0 \geq V(q_0, Y, \mathbf{z},)] \quad (11)$$

Let $\varepsilon = \varepsilon_1 - \varepsilon_0$. Then (11) becomes:

$$\Pr(\text{Yes}|\ X) = \Pr[V(q_1, Y\text{-}A, \mathbf{z}) + \varepsilon \geq V(q_0, Y, \mathbf{z},)] \quad (12)$$

The right hand side of equation (12) may be rearranged in terms of the deterministic and stochastic components of indirect utility as follows:

$$\Pr(\text{Yes}|\ X) = \Pr[V(q_1, Y\text{-}A, \mathbf{z}) - V(q_0, Y, \mathbf{z},) + \varepsilon \geq 0] \quad (13)$$

Haab and McConnell (2003) present a similar formula shown below.

$$\Pr(\text{Yes}|\ X) = 1 - F_\varepsilon\ [-V(q_1, Y\text{-}A, \mathbf{z}) - V(q_0, Y, \mathbf{z},)] \quad (14)$$

Where F_ε (.) is the cumulative distribution function of a standard logistic variate 'ε'**.**

The utility change of the restoration and preservation programme may be expressed as:

$$\Delta V = V(q_1, Y\text{-}A, \mathbf{z}) - V(q_0, Y, \mathbf{z}) + \varepsilon \quad (15)$$

The parameterization of the probability function may be achieved by expressing Pr(Yes|X) as a logit model as follows (assuming a linear utility function; $\Delta V = \alpha - \beta A + \gamma Y + \theta Z$):

$$\Pr(\text{Yes}|\ X) = F_\varepsilon(\Delta V) = \frac{1}{1+\exp(-\Delta V)} = \frac{1}{1+\exp\{-(\alpha - \beta A + \gamma Y + \theta Z)\}} \quad (16)$$

Where F_ε (.) is the cumulative distribution function (c.d.f) of a standard logistic variate $\boldsymbol{\varepsilon}$ in the case of a logit model or the c.d.f of a standard normal variate in the case of a probit model (Hanemann, 1984; Lee and Han, 2002); α is the intercept; β is the coefficient of bid amount; γ is the coefficient of income; and θ is a vector of coefficients of the socio-economic and site characteristics. It is expected, in terms of economic theory that β will have a negative sign ($\beta \leq 0$), γ the coefficient of Y will have a positive sign ($\gamma > 0$), and θ may be less than or greater than zero ($0 > \theta$, or $\theta > 0$).

Equation (16) may be rewritten as:

Pr (Yes| X) = $F_\varepsilon(\Delta V)$ = $\left(1+\exp\{-(\alpha-\beta A+\gamma Y+\theta Z)\}\right)^{-1}$ (17)

The parameters for the binary response model will be estimated using maximum likelihood (ML) since generalized least squares (GLS) is ideal where many individuals are receiving the same bid offer, or have the same income, or have identical socioeconomic characteristics (Haab & McConnell, 2003; Amirnejad *et al*., 2006). There is no a-priori information suggesting that the condition ideal for the application of GLS is met hence the selection of ML.

The odds in favour of a "yes" response can be expressed as (Wonnacott & Wonnacott, 1979):

Odds (Yes) = Pr (Yes|X))/[1 – Pr (Yes| X)] (18)

The ratio of Pr (Yes| X) to the Pr (1 - Pr (Yes| X) is the odds in favour of saying "Yes". This gives the probability (P_i) that a given household will say "Yes" to the probability that it will say "No" to a given bid amount ($A). P_i can be expressed as:

$$P_i = \frac{\Pr(Yes|X)}{\Pr(1-\Pr(Yes|X))} = \frac{[1+\exp\{-(\alpha-\beta A+\gamma Y+\theta Z)\}]^{-1}}{1-[1+\exp\{-(\alpha-\beta A+\gamma Y+\theta Z)\}]^{-1}}$$

$$= \exp(\alpha-\beta A+\gamma Y+\theta Z) = \exp(\Delta V_i) \quad (19)$$

[Note $P_i = \exp(\Delta V_i)$]

Taking the natural log (log base e) on both sides and disregarding the subscript i gives us:

$$\ln(Odds) = \ln[\exp(\Delta V)]$$
$$\ln(P) = \ln[\exp(\Delta V)]$$
$$L = \ln(P) = \ln[\exp(\Delta V)]$$
$$L = \Delta V = \alpha-\beta A+\gamma Y+\theta Z \quad (20)$$

Where L is the logit - the log (log base e) of the odds; α is the intercept and represents the value of the log-odds in favour of saying "Yes" if the suggested bid is zero (natural or threshold response rate); β is the coefficient of the Bid amount; γ is the coefficient of income, θ is a vector of coefficients of Z. (Note: α, β, γ, and θ are the parameters of the utility difference function (see equation 16). β, γ, and θ measure the change in L for a unit change in the relevant variable). In order to estimate the parameters of the logit model, an error term is added to equation (20) since L is not deterministic so that the equation becomes:

$$L = \Delta V = \alpha - \beta A + \gamma Y + \theta Z + u \tag{21}$$

The estimated logit model provides estimates of parameters in equation (21). The expected value of WTP (truncated mean) can be calculated by numerical integration ranging from zero to maximum bid ($A) as follows (Hanemann, 1984; Lee & Han, 2002; Haab & McConnell, 2003; Amirnejad *et al*., 2006):

$$E(WTP) = \int_0^{Max.A} F_\eta(\Delta V)\,dA \tag{22}$$

$$= \int_0^{Max.A} \left(\frac{1}{1+\exp\{-(\alpha^* + \beta A)\}}\right) dA$$

$$Where\ \alpha^* = \alpha + \gamma\overline{Y} + \theta\overline{Z};\ and\ \ \beta < 0$$

There are three possible welfare measures that can be estimated from the model. These are; the overall mean WTP; the median WTP; and the truncated mean WTP. Hanemann (1984) advocates for the use of the median WTP as the preferred welfare measure on the grounds that it is likely to be more robust than the mean where there are errors and outliers in the responses. He further contends that the median is better still as it is conservative and represents the value which applies to at least 50% of the respondents. The criticism of the median as a welfare measure is that it has no direct economic interpretation and excludes outliers even where these are important and therefore underestimates the benefits of a project. Duffield and Patterson (1991) suggest three basic criteria for selecting the appropriate measure: consistency with theoretical constraints, statistical efficiency, and ability to be aggregated. The overall means [solution to equation (22) by numerical integration from - ∞ to + ∞] for models that are skewed to the right and unbounded above set the upper limit of the WTP distribution at infinity which is inconsistent with the limit set by the budget constraint at the level of income. Estimating overall means for such models is difficult, imprecise as it requires extrapolation beyond the range of the data, and sensitive to the model chosen between logit and probit (Duffield & Patterson, 1991). The truncated mean satisfies all three criteria and is the preferred measure by Duffield and Patterson (1991).

In this study the recommendation by Duffield and Patterson (1991) to estimate the truncated mean WTP will be adopted but the median WTP and mean WTP [solution to equation (22) by numerical integration from 0 to + ∞] will also be estimated for comparison purposes.

5.4.2 Model for Analyzing Responses to the Open-ended Valuation Question

Open ended valuation questions produce a set of welfare measures WTP_i $(i = 1....i...,...n)$ for n respondents in the sample. The mean WTP can be estimated as:

$$Mean\ WTP = \frac{\sum_{i=1}^{n} WTP_i}{n}$$

An estimate of total value is obtained by multiplying the mean WTP by the population size. Alternatively the total value may be estimated from the estimated WTP function (bid function) by using the population data on the estimated equation (see estimation procedure below).

The open-ended WTP model is specified as per Seller, Stoll and Chavas (1985) as:

WTP = *f*(D, A, G, FS, MEV, MSC, MSB, CWU, FWU, AWN, Y)

Where:
- WTP = Hicksian compensating measure of WTP
- D = distance from site
- A = age of head of household (years)
- G = gender of head of household (male = 1; female = 0)
- FS = family size (number of people in household)
- MEV = membership to environmental organisation

MSC = membership to shooting club

MSB = membership to boating club

CWU = current wetland usage

FWU = future wetland usage

AWN = awareness of the existence of the site

Y = household annual income (in thousands)

Since there is no *a priori* information about the choice of the functional form of the model, the above equation will be estimated in a number of ways (linear, semi-log, double log etc) and the model that best fits the data will be selected.

The methodology discussed in this chapter is an important part of this study as it will be employed in survey questionnaire design, implementation, and administration of the survey to ensure that the responses analysed in the next chapter provide results that are consistent with economic theory.

CHAPTER 6

Responses and Data Analysis

In this chapter we present results of the analysis of responses to the contingent valuation survey. Dollar value estimates of willingness to pay (WTP) for the restoration and preservation of Pekapeka Swamp are estimated from the fitted models. WTP estimates from the dichotomous choice (DC) questions are compared with estimates obtained with the open-ended question. Further, we estimate aggregate WTP, distance decay functions, net present values, and unit values for the Pekapeka Swamp based on the fitted models.

6.1 Response Analysis

Table 6.1 is a summary of survey responses. For the full response analysis, see Appendix 4.1. Of the original sample of 958 households, 80 (8.35%) questionnaires were returned for the reasons indicated in the Table 6.1. A total of 177 (18.48%) responses were obtained before the deadline from the initial mail out. The first reminder resulted in a further 63 (6.58%) responses whilst the second reminder had 165 (17.22%) responses giving a total response rate of 42.28%. A total of 473 (49.37%) respondents did not return the questionnaire. It is interesting to note that the first time response rate of 18.48 is close to the pre-test response rate of 17.48% where no follow ups were made. The achievement of a higher response rate of 42.28% in the main survey highlights the importance of making follow-ups.

Table 6.1 Response Summary

Number of questionnaires mailed out	Questionnaires not reaching destination[1]	Responses before first deadline	Responses following first reminder	Responses following second reminder	No response by closing date (23/01/09)
958	80 (8.35)*	177(18.48)	63 (6.58)	165 (17.22)	473 (49.37)

[1]Mail was returned for various reasons such as, box closed, deceased, not known, no such number, insufficient address, not at this address, and no delivery point.
* Figures in parentheses are in percentages calculated as a percentage of the original mail out as recommended by Mitchell and Carson (1989).

The response rates per mail-out listed in Table 6.2a contradict the expectation that the response rate falls from first mail-out to the last mail-out. The reason for this expectation is that individuals who do not respond to the first mail-out are probably the least interested in the survey and are less likely to respond to reminders. Heberlein and Baumgartner (1978) reviewed 98 CVM studies employing the mailed questionnaire and obtained results indicating that on average the initial mail-out, first reminder, second reminder, and third reminder produce response rates of approximately 48%, 20%, 12%, and 10% respectively. Wellman (1980) reports similar findings.

Our first reminder produced a lower response rate than the original mail-out as expected but the response to the second reminder was a surprise as the response rate was far better than the original mail out when calculated on a mail-out basis (see Table 6.2a). Generally the response rate to the second reminder is expected to be lower than the previous mail-outs. In this study the response rate to the second mail-out was expected to be made worse by the timing of the mail-out given that the questionnaire was mailed out only six days prior to Christmas. People are expected to be too busy with their holiday arrangements to be bothered with completing questionnaires. Dillman (1978) suggests avoiding mail-outs during the entire month of December.

Possible explanations for the unexpectedly higher response to the second reminder are:

a) The first reminder produced the least responses because some respondents, having decided not to respond in the first instance, disposed of the questionnaire. Other respondents might have intended to complete the questionnaire at a later convenient time but misplaced the questionnaire. Since the first reminder was a post card and did not include the questionnaire, such individuals were unable to respond even if they wanted to unless they were provided with a new copy of the questionnaire. For instance, after the first reminder two respondents sent e-mails requesting copies of the questionnaire because they could not locate their original copies.
b) The second reminder was mailed out on Thursday, December 18, 2008. This is a time of year when a lot of people are on leave and have time to spare. Also the festive mood may have influenced the respondents’ decision to participate in line with the spirit of Christmas!

c) The second reminder contained a copy of the survey questionnaire making it possible for respondents to respond immediately.

Table 6.2a Response rate per mail-out

Mail-out	Number sent out	Number of responses	Response rate per mail-out
First mail-out (07/11/08)	958	177	18.48
First Reminder (18/11/08)	732	63	8.61
Second Reminder (18/12/08)	655	165	25.19

6.1.1 Overall Response Rate

When undelivered mail is removed and the response rate calculated as a percentage of the mail assumed to have reached the respondents, a slightly higher response rate of 46.13% is obtained. A breakdown of responses into categories is presented in Table 6.2b below.

Table 6.2b Breakdown of Responses

Genuine zeros	77 (8.77%)
Protest zeros	48 (5.47%)
Refusals	41 (4.67%)
No opinion	17 (1.93%)
Incomplete valuations	21 (2.39%)
Non-zero responses	201 (22.89%)
Total responses	405 (46.13%)

Previous studies achieving response rates of similar magnitude are: Cicchetti and Smith (1973) - 40%; Brookshire, Eubanks and Randall (1983) – 30%; Walsh, Loomis, & Gillman (1984) - 41%; Bennett, Morrison and Blamey, (1998) - 47.3%. Omwenga (1995) achieved a response rate of 25.8% and lists three New Zealand CVM studies – Greer and Sheppard (1990); Sheppard *et al*. (1993); and Rosawati, (1993) as having achieved response rates of 47.1%, 44.2%, and 46.7% respectively. It is interesting to note that our response rate is similar to the response rate of 47.3% from a study by Bennett, Morrison and Blamey (1998) that used exactly the same two stage follow-up method as in our study.

6.1.2 Frequency Distribution of Responses by Bid Amount and Identification of Possible Strategic Behaviour

The distribution of responses to the dichotomous choice (DC) question is analysed to identify the existence of strategic behaviour among the respondents in answering the valuation question. Responses to the DC question are tabulated in Table 6.3 below. The data from this table was used to construct the graphs in Figure 6.1. The graphs depict a right skewed distribution of "yes", "no", and "no opinion" responses to the DC question. There is no *a priori* expectation for the responses to follow a normal distribution. A right skewness is generally expected of DC response distributions and the results are therefore not surprising. Despite the seemingly low number of respondents to the $60 bid, the distribution of the responses does not appear to be bimodal. This suggests the possible absence or insignificance of strategic behaviour amongst the respondents. However without knowledge of the true underlying distribution of the values, visual inspection does not constitute a completely satisfactory test for strategic bias (Sutherland and Walsh, 1985)

Table 6.3 Response Distribution

Seed (NZ$)	Responses by bid level	Response categories					
		"yes"	prop yes[2]	"no"[1]	prop no[2]	"no-opinion"	prop no-op[2]
1.00	8	5	0.63	2	0.25	1	0.13
10.00	9	7	0.78	2	0.22	0	0.00
20.00	17	8	0.47	8	0.47	1	0.06
30.00	23	6	0.26	17	0.74	0	0.00
40.00	34	12	0.35	19	0.56	3	0.09
50.00	40	14	0.35	22	0.55	4	0.10
60.00	26	11	0.42	13	0.50	2	0.08
70.00	36	10	0.28	23	0.64	3	0.08
80.00	30	5	0.17	21	0.70	4	0.13
90.00	24	6	0.25	18	0.75	0	0.00
100.00	18	6	0.33	11	0.61	1	0.06
120.00	16	4	0.25	11	0.69	1	0.06
140.00	19	6	0.32	13	0.68	0	0.00
160.00	15	1	0.07	13	0.87	1	0.07
180.00	14	0	0.00	14	1.00	0	0.00
200.00	15	5	0.33	10	0.67	0	0.00

[1]Includes protests
[2]Proportion of respondents answering "yes", "no", or "no opinion" to the DC question

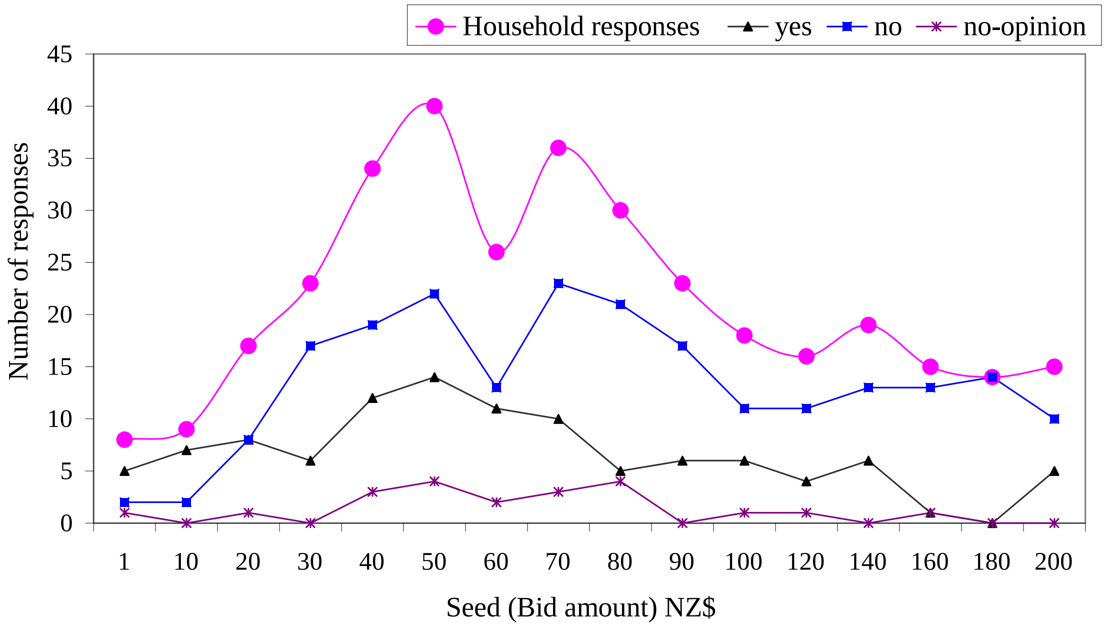

Figure 6.1 Frequency distribution of DC responses

6.1.3 Response Rates by Bid Amount

Table 6.4 and Figure 6.2 show the response/non-response rates to individual bid amounts. The response/non-response rates are calculated after deducting undelivered mail from the original questionnaires mailed out for each bid amount. The objective of this analysis is to find out if the individual bid amounts influence respondents' decision to participate in the survey. The response/non-response rate seems to vary randomly from one bid amount to the other. A linear trendline fitted to the response and non-response series indicates a slight downwards trend for the non-response rates and a slight upwards trend for the response rate as the bid amount increases. The explanation for this observation is likely to be due to the influence of the high (low) non-response (response) rate to the $1 bid amount otherwise the two trend-lines could be nearly horizontal indicating that in general, the bid amount does not significantly influence respondents' decision to participate.

Contrary to expectation, the response rate for the $1 bid amount was the lowest at 34.48%. It is expected that respondents offered the $1 bid would find it easy to respond positively to the valuation question as the financial burden associated with the "yes" response would be low. The probable explanation for the observed low response rate to the $1 bid could be that respondents offered this bid amount did not believe that the proposed restoration and preservation programme could be financed through such small contributions; did not take the survey seriously and therefore did not bother to participate. The alternative explanation could be that respondents offered the $1 bid did not think it worthwhile to cast a vote as a decision to adopt the proposed programme would not significantly affect them financially. However, Carson, Groves, and Machina (2000) argue that respondents who face low bids that seem unrealistic are likely to replace these bids with ‘expected cost’ and respond accordingly resulting in a higher proportion of "No" responses to the bid than one would otherwise expect.

Table 6.4 Response/Non-response rates by Bid amount

Bid Amount (NZ$)	Mailed out	Returned Undelivered	Assumed Delivered	Responses[1]	Response Rate	Non-Response	Non-Response rate
1	30	1	29	10	34.48	19	65.52
10	35	4	31	14	45.16	17	54.84
20	40	5	35	17	48.57	18	51.43
30	64	2	62	26	41.94	36	58.06
40	87	6	81	38	46.91	43	53.09
50	101	13	88	45	51.14	43	48.86
60	87	4	83	31	37.35	52	62.65
70	80	5	75	40	53.33	35	46.67
80	80	7	73	37	50.68	36	49.32
90	68	9	59	34	57.63	25	42.37
100	65	4	61	24	39.34	37	60.66
120	50	4	46	20	43.48	26	56.52
140	50	2	48	21	43.75	27	56.25
160	46	4	42	17	40.48	25	59.52
180	40	7	33	16	48.48	17	51.52
200	35	3	32	15	46.88	17	53.13

[1]Includes incomplete responses which did not address the valuation question and respondents who advised that they did not wish to participate

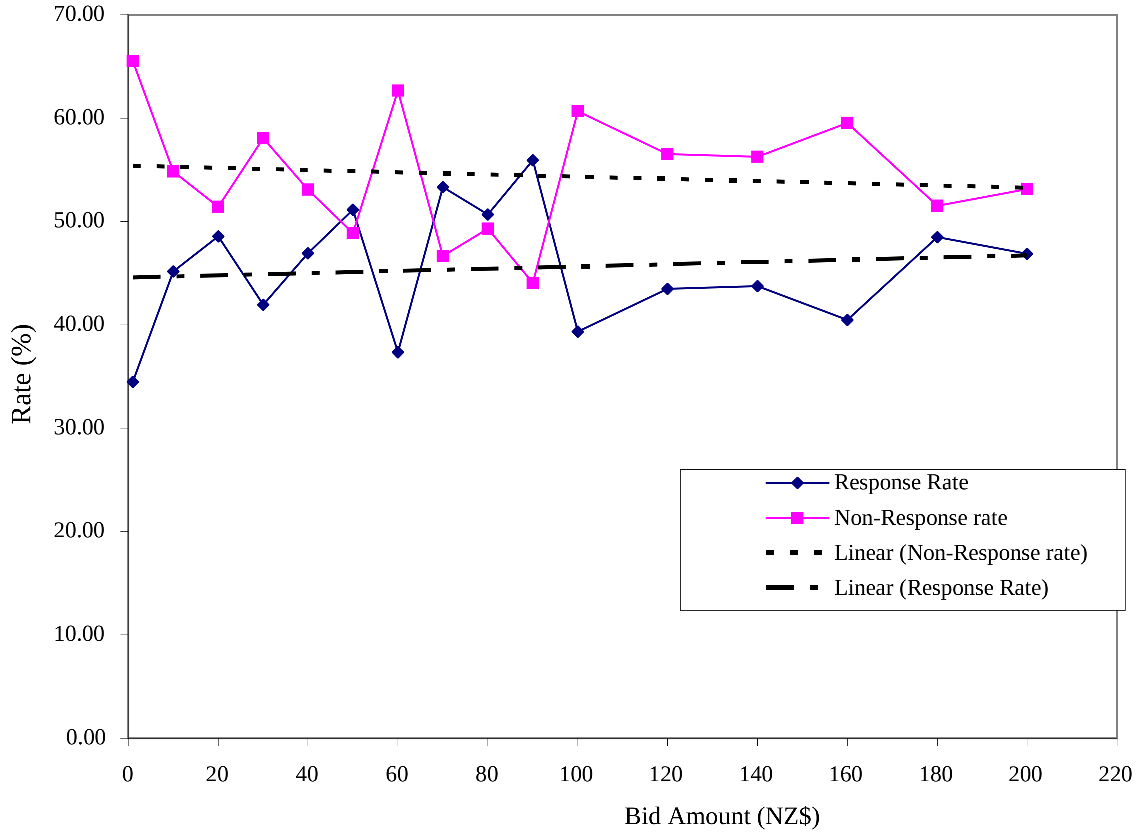

Figure 6.2 Response / non response rates per bid level

Figure 6.3 (constructed from Table 6.3 data) indicates that the proportion of respondents answering "yes" (the probability of saying yes) to the DC question falls as the bid amount increases whilst the proportion of respondents answering "no" increases. Wheeler and Damania (2001) report a similar pattern in "yes" responses to the DC question as the bid amount increases. Economic theory predicts a downward trend in consumer response to increases in the price of a normal good or service. It may be concluded that respondents in this survey behaved in a manner consistent with economic theory and the responses are likely to reflect their true preferences. Responses to this survey questionnaire may therefore be given an economic interpretation. It is also interesting to note that the proportion of respondents answering "yes" to the DC question is higher than that of respondents answering "no" at bid amounts below NZ$20. This means that respondents are more likely to say "yes" than "no" to the DC question at low bid amounts but this trend reverses once a significant or threshold bid amount, in this case NZ$20, is offered. Below NZ$20, the restoration and preservation of the Pekapeka Swamp is preferred by a majority of respondents.

The proportion of respondents expressing “no opinion” slowly declines as the bid amount increases suggesting that respondents facing higher bids tend to give more consideration to the question. This might suggest that the high bid amounts induce a sense of importance to the resource being valued and therefore encourage respondents to think through the whole value formulation process more seriously.

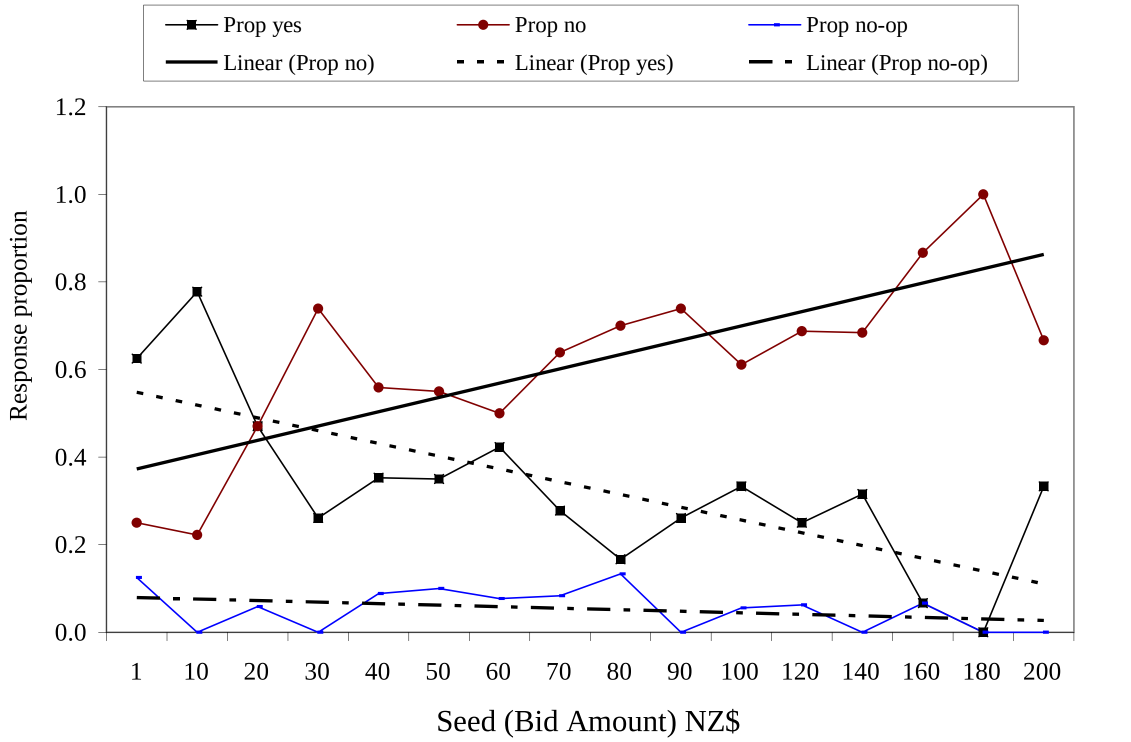

Figure 6.3 Analysis of responses to the DC question

Table 6.5 Frequency distribution of open ended WTP values for the restoration and preservation of the Pekapeka Swamp, Hawke's Bay 2008

Value Categories		Number of Respondents	Proportion of households (%)
Zeros	Genuine Zeros	77	8.77
	Protest Zeros	48	5.47
1 – 9.99		5	0.57
10 – 19.99		18	2.05
20 – 29.99		36	4.10
30 – 39.99		7	0.80
40 – 49.99		9	1.03
50 – 59.99		46	5.24
60 – 69.99		13	1.48
70 – 79.99		6	0.68
80 – 89.99		5	0.57
90 – 99.99		0	0.00
100 – 119.99		29	3.30
120 – 139.99		5	0.57
140 – 159.99		9	1.03
160 – 179.99		2	0.23
180 – 199.99		0	0.00
200 – 239.99		8	0.91
240 – 259.99		2	0.23
300 and above		1	0.11
No Opinion		17	1.93
Missing Value		21	2.39
Refusals		41	4.67
No response		473	53.87
Total		878	100.00
Mean Value (NZ$)		46.57*	
Median (NZ$)		30.00	

$$* \, Mean = \sum_{i=1}^{n} WTO_{OEi} = 12947 \div 278 = 46.57$$

6.1.4 Comparison of Sample and Population Statistics

To investigate how closely our sample represents the population, we compared the sample statistics to the population statistics provided by NZ Statistics. Table 6.6 compares respondents' demographic characteristics with those of the Hawke's Bay and national population. The sample household size is consistent with the 2006 census statistics. Significant differences are observed in the age distribution between the survey results and the census results with the sample and pre-test figures for the age groups 0 – 14, and the 65+ being lower and higher respectively. The differences in the figures may be attributed to sampling error and/or changes in population dynamics. The survey figure for the dominant age group, the 15 – 64, is similar to that of the census.

Annual income distribution statistics from the survey reveal a lower (higher) proportion of households earning less (more) than NZ$20,000 (NZ$50,000) compared to the census statistics. In the sample the proportion of the population falling in the income brackets NZ$20,000 – NZ$29,999 and NZ$30,000 – NZ$49,999 is 15.4 and 19.2 respectively compared with NZ overall (13.8 and 21.1).

Survey data on ethnicity shows higher (lower) proportions of European (Maori and Other) than the census data. The higher proportion of Europeans may be due to the different classifications used as the survey did not have a category for 'New Zealander' resulting in individuals in this category indicating their ethnicity as NZ European. The other explanation could be sampling error and/or self selection bias if most 'Maori' and 'Other' did not respond to the survey questionnaire. An analysis of gender statistics shows that the survey and census male and female proportions are nearly identical. On the basis of the above, it may be argued that the sample was reasonably representative of the population.

Table 6.6 Demographic profile of respondents versus Hawke's Bay and national population

Characteristic	Hawke's Bay[1] Region (%)	National[1] (%)	Sample Statistics (%)	
			Pre-test	Main Survey
Household Size	2.7*	2.8*	2.1*	2.4*
Age Group				
0-14	23.0	21.5	13.21	12.9
15-64	63.1	66.2	60.38	55.6
65+	13.9	12.3	22.64	22.9
Not Stated	-	-	3.77	8.6
Income Group				
< 10,000	17.8	19.3	4.0	3.0
10,000-19,999	22.8	19.5	20.0	10.7
20,000-29,999	15.4	13.8	12.0	15.4
30,000-49,999	21.1	21.1	12.0	19.2
50,000 +	12.4	16.2	40.0	39.3
Not Stated	10.4	10.2	12.0	12.4
Ethnicity				
European	61.6	67.6	76.0	85.5
Maori	21.1	14.6	8.0	4.4
Other	17.3	17.8	4.0	6.6
Not Stated	-	-	12.0	3.5
Gender				
Male	48.6	48.80	58.8	48.7
Female	51.4	51.20	41.2	51.3

[1]Data source: NZ Statistics – 2006 Census Data
* These are actual numbers not percentages

6.1.5 Summary of Reasons Given for and Against Supporting a Restoration and Preservation Programme with no Direct Cost to the Household

The reasons given for or against supporting a restoration and preservation programme with no direct cost to the household were grouped into 14 broad categories as indicated in Table 6.7. About 90.22% of the households indicated that they would support a restoration and preservation programme if it did not directly cost them any money. Category 6 (wetlands/nature are important) is the most popular with 21.01% of household responses falling within this category suggesting that respondents appreciate the importance of wetlands and nature in general in supporting life. Category 2 and 4 are tied in second place indicating that respondents place considerable importance to option use, bequest value, habitat and biodiversity. It is interesting to note that some households (13.77%) demonstrate appreciation of the importance of conservation and caring for the environment and were able to link environmental degradation to global warming. About 3.26% of the households indicated that they would support the programme on the basis of zero direct costs suggesting budgetary constraints or zero valuation of wetlands. Of those households expressing support for the "free" programme, 16.30% did not provide reasons for doing so.

Categories 10 to 14 summarise the responses of households that do not support the "free" programme. The main reason given for not supporting the programme was respondents did not believe that the programme could be provided at no direct cost to the household. This suggests that some respondents may have their own 'self-assessed cost' for the programme so that, when they are presented with a bid amount lower than the 'self-assessed cost', they will substitute the 'self-assessed cost' for the bid amount and answer "no" to the valuation question (Carson, Groves, and Machina, 2000) even if their true WTP is above the offered bid. It is surprising that 'old age' (2.17%) is given as one of the reasons for not supporting the programme suggesting that some elderly people do not care about the environment or that they are not concerned about future generations. Only 1 respondent (0.36%) indicated that the wetland should be converted to agricultural land. Other reasons for not supporting the programme are; wetlands are of no interest to respondents (1.45%); and that the site is too far from respondents' residence (0.72%). Some respondents did not provide reasons for their "no" response (2.54%).

Table 6.7 Reasons for and against supporting a programme that would not directly cost the households

Reason	Proportion of respondents (%)
Support	90.22*
1. It does not cost us anything	3.26
2. Important habitat/ ecology/ biodiversity	14.13
3. Recreation	4.35
4. Future use and future generation	14.13
5. Care for the environment/ conservation/ global warming	13.77
6. Wetlands/nature are important	21.01
7. It is the public's responsibility	2.90
8. It looks awful now	0.36
9. No reasons given for support	16.30
Do not support	9.78
10. Old age	2.17
11. Should be converted to agricultural land	0.36
12. Wetlands are of no interest to us	1.45
13. Does not believe that it won't directly cost any money	2.54
14. Pekapeka is too far from residence	0.72
15. No reasons given for not supporting	2.54

* Respondents who did not answer this question but indicated WTP above zero were assumed to support the "free" programme

6.1.6 Households Participation in Wetland Based Activities

Responses to the question on current wetland based activities suggest familiarity with all wetland based activities. The second column in Table 6.8 records the number of households who indicated that the corresponding wetland based activity is 'Important' for the household while the third and fourth columns list the number of households indicating the 'Main' activity and possible 'Future' activities respectively. Nature appreciation (15.7%, 16.8%, and 13.7%) and walking (15.3%, 23.2%, and 18%) dominate the list as Important, Main and Future activities respectively. Figure 6.4 highlights the relative importance of various wetland based activities to the Hawke's Bay community.

All the activities are indicated as important, main, and future activities suggesting widespread appreciation and participation in current and future wetland-based activities. About 71 (7.1%) of the households indicated that they do not participate in wetland-based activities. However, a lower number of households (40) ticked the box corresponding to 'Don't undertake activity in wetlands' when asked to indicate future activities suggesting possible increased participation in future wetland based activities.

Table 6.8 Summary of household responses on wetland-based recreation

Activity	Important** Activities	Main Activity	Future Activities
Game bird hunting	38 (3.8%)	22 (6.1%)	28 (3.3%)
Gundog trails	13 (1.3%)	1 (0.3%)	9 (1.1%)
Fishing	64 (6.4%)	22 (6.1%)	56 (6.6%)
Photography	70 (7.0%)	7 (2.0%)	71 (8.4%)
Bird-watching	81 (8.1%)	16 (4.5%)	67 (7.9%)
Scientific research	44 (4.4%)	2 (0.6%)	15 (1.8%)
Teaching and education	83 (8.4%)	24 (6.7%)	60 (7.1%)
Nature appreciation	156 (15.7%)	60 (16.8%)	116 (13.7%)
Walking	152 (15.3%)	83 (23.2%)	152 (18.0%)
Picnics	82 (8.3%)	22 (6.1%)	87 (10.3%)
Swimming	43 (4.3%)	8 (2.2%)	43 (5.1%)
Boating	39 (3.9%)	11 (3.1%)	41 (4.8%)
Camping	50 (5.0%)	10 (2.8%)	52 (6.1%)
Don't*	71 (7.1%)	67 (18.7%)	40 (4.7%)
Other	8 (0.8%)	3 (0.8%)	9 (1.1%)
Total	994 (100)	358(100)	846(100)

* Don't undertake activity in wetlands. ** Percentages are based on the total number in each category

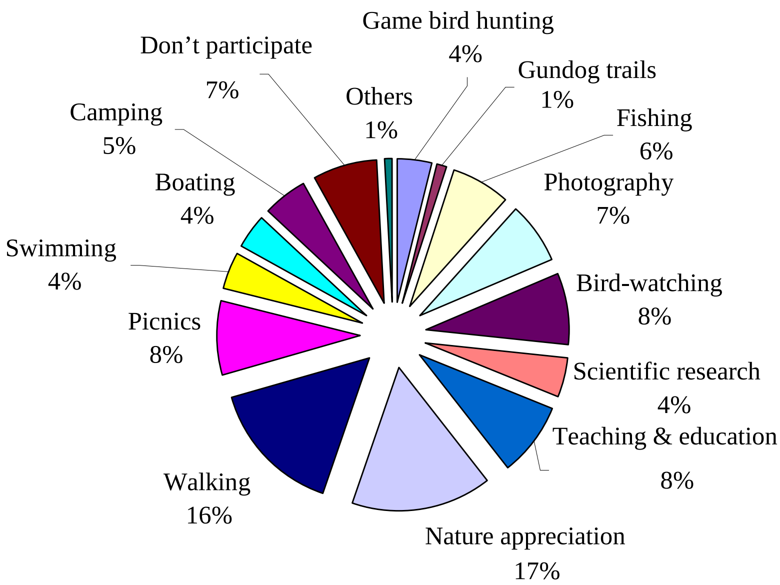

Figure 6.4 Relative importance of wetland-based activities

A large number of respondents (167 about 60.5%) indicated that they had not spent any days in recreation at wetlands in New Zealand in the last 12 months. Of those households that had spent some days in recreation at wetlands, 75 (27.2%) had spent between 1 and 10 days and 29 (9.1%) had spent more than 10 days. About 3.2% of the respondents did not answer the question (Q-2) (see Appendix 4.2 for item non-response).

6.1.7 Potential use of the Restored Pekapeka Swamp

Pekapeka Swamp appears to be well known by the residents of Hawke's Bay as evidenced by 219 (79.3%) of the respondents indicating prior awareness of its existence (Q-1). Households indicating that they were not aware of its existence, before the survey, accounted for 17.4% of the responses. The item non-response rate was 3.3%. This appears to be very close to the item non-response rate for (Q-2) discussed in the pervious section suggesting that respondents who did not answer this question (Q-1) also did not answer (Q-2). These are the first two questions in the survey questionnaire and appear at the bottom of the same page and might have been overlooked by some respondents.

Indications are that the restored Pekapeka Swamp is likely to be utilised by a sizeable number of Hawke's Bay residents. About 52.5% of the respondents indicated that on average they would spend between 1 and 10 days per year at the restored Pekapeka Swamp, and 5.1% would spend more than 10 days. Respondents indicating zero days account for 34.1%. Item non-response rate was 8.3%. Figure 6.5 and Table 6.9 summarise respondents' responses to (Q-22) on the potential use of the restored site. Respondents were permitted to make multiple selections of activities under any of the categories. The percentage figures given are based on the total number of selections under each category and indicate the relative position of each activity under the same category.

Walking (186 or 17.9%) is considered to be potentially the most important wetland activity at the restored swamp followed by nature appreciation (169 or 16.2%), picnics (120 or 11.5%), photography (97 or 9.3%), bird-watching (95 or 9.3%), and teaching and education (90 or 8.7%). These activities also dominate as potential main and future activities at the swamp. Gundog trails (7 or 0.7%) is potentially the least important activity.

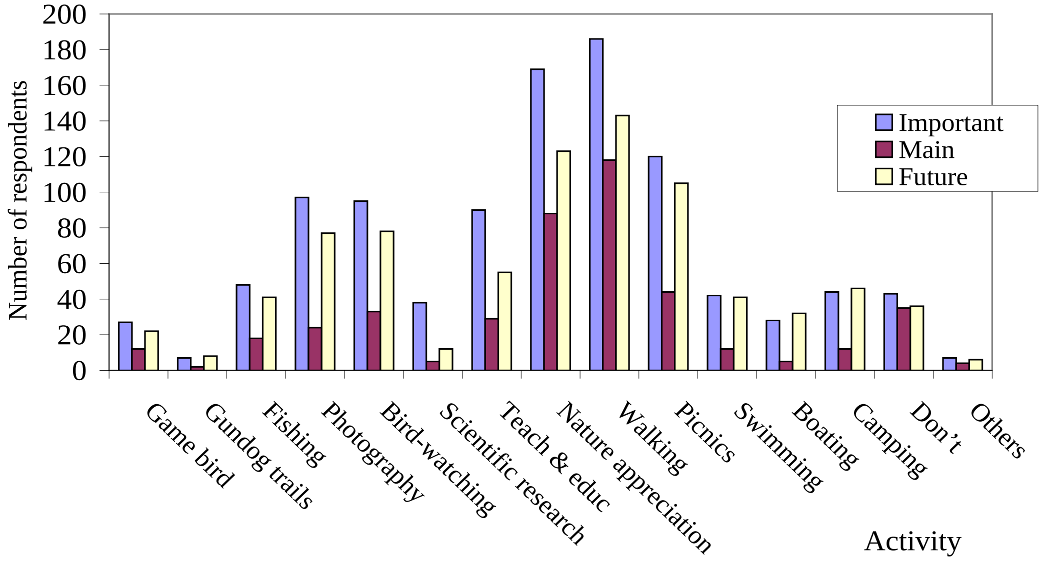

Figure 6.5 Future use of the restored Pekapeka Swamp

Table 6.9 Potential future participation in wetland based activities at Pekapeka Swamp

Activity	Important	Main	Future
Game bird hunting	27 (2.59%)	12 (2.72%)	22 (2.26%)
Gundog trails	7 (0.67%)	2 (0.45%)	8 (0.97%)
Fishing	48 (4.61%)	18 (4.08%)	41 (4.97%)
Photography	97 (9.32%)	24 (5.44%)	77 (9.33%)
Bird-watching	95 (9.13%)	33 (7.48%)	78 (9.45%)
Scientific research	38 (3.65%)	5 (1.13%)	12 (1.45%)
Teaching and education	90 (8.65%)	29 (6.58%)	55 (6.67%)
Nature appreciation	169 (16.23%)	88 (19.95%)	123 (14.91%)
Walking	186 (17.87%)	118 (26.76%)	143 (17.33%)
Picnics	120 (11.53%)	44 (9.98%)	105 (12.73%)
Swimming	42 (4.03%)	12 (2.72%)	41 (4.97%)
Boating	28 (2.69%)	5 (1.13%)	32 (3.88%)
Camping	44 (4.23%)	12 (2.72%)	46 (5.58%)
Don't undertake activity in wetlands	43 (4.13%)	35 (7.94%)	36 (4.365)
Others	7 (0.67%)	4 (0.91%)	6 (0.73%)
Total	1041(100%)	441 (100%)	825 (100%)

6.1.8 Effect of Distance on the Response Rate

The coefficient of correlation between the response rate and the distance from the site is negative as expected but it is small and highly insignificant. This suggests that the response rates from the different areas within the Hawke's Bay were not influenced by distance (see Appendix 4.3 for response rates by area). This is expected as all respondents reside within a 200km radius from the site, and 95.65% of the respondents reside within 100km of Pekapeka Swamp. The effect of distance on WTP will be examined later.

6.1.9 Analysis of Early and Late Responses and Comment on the Acceptability of the Overall Response Rate

The hypothesis that early and late respondents differ in their characteristics, attitudes, and behaviours was tested using analysis of variance (ANOVA) on a selected number of variables. The results of this analysis are presented in Tables 6.10.

Table 6.10 ANOVA Results

Analysis of Variance on Selected socio-economic, demographic, behavioural, and attitudinal variables by wave of questionnaire return (Early, Middle, and Late)

Variable*	F-Value	P-value	F critical
Income (MIncome)	0.2343	0.7913	3.0354
Age of household head	0.9688	0.3811	3.0354
Household size	1.8518	0.1593	3.0354
Membership	2.3399	0.0986	3.0354
Score	1.1125	0.3305	3.0354
WTP open-ended	2.3477	0.0979	3.0354
Aware (Knowledge)	1.4026	0.2481	3.0354
Distance	0.07661	0.9268	3.0354
Supports	1.3664	0.2571	3.0354
Activity2	3.7290	0.0255	3.0354
Gender	1.1944	0.3045	3.0354
Educ	0.4266	0.6533	3.0354
Employ	0.3880	0.6789	3.0354
Active	2.2284	0.1100	3.0354

*Variables are defined in the next section

The null and alternative hypotheses are:

Null Hypothesis: *There is no significant difference in the population means across the three response categories.*
Alternative Hypothesis: *The means are not the same.*

The ANOVA results summarised in Table 6.10 suggest that the null hypotheses for all the variables, except Activity2, may not be rejected at the 5% level, and we may conclude that the means of these variables across the three response categories do not differ significantly from each other at the 5% level. With the exception of Activity2, the p-values are large and the F values are lower than the corresponding critical values. Activity2 has an F value of 3.7290 that is greater than the F critical value of 3.0354 and p-value of 0.0255 indicating that the mean of this variable differs significantly across response categories. The null hypothesis that the mean of Activity2 is the same across response categories is rejected at the 5% level and we conclude that responses as measured by the variable Activity2 differ significantly across response categories.

Based on the above results we may conclude, with qualification, that our response rate is adequate and that it may represent the population as well as would a higher response rate because early and late respondents did not report values that are statically different (Walsh, Loomis, & Gillman, 1984; Sutherland & Walsh, 1985) at the 5% level except for Activty2. Our results generally support the findings by Wellman *et al*., (1980) that there is no significant difference between early and late respondents.

6.1.10 Definition of Variables

The variables defined below will be used in the estimation of the logit model and the WTPOE model. Active, Score, Supports, and Activity2 were constructed from responses to (Q-3) to (Q-5), (Q-6) to (Q-17), (Q-21), and (Q-22) respectively. Active is the total number of selected activities under columns A, B and C in the survey questionnaire. The basis for using Active as an index for current wetland activities is that individuals who select more activities as either important, main or future activities are likely to value the wetland more than respondents who do not regard wetlands activities as important now and in the future. Score is the average score for Q-6 to Q-17 where respondents were asked to indicate the importance of each of the value components of a wetland on a scale of ‘No Opinion’ (0) to ‘Extremely Important’ (4). Activity2 is constructed in a similar way to Active but differs in that it specifically relates to Pekapeka Swamp whereas Active relates to current wetland activities in general. Table 6.11a and 6.11b lists the variables and variable statistics respectively.

Table 6.11a Description of variables

Variable	Description
Active	Index for current wetland activities (continuous)
Activity2	Score for future potential use of the restored Pekapeka Swamp
Age	Age of household representative completing the form in years
Aware	Awareness of the existence of the Pekapeka Swamp (Yes = 1; No =0)
Distance	Distance of respondents’ residence to the site in kilometres
Educ	Level of education of the household representative (high school + in years)
Employ	Employment status of household representative (employ = 1; 0 otherwise)
Gender	Gender of household representative (Male = 1; Female = 0)
Income	Annual household income (coded)
Membership	Membership of environmental group (yes = 1; no = 0)
MIncome	Annual household income in 2008 NZ$
Score	Household average score for attitude towards the environment
Seed	Bid offered in 2008 NZ$
Size	Number of persons in household
Supports	Indicates attitude towards environmental conservation (yes = 1; 0 otherwise)
WTPOE	Respondents’ open-ended WTP response
YDC	Response to the DC question (yes = 1; no = 2)

Table 6.11b Summary of variables statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
MIncome	231	53701	32128	12404885	5000	115000
Income	231	5.87	3.21	1356.00	1.00	12
Score	231	2.64	0.87	610.75	0.00	4
Active	231	6.95	5.53	1606.00	0.00	24
Supports	231	0.90	0.31	206.00	0.00	1
Age	231	58.82	14.62	13587.00	21.00	92
Seed	231	77.48	51.23	17898.00	1.00	200
Educ	231	5.25	2.64	1213.00	0.00	16
Size	231	2.49	1.38	576.00	1.00	8
Distance	231	34.46	28.74	7960.00	4.70	198
Membership	231	0.16	0.36	36.50	0.00	1
Activity2	231	7.57	6.20	1748.00	0.00	28
Gender	231	0.51	0.50	117.00	0.00	1
Employ	231	0.58	0.48	133.00	0.00	1
Aware	231	0.80	0.39	185.00	0.00	1
WTP_{OE}	231	47.88	56.50	11060.00	0.00	300
lnDistance*	231	3.32	0.62	768.03	1.55	5.29
lnMIncome*	231	10.67	0.74	2464	8.52	11.65
lnSeed*	231	4.03	1.03	930.05	0	5.30

*These are natural logs of the relevant variables

6.1.11 Correlation Analysis

A SAS 'proc corr' statement was used to analyze the correlation between the variables Income, Score, Active, Supports, Age, Seed, Educ, Size, Distance, Membership, Activity2, Gender, Employ, and Aware. Results indicate significant correlation between some paired variables. For example, as expected, Income is significantly correlated[22] with Age (-0.49), Educ (0.36), Size (0.37), and Employ (0.58) since in reality these variables influence the level of Income. This suggests that respondents provided true information on these variables. The influence of Income on variables like Active (0.25), Activity2 (0.26), Score (0.32), and Supports (0.18) are clearly evident in the highly significant correlation coefficients. This is expected because as people's incomes increase, the demand for a higher quality environment is expected to increase which positively influences these variables. Other significant correlations worth noting are: Supports with Score (0.29) and Active (0.23); Activity2 with Age (-0.26), Aware (0.19) and Employ (0.3); and Employ with Age (-0.59). Spurious or nonsense correlations such as Seed with Score are ignored because the relationship is meaningless.

When significantly correlated variables are used as predictor variables in a regression, their relationship may potentially affect the magnitude and signs of the coefficients of the variables concerned. To investigate the possible effects of this problem (multicollinearity), Income was used as an instrumental variable (IV) for Age, Educ, Size, and Employ; and Supports as an IV for Score, and Active. This however did not provide a better model fit suggesting very little or no effect and the results are not reported.

6.1.12 Testing for Anchoring Effects

Existence of anchoring was investigated using One-Way ANOVA with Pairwise Comparisons to establish whether there is any significant correlation between the bid offer and stated WTPOE, and whether respondents' mean WTPOE varies significantly across bid levels. The null hypothesis is that all the means (mean WTPOE) are the same i.e. they are not significantly different across bid levels and the alternative hypothesis is that the group means are not equal. These may be stated as:

---

[22] Correlation coefficients are given in parenthesis and are significant at the 1% level.

H_0: $\mu_1 = \mu_2 = \mu_3 \ldots\ldots\ldots\ldots\ldots = \mu_{16}$

H_1: $\mu_i <> \mu_j$

The fitted model's R^2 (0.16) and coefficient of variation (111.90), suggests some influence of the bid offer (Seed) on WTP responses to the open-ended question. The ratio of model Mean Square to error Mean Square (7798.54/2870.57 = 2.72) gives an F value of 2.72 with a small p-value less than 0.0008, suggesting that the group means significantly differ from each other. The probability of observing an F value of 2.72 by chance is highly unlikely. H_0 may be rejected in favour of the alternative hypothesis (H_1) that the means are significantly different. The test does not tell us which pairs are different but only suggests evidence that at least one pair of means differs significantly.

To investigate how serious the differences are, a multiple comparison procedure was performed. A summary of the results of the analysis are presented in Table 6.11c and Figure 6.6. Table 6.11c lists the group means (WTPOE), their standard errors and the 95% confidence intervals for the group means. The groups with the same letter under the '(Dunn)* t Test' column have means that are not significantly different from each other. Figure 6.6 is a graphical presentation of the group means and their corresponding 95% confidence intervals.

Table 6.11c Summary results of One-Way ANOVA with Pairwise Comparisons

SEED (NZ$)	Number[1] of responses	Mean WTPOE	(Dunn)* t Test	SE	95% Confidence Interval	
					Lower bound	Upper bound
1	8	12.00	B -	17.62	-22.54	46.54
10	8	13.13	B -	7.04	-0.67	26.92
20	13	21.85	B -	29.68	-36.33	80.02
30	16	23.44	B -	30.37	-36.09	82.96
40	23	40.87	B A	47.38	-51.99	133.73
50	26	36.65	B A	33.27	-28.56	101.87
60	17	71.18	B A	75.98	-77.75	220.10
70	22	50.23	B A	37.62	-23.51	123.97
80	16	38.75	B A	38.92	-37.54	115.04
90	19	65.79	B A	76.18	-83.52	215.10
100	10	72.00	B A	64.60	-54.62	198.62
120	11	62.73	B A	58.15	-51.25	176.71
140	15	67.80	B A	64.57	-58.76	194.36
160	10	41.50	B A	55.18	-66.65	149.65
180	6	18.33	B -	40.21	-60.47	97.14
200	11	106.36	- A	99.32	-88.31	301.04

* Bonferroni (Dunn) t test for WTPOE. [1]Based on the final dataset.

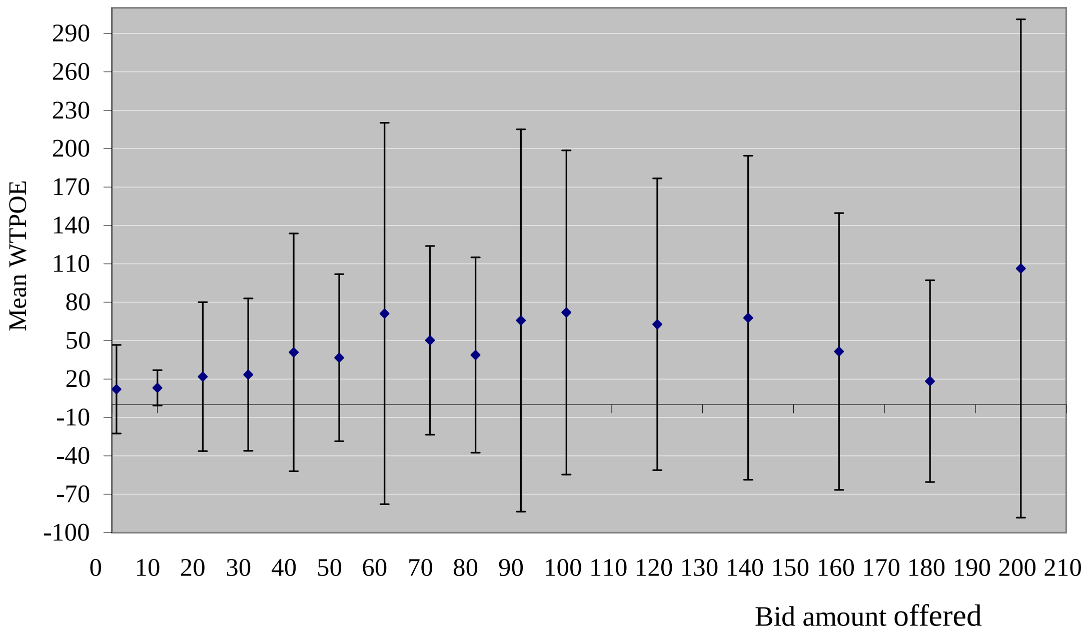

Figure 6.6 Mean WTPOE and 95% confidence intervals by bid level

The Bonferroni (Dunn) t Test for WTPOE reveals that the group means of WTPOE values solicited from 15 of the 16 bid levels are not significantly different suggesting the absence, or insignificance, of anchoring effects. Mean WTPOE for the group corresponding to the bid level of $200 significantly differs from those of the other bid levels taken together. Figure 6.6 shows that mean WTPOE corresponding to the $200 bid level lies outside the confidence intervals of six groups. Possible explanations for the seemingly higher than normal group mean for respondents offered the $200 bid are, ‘yea-saying’, and/or respondents took the offered bid as an indicator for the expected cost of the project. However, the large variance of the group mean WTPOE suggests that respondents offered the $200 bid stated a wide range of WTP values which are not clustered around the $200 mark. The general conclusion that may be drawn from these results is that anchoring effects may not have been significant in influencing responses to the open ended valuation question.

6.2 Model Estimation

A number of models are estimated to determine the factors that influence WTP and to investigate the sensitivity of the estimated sample mean (or median) WTP to the fitted models. We apply different methods of estimating the value of WTP (i.e. mean WTP, truncated mean WTP, and median WTP) from the fitted models to explore their possible effect on the reported value of WTP and aggregate WTP. We start by estimating a full multivariate model (Model A) which includes all the variables hypothesised to have an influence on the response to the valuation question, followed by: (1) a simple (univariate) model with Seed as the only explanatory variable (Model B); (2) a linear model fitted using forward stepwise selection procedure with alpha set between 0.15 and 0.35 (Model C); (3) a linear model fitted using forward stepwise selection procedure with alpha set at 0.05 (Model D); and (4) a model with a logarithmic specification fitted using forward stepwise selection procedure with alpha set at 0.05 (Model E).

All the estimated models (except Model E) are based on a simple linear utility function. Some studies have estimated models based on a semi-log utility function where the natural logs of income and/or bid amount enter the model as explanatory variables (Bishop & Heberlein, 1979; Bishop, Heberlein & Kealy, 1983; Bowker & Stoll, 1988). Hanemann (1984, p. 332) criticizes such models and argues that they are “not strictly compatible with the utility-maximization hypothesis” and the parameters of the estimated logit model are not easy to interpret. However, Bowker and Stoll (1988) find that the models based on the logarithmic specifications perform better on the basis of goodness of fit statistics. A comparison of model fit statistics for Models D and E will test Bowker and Stoll’s (1988) findings.

The hypotheses on the relationships between the dependent variable and the explanatory variables are the same for all the models (the various hypotheses are discussed below). The dataset used to estimate the models excludes respondents whose responses to the DC and open ended valuation questions are inconsistent. For example, if a respondent is offered a bid amount of $100 and says “yes” to the DC question but states a WTP value below $100 in response to the open ended question, the valuation is considered as inconsistent and is dropped from the dataset used to estimate the models. The exclusion of inconsistent responses[23] reduced the useable sample to 231. The full logit model reflecting these hypotheses may be expressed as:

$$logit = logOdds = log(p/q) = \alpha + \beta_1 MIncome + \beta_2 Score + \beta_3 Active + \beta_4 Supports - \beta_5 Seed$$
$$- \beta_6 Age + \beta_7 Educ - \beta_8 Size - \beta_9 Distance + \beta_{10} Membership$$
$$+ \beta_{11} Activity2 + \beta_{12} Gender + \beta_{13} Employ + \beta_{14} Aware \quad (1)$$

Income (MIncome) is expected to have a positive influence on the respondents' WTP based on the theory of demand. The coefficient on 'Score' is expected to be positive as respondents who attach high importance on various aspects of the environment are likely to state higher values for environmental improvement. 'Active' is an index for current wetland based recreational activities. Respondents expressing a high score are expected to be fully aware of the benefits from wetlands and are likely to more willing to pay than respondents who are not currently enjoying wetland based recreation. The coefficient on 'Active' may turn out to be negative if the wetlands currently utilised for recreational purposes are viewed as substitutes for Pekapeka Swamp. 'Supports' is a dummy for attitude towards environmental improvement. Respondents expressing support for environmental improvement are more likely to be willing to pay more that those who don't.

The coefficient on Seed is expected to have a negative sign, assuming a downward slopping demand curve. As the seed amount increases, the likelihood of a "yes" response is expected to fall. The relationship between the dependent variable and 'Age' is hypothesised to be negative as older respondents' participation in wetland based recreation is expected to be lower than that of younger respondents. Also older respondents may view the restoration and preservation programme as not relevant to them if they think that they might not be around long enough to enjoy the future benefits of the restored wetland. However some older respondents may state high WTP values if they attach more importance on non-use value such as bequest, and existence values.

Respondents with high educational qualifications are hypothesised to state higher WTP

[23] A total of 45 respondents whose valuations were deemed inconsistent were dropped from the final dataset used to estimate the model. The large number of inconsistent responses may indicate a number of issues such as, ticking the wrong box, lake of understanding of the question, protesting, not taking the valuation seriously, and the difficulty associated with value formulation.

values on the assumption that they are more likely to be knowledgeable and have more access to information on environmental issues, making them more appreciative of the importance of the environment. ‘Size’ measures the number of individuals within each household. It is hypothesised that a large household’s WTP is likely to be more sensitive to the household’s budget constraint than a smaller household with the same characteristics. Respondents staying far from the site are less likely to visit the site because of higher travel cost, increased likelihood of nearby substitutes as distance increases, and the possibility of lack of knowledge of the existence of the site. This may not hold if the site is of national or international importance.

Respondents who are members of environmental groups are likely to be more environmentally aware than non-members and are therefore hypothesised to express higher WTP values, hence the positive sign on the coefficient on ‘Membership’. ‘Activity2’ is an index for potential use of the restored site. Respondents who indicate higher potential use of the site are expected to state higher WTP values than respondents whose potential use of the site is low. The positive sign on the coefficient on ‘Gender’ is arbitrary as we have no *a priori* expectation as to the sign of the coefficient on this variable.

Employ is a dummy variable indicating whether the respondent is employed or not. Unemployed respondents are more likely to be financially constrained than the employed and are therefore likely to express lower WTP value, ceteris paribus. Aware is a dummy for awareness of the existence of the site before the respondents received the survey. Respondents who are aware of the existence of the site are likely to be aware of its current degraded state, stay close to the site, have visited the site before, and have probably thought about the issue before hand. Their WTP is expected to be higher than that of respondents who are unaware of its existence, assuming that they are concerned about environmental issues.

6.2.1 Fitting a Multivariate Logit Model (Model A)

SAS command for fitting a multivariate logit model

```
proc logistic data=sasuser.valid;
model YDC=MIncome Score Active Supports Seed Age Educ Size Distance Membership Activity2 Gender Employ Aware /rsq lackfit;
run;
```

To investigate the relationship between the response variable and a set of explanatory variables hypothesised to influence it, the above SAS logistic regression command was use to generate the output summarised in Tables 6.12a to 6.12d

Table 6.12a Model Fit Statistics for logit Model A

Criterion*	Model I Intercept Only	Model II Intercept and Covariates
AIC	316.940	271.390
SC	323.383	323.026
-2 Log L	317.940	241.390

* AIC and SC are the Akaike Information Criterion and Schwarz Criterion respectively. (These are deviants of -2 Log L. They penalise the Log L by the number of predictors in the model).

The lower values of AIC, SC, and the -2Log L for Model II compared to the Model I (with intercept only) indicate that Model II as a whole fits significantly better than an empty model: the lower the values the better the model (see Table 6.12a). The global null hypothesis that all the coefficients of the explanatory variables are not significantly different from zero is rejected even at the .001 level on the bases of all three tests; the Likelihood Ratio, Score and Wald, with p-values of <.0001 each (see Table 6.12b). The Hosmer and Lemeshow Goodness-of-Fit Test with a Chi-Square of 4.3160, 8 degrees of freedom, and a p-value of 0.8275 rejects the hypothesis that the fitted model is not adequate. The adjusted R-Square of 0.3774 is above the minimum standard of an R-Square of at least 0.15 for contingent valuation studies suggested by Mitchell & Carson (1989). Our R-Square compares well with similar studies estimating a logistic model (Walsh, Loomis & Gillman, 1984; Seller Stoll, & Chavas, 1985; Brouwer & Bateman, 2005). An adjusted R-Square of 0.3774 indicates that 37.74% of the total variations in the logit or log of odds are explained by the variables included in the function. Walsh, Loomis and Gillman (1984) obtained adjusted R-square values of between 0.37 and 0.42 and concluded that they represent a satisfactory level of explanation for data from a cross section survey of households. The c statistic in Table 6.12d indicates that the model is able to correctly predict 81.8 % of the observed responses. The conclusion that may be drawn from the model test results is that the estimated model fits the data well.

Table 6.12b lists the variables' estimated coefficients, standard errors, Wald Chi-Square and corresponding p-values, and model fit statistics. The estimated coefficients on MIncome, Score, Active, Supports, Membership, Activity2, Aware, and Employ have positive signs as expected. MIncome is significant at the 0.10 level; Distance, Membership, and Activity2 are significant at the 0.05 level; Supports and Seed are significant at the 0.01 level; and the rest of the variables are insignificant at the 0.10 level. The positive sign of the coefficient on Gender is interesting in the sense that it implies that having a male household representative increases the probability of a "yes" response to the valuation question. This would make sense if men were more environmentally aware, enjoy more wetland recreation than women, and place a larger bequest value on natural resources than women.

The coefficients on Seed, Age, Educ, Size, and Distance have negative signs as expected except for Educ. The negative sign on Educ is surprising as we had expected it to be positive. This suggests that educated people are less likely to be willing to pay for the programme. This makes intuitive sense where educated respondents have knowledge of who should be held responsible for creating the problem in the first place and expect them to pay for the restoration of the swamp. The negative sign of the coefficients on Seed, Age, and Distance accord with previous empirical findings in environmental valuations (Sutherland, & Walsh, 1985; Pate, & Loomis, 1997; Bateman *et al*., 2006).

Since the dependent variable in the regression is the logit or log of odds in favour of a "yes" response, the coefficients may be interpreted as the partial effects of the individual variables on the log of odds or the logit. For example, the coefficient on MIncome of 0.000011 means that a one unit ($1) change in household income results in a 0.000011 unit change in the logit or log of odds whilst holding other variables constant. Exponentiating the coefficient on MIncome 0.000011 gives $e^{0.000011}$ which is equal to 1, the odds ratio for MIncome. Table 6.12c lists the odds ratio point estimates and their 95% Wald confidence limits. The odds ratio for income of 1 means that for a unit ($1) increase in MIncome, the odds of saying "Yes" to the valuation question increase by (1 – 1)*100% = 0%. This is expected from the assumption which is often adopted that the income effects for environmental goods is small hence the small coefficient on MIncome, and is consistent with results from other studies (Bennett, Morrison, & Blamey, 1998; Brouwer, & Bateman 2005). Large changes in income are required before its influence on WTP can be experienced. For variables with odd ratios less than 1, a unit increase in each variable reduces the odds of saying "Yes" to the valuation question.

The estimated intercept has a negative sign implying that the log of odds or the logit has a negative sign when the effect of all other variables is ignored and the suggested bid amount is zero. The antilog of the intercept is the odds in favour of saying "Yes" to the project when the programme does not cost anything. This value is given by $e^{-2.7106}$ and is equal to 5.429. This means that a respondent is 5.429 times more likely to agree to the programme than oppose it if it cost him/her nothing.

The positive but small coefficient on MIncome (income) is consistent with economic theory. Since the annual payments are a very small fraction of annual household income, the resulting income effects are small. The coefficient on income is insignificant at the 0.05 level. This may be due to measurement error on household income. Respondents were not asked to state their actual income but were asked to merely indicate the range in which their incomes lay. This was done to avoid 'item non-response' as respondents may not be prepared to disclose their actual incomes. Even if respondents provide correct information on income, the income bands normally used (as in this case) are very wide resulting in respondents with, a $10 000 annual income difference being lumped together and assigned the same annual income. The respondents, who answered the valuation question and provided information on all other variables but refused to provide their income, were assigned the sample average income. It is also possible that some respondents may have provided individual income as opposed to household income.

Table 6.12b Analysis of Maximum Likelihood Estimates and fit statistics for logit Model A

Variable	DF	Coefficient	Standard Error	Wald Chi-Square*	Pr > ChiSq
Intercept	1	-2.7106	1.7298	2.4556	0.1171
MIncome	1	0.000011	6.663E-6	2.7783	0.0956
Score	1	0.3125	0.2241	1.9452	0.1631
Active	1	0.00349	0.0435	0.0065	0.9360
Supports	1	2.6865	1.0765	6.2285	0.0126
Seed	1	-0.0147	0.00360	16.7423	<.0001
Age	1	-0.00517	0.0155	0.1114	0.7386
Educ	1	-0.0923	0.0654	1.9925	0.1581
Size	1	-0.1131	0.1355	0.6962	0.4041
Distance	1	-0.0140	0.00717	3.8144	0.0508
Membership	1	0.9482	0.4905	3.7369	0.0532
Activity2	1	0.0788	0.0382	4.2509	0.0392
Gender	1	0.3902	0.3431	1.2929	0.2555
Employ	1	0.1171	0.4531	0.0668	0.7960
Aware	1	0.1632	0.4452	0.1345	0.7138

Testing Global Null Hypothesis: Beta = 0

Test	DF	Chi-Square	Pr > ChiSq
LR	14	76.5503	<.0001
Score	14	61.8668	<.0001
Wald	14	44.5796	<.0001

Hosmer and Lemeshow Goodness-of-Fit Test (with 8 DF) 4.3160 0.8275

R – Square 0.2821 Max-rescaled R – Square 0.3774

*Wald Chi-Square = (estimated coefficient÷standard error)^2
**Transformed coefficient is obtained by dividing the corresponding coefficient in the second column by the absolute value of the coefficient on Seed

Table 6.12c summarizes the odds ratio point estimate and their corresponding 95% Wald Confidence Intervals. The confidence intervals give the range in which the expected values of the true population parameters lie at the 95% level.

Table 6.12c Odds Ratio estimates for logit Model A

Effect	Point Estimate	95% Wald Confidence Interval Lower CL	Upper CL
MIncome	1.000	1.000	1.000
Score	1.367	0.881	2.121
Active	1.003	0.922	1.093
Supports	14.681	1.780	121.072
Seed	0.985	0.978	0.992
Age	0.995	0.965	1.026
Educ	0.912	0.802	1.037
Size	0.893	0.685	1.165
Distance	0.986	0.972	1.000
Membership	2.581	0.987	6.750
Activity2	1.082	1.004	1.166
Gender	1.477	0.754	2.894
Employ	1.124	0.463	2.732
Aware	1.177	0.492	2.817

Figure 6.12d Association of predicted probabilities and observed responses for logit Model A

Percent Concordant	81.8	Somers' D	0.637
Percent Discordant	18.1	Gamma	0.638
Percent Tied	0.2	Tau-a	0.317
Pairs	13208	c	0.818

From the standard logit equation:

$$\text{Logit} = \log(\text{Odds}) = \log(p/q) = \alpha + x\beta \tag{2}$$

Where α is the intercept, x and β are vectors of the variables and their coefficients respectively. The above logit model assumes a linear utility function. Taking antilog on both sides of the equation gives us:

$$\text{Odds} = p/q = e^{(\alpha + x\beta)} \tag{3}$$

The estimated logit model including all the variables hypothesized to have an influence on an individual household's WTP for the restoration and preservation of Pekapeka Swamp is (standard errors are in parenthesis):

$$
\begin{aligned}
Logit = Log\ of\ Odds = Log(p/q) = & -2.7106 + 0.00001 * MIncome_i + 0.3125 * Score_i \\
& \quad (1.7298) \quad (6.663E-6) \qquad\qquad (0.2241) \\
& + 0.00349 * Active_i + 2.6865 * Supports_i - 0.0147 * Seed_i - 0.00517 * Age_i \\
& \quad (0.0435) \qquad\quad (1.0765) \qquad\qquad (0.0036) \qquad (0.0155) \\
& - 0.0923 * Educ_i - 0.1131 * Size_i - 0.0140 * Distance_i + 0.9482 * Membership_i \\
& \quad (0.0654) \qquad (0.1355) \qquad (0.00717) \qquad\quad (0.4905) \\
& + 0.0788 * Activity2_i + 0.3902 * Gender_i + 0.1171 * Employ_i + 0.1632 * Aware_i \\
& \quad (0.0382) \qquad\quad (0.3431) \qquad\quad (0.4531) \qquad\quad (0.4452)
\end{aligned}
\tag{4}
$$

The estimated logit (log odds) model provides useful information for policy purposes by making it possible to deduce the sensitivity of the resource value to changes in the level of the factors that affect it. When the above equation is evaluated at the means of all the variables except Seed and the products, including the intercept, summed up, it reduces to[24]:

$$\text{logit} = \text{log Odds} = \text{log}(p/q) = 0.740189 - 0.0147\text{Seed} \tag{5}$$

$$\text{Odds} = e^{0.740189 - 0.0147\text{Seed}} \tag{6}$$

From equation (6) we can estimate the odds in favour of a "yes" response, at a given bid level, for a typical household in the Hawke's Bay region by substituting the offered bid amount into the equation. For example, if the bid amount is set at \$20, the odds in favour of a "yes" response are equal to $e^{0.740189-(0.0147*20)}$ equals 1.56. This means that on average a typical household in the Hawke's Bay, when offered a \$20 bid, is 1.56 times more likely to vote in favour of the programme than vote against it.

[24] The products of the means of the variables and their corresponding coefficient are summed up and added to the intercept leaving the Seed as the only explanatory variable.

6.2.1.1 Estimating WTP Value from the Fitted Logit Model A

In chapter 5, the formula for estimating the expected value of WTP (truncated mean WTP) is stated as;

$$E(WTP) = \int_0^{Max.A} F\eta(\Delta V)dA$$

$$= \int_0^{Max.A} (1+\exp[-(\alpha^* + \beta A)])^{-1} dA \qquad (7)$$

$$Where\ \alpha^* = \alpha + \sum_{i=1}^{n-1} \overline{X}_i \beta_i;\ and\ \beta < 0$$

For the fitted model, equation (7) becomes;

$$\mathrm{E(WTP)} = \int_0^{\mathrm{Max.A}} (1+\exp(-(0.740189 - 0.0147\mathrm{A})))^{-1}\,\mathrm{dA} \qquad (8)$$

The solution to equation (7) or (8) provides an estimate of the truncated mean. This value may be approximated by estimating the area under the curve of the estimated function through numerical integration (Lee & Han, 2002; Amirnejad *et al.*, 2006) using the trapezoidal rule. However, Hanemann (1989) provides an alternative solution to equation (7) as:

$$E(WTP) = \frac{1}{\beta}\ln\left(\frac{1+\exp(\alpha^*)}{1+\exp(\alpha^* - \beta MaxA)}\right) \qquad (7b)$$

Applying equation (7b) to our data, an estimate of truncated mean WTP of \$69.74 is obtained. Based on Model A, a typical household in the Hawke's Bay region would be willing to pay, on average, a maximum amount of \$69.74 per annum for five years in order to secure the future benefits of a fully functional Pekapeka Swamp. The 95% confidence interval[25] for the estimated truncated mean is \$61.33 to \$77.19. Seller, Stoll & Chavas (1985) construct 'quasi-confidence' intervals based on the lower and upper

---

[25] Predicted WTP for each respondent was estimated from the equation: $\overline{WTP_j} = \frac{1}{\gamma}(\alpha + \sum_{i=1}^{k} \sum_{j=1}^{n} \beta_i X_{ij})$.

The sample mean and variance were then estimated from which a 95% confidence interval for the mean was constructed.

bounds for only one coefficient and ignore the rest. Applying a similar method to our results, with only the lower and upper bounds for the coefficient on Seed, the 'quasi-confidence' interval for the truncated mean estimate is NZ$34.02 to NZ$96.83. Equation (7)[26] understates mean WTP by truncating the integral at the maximum bid level i.e. by setting the maximum WTP for respondents who said "yes" to the $200 bid at that bid and excluding any possible valuations above the maximum bid; and overstates it by censoring WTP at zero thereby ignoring any possible negative WTP values.

Hanemann (1984, 1989), Cameron (1988), Pate and Loomis (1997), Haab and McConnell (2003) suggest another formula for estimating the mean (or median) from the fitted model using a formula of the form:

$$E(WTP) = (\frac{\alpha}{\gamma}) + \sum_{i=1}^{k-1} \frac{\beta_i}{\gamma} \overline{X}_i \qquad (9)$$

Where γ is the coefficient on Seed, α is the intercept, k is the number of explanatory variables, $\overline{X}_i$'s are the variable means and β_i's are the coefficients.

It has been proved that the mean and median estimated from equation (9) are equal assuming that the random error term ε is symmetric with mean zero (Hanemann, 1989; Haab & McConnell, 2003). We are going to refer to WTP estimates from equation (9) as 'mean (or median)'. E(WTP) estimated from the above equation is a non-linear function of the estimated parameters of the logit model which are themselves random variables (Bockstael & Strand, 1987; Park, Loomis, & Creel, 1991). Hanemann (1989) argues that equation (9) is the correct formula for estimating the mean (or median) WTP using the parameters estimates from the fitted logit model.

The method involves transforming all the coefficients in the estimated model (except the coefficient on the bid (Seed) amount by dividing them by the absolute value of the coefficient on Seed, multiplying each transformed coefficient by the mean of the corresponding variable, and then summing them up (see Table 6.12e). By dividing all the coefficients in the estimated logit equation by the absolute value of the coefficient

[26] Equation (7) and (7b) will be used interchangeably as they refer to the same estimate.

on Seed, we transform them "into coefficients with ordinary least squares interpretation, insofar as the estimation of the impact on WTP" (Pate & Loomis, 1997, p. 203). The logic behind this method is that the bid amount in the utility difference equation must equal Maximum WTP[27] when utility difference is zero. If the estimated model is set to zero, we can solve for Seed (which is equal to maximum WTP) by dividing all the terms on the right hand side of the equation by the coefficient on Seed. The expected value of WTP is then obtained by evaluating the resulting formula for WTP at the means of the variables. Applying equation (9) to the fitted model provides an estimate of mean (or median) WTP of $50.35. This mean estimate is lower than the estimate obtained using equation (7) suggesting that it might be estimating the median rather than the mean if WTP distribution is skewed to the right.

Table 6.12e Transformed coefficients for the fitted logit Model A

Variable	Coefficient	Variable Mean	Transformed Coefficient	Transformed Coefficient *Mean
Intercept	-2.710600	1.00	-184.394558	-184.39
MIncome	0.000011	53,701.00	0.000748	40.18
Score	0.312500	2.64	21.258503	56.12
Active	0.003490	6.95	0.237415	1.65
Supports	2.686500	0.90	182.755102	164.48
Seed	-0.014700	77.48		
Age	-0.005170	58.82	-0.351701	-20.69
Educ	-0.092300	5.25	-6.278912	-32.96
Size	-0.113100	2.49	-7.693878	-19.16
Distance	-0.014000	34.46	-0.952381	-32.82
Membership	0.948200	0.16	64.503401	10.32
Activity2	0.078800	7.57	5.360544	40.58
Gender	0.390200	0.51	26.544218	13.54
Employ	0.117100	0.58	7.965986	4.62
Aware	0.163200	0.80	11.102041	8.88
Total ($)				50.35

[27] This is the compensating surplus measure which, when taken away from a respondent, will leave him/her indifferent between the status quo and the alternative scenario.

Loomis *et al*. (2000) suggest another formula for estimating mean WTP from the estimated model where WTP is expected to be greater than or equal to zero. This condition is satisfied in our study as we expect WTP to be equal to or greater than zero since we are dealing with an improvement and we assume, and reasonably so, that the improvement is not a disutility for any respondents. Furthermore, the survey questionnaire did not provide respondents with an opportunity to express negative WTP. The formula suggested by Loomis *et al*., (2000) is:

$$Mean\ WTP = (\frac{1}{\beta_1}) * \ln(1 + e^{\beta_0}) \qquad (10)$$

Where β_1 *is the coefficient on Seed*, β_0 *is the grand constant obtained by summing the products of all other coefficients and their respective variable means*: $\beta_0 = \alpha + \sum \beta_i \overline{X}_i$

Equation (10) is a solution for the integral of the cumulative density function of WTP, given in equation (7), from zero to infinity and provides an estimate of the mean WTP (censored at zero and untruncated above) (Hanemann, 1989). Applying equation (10) to the estimated model provides an estimate of mean WTP of $76.89 which is higher than the estimates obtained using equations (7) and (9). We will refer to the estimate from equation (10) as ‘mean’. Equation (10) was suggested by Hanemann (1989) as a solution when the integral from equation (7) is evaluated over the range zero to infinity where WTP took on non-negative values only. However, Hanemann (1989, p.1058) warns that the equation “should not be used [for estimating] expected willingness to pay [in models where WTP may take on negative values]…. I did not intend to suggest that it should, but that is the impression I may have created.” Despite this clear warning, some studies continue to use the formula because of computational ease compared to the integral solution. Equation (10) unambiguously overstates the mean (Hanemann, 1989; Haab & McConnell, 2003) as it is a solution for an integral whose upper bound is infinity.

The estimated WTP function for the i^{th} household and the WTP probability function for a typical Hawke’s Bay household from the fitted logit Model A are given below.

$$WTP_i = -184.39 + 0.0007 * MIncome_i + 21.26 * Score_i + 0.24 * Active_i + 182.76 * Supports_i \\ - 0.3517 * Age_i - 6.28 * Educ_i - 7.69 * Size_i - 0.95 * Distance_i + 64.50 * Membership \\ + 5.36 * Activity2_i + 26.54 * Gender_i + 7.97 * Employ_i + 11.10 * Aware_i \quad (11a)$$

$$Pr(yes|Seed_i) = \{1 + \exp(-(0.740191 - (0.0147 * Seed_i)\}^{-1} \quad (11b)$$

Where $Pr(yes|Seed_i)$ is the predicted probability of a "yes" response to the i^{th} Seed; 0.740191 is the grand intercept obtained by summing the products of the variable means and their corresponding coefficients and the intercept term; and -0.0147 is the coefficient on Seed including its sign.

6.2.2 Fitting a Simple Univariate Logit Model (Model B)

The results of the simple univariate model with Seed as the only explanatory variable are summarised in Tables 6.13a – 6.13d below. The coefficient on Seed is significant at the .01 level. The global null hypothesis that all the parameter estimates of the model are not significantly different from zero is rejected on the basis of the Likelihood Ratio, Score, and Wald tests at the .01 level. The Hosmer and Lemeshow Goodness-of-Fit test indicates that the fitted model is adequate. However, the fitted simple model performs worse than Model A, as evidenced by the lower adjusted R-square value (0.0567), higher AIC and -2Log L and a lower c statistic.

The coefficient on Seed has the expected sign and can be interpreted in the same manner as explained under the multivariate Model A. When equations (7b), (9), and (10) are applied to the fitted univariate logit model to estimate truncated mean, mean (or median), and mean WTP, the results are \$47.18, \$52.44, and \$69.13 respectively. The 'quasi-confidence interval for the mean is NZ\$31.91 to NZ\$147.06. WTP estimates for all the logit models are summarised in Table 6.17b.

Table 6.13a Model fit statistics for simple univariate logit Model B

Criterion	Model I Intercept Only	Model II Intercept and Covariates
AIC	316.940	311.930
SC	323.383	318.815

-2 Log L	317.940	307.930

Figure 6.13b Association of predicted probabilities and observed responses for logit Model B

Percent Concordant	58.7	Somers' D	0.242
Percent Discordant	34.5	Gamma	0.260
Percent Tied	6.7	Tau-a	0.120
Pairs	13208	c	0.621

Table 6.13c Analysis of Maximum Likelihood Estimates for logit Model B

Variable	DF	Coefficient	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	0.4489	0.2473	3.2956	0.0695
Seed	1	-0.00856	0.00281	9.2736	0.0023

Testing Global Null Hypothesis: Beta = 0

Test		Chi-Square	Pr > ChiSq
LR	1	10.0099	0.0016
Score	1	9.6867	0.0019
Wald	1	9.2736	0.0023

Hosmer and Lemeshow Goodness-of-Fit Test (with 8 DF) 6.4478 0.5972

R – Square 0.0424 Max-rescaled R – Square 0.0567

Table 6.13d Odds Ratio estimates for logit Model B

Effect	Point Estimate	95% Wald Confidence Interval	
		Lower CL	Upper CL
Seed	0.991	0.986	0.997

Expected WTP and the probability that a typical Hawke's Bay household will answer "yes" to the valuation when presented with the i[th] Seed may be represented as;

$$E(WTP) = 52.44 \quad \left(\text{This is a ratio of the parameter estimates of the logit model}\right) \quad (12a)$$

and

$$\Pr(\text{yes}|Seed_i) = \{1 + \exp(-(0.4489 - (0.00856 * Seed_i)\}^{-1} \quad (12b)$$

6.2.3 Fitting a Multivariate Logit Model Using the Forward Stepwise Selection Procedure under Specific Entry (slentry = 0.3) and Stay (slstay = 0.35) Conditions (Model C)

<u>SAS command for fitting a multivariate logistic model using the forward stepwise selection procedure</u>

```
proc logistic data=sasuser.valid outest=betas covout;
model YDC=MIncome Score Active Supports Seed Age Educ Size Distance Membership Activity2 Gender Employ Aware /rsq lackfit selection=stepwise slentry=0.3 slstay=0.35 details;
run;
```

The forward stepwise selection procedure was executed using the above SAS command to fit the best model to our dataset under the specified conditions for variable selection for entry and exit from the model (slentry = 0.3 and slstay = 0.35). The 'slentry = 0.3 and slstay = 0.35' condition ensures that variables with Score Chi-Square p-values of 0.3 and below are selected for entry into the model whilst retaining those with p-values of 0.35 and below. The standard practice in economics and social sciences is to set alpha at 0.05. However, some studies have included variables that are significant at the 0.10 level while some have used variables that are insignificant (Boyle *et al.*, 1996; Bateman *et al.*, 1995).

Lee and Koval (1997 in Shtatland, Kleinman, & Cain, 2003) argue that the selection of alpha = 0.05 is arbitrary and very restrictive, and show that the best alpha varies between 0.05 and 0.40. Steyerberg *et al.* (2000) recommend the use of alpha = 0.50 to include all useful variables for a better prediction. In our search for the model that provides the best fit for our data, we avoid "the kitchen sink approach, in which explanatory power [of the model] is maximized by the indiscriminate use of as many variables as possible" (Mitchell & Carson, 1989, p. 213) by only including variables hypothesized to have an effect on WTP.

The stepwise selection procedure starts by estimating a model without covariates. All the variables are analyzed for eligibility for entry into the model on the basis of Score Chi-square test. Step 1 enters the variable with the lowest p-value and the model with only one variable is estimated. The subsequent steps proceed with one variable added each time with the most significant remaining variable being entered. Since we set a condition for entry at the 0.30 level, only variables satisfying this condition are selected for entry. Once a variable enters the model the overall model is assessed and each individual variable in the model tested for eligibility for removal when its p-value exceeds 0.35.

Table 6.14a provides a summary of the stepwise selection process (See Appendix 4.4 for more output tables). The procedure terminated after nine steps when no more remaining variables could satisfy the conditions for selection for entry and staying. Activity2 was entered first as it is the most significant with a p-value of <.0001. This is expected since this variable is an index measuring potential direct and indirect use of the restored wetland. We expect respondents who indicate high potential direct and indirect use to be more likely to vote in favour of the programme when presented with a given bid amount than those respondents who indicate little or no potential direct use. Variables Active, Size, Age, Employ and Aware were excluded because they did not meet the 0.30 significance level criterion for entry.

Table 6.14a Summary of forward stepwise selection for logit Model C

Step	Effect		DF	Number in	Score Chi-Square	Pr >ChiSq
	Entered	Removed				
1	Activity2		1	1	19.4142	<.0001
2	Seed		1	2	15.8543	<.0001
3	Supports		1	3	11.9847	0.0005
4	Score		1	4	7.0127	0.0081
5	Distance		1	5	5.4058	0.0201
6	Membership		1	6	3.8416	0.0500
7	MIncome		1	7	3.3939	0.0654
8	Educ		1	8	1.9670	0.1608
9	Gender		1	9	1.3680	0.2422

Table 6.14c summarizes the results of the stepwise selection model estimation. At each step, model fit statistics, and estimated coefficients and standard errors are provided. The models fitted up to step 3 are not adequate at the 0.05 level as evidenced by the low p-values for the residual Chi-Square. From step 4 onwards the fitted models are adequate at the 0.05 level with all residual Chi-Square p-values grater than 0.05. As the steps progress, -2Log L falls indicating an improvement in model fit as variables are added to the model. Improvement in -2Log L from a variable entering the model at each step is indicated under the Improvement row. R-Square improves, as variables enter the model, from 0.1113 for the univariate model, to 0.373 for the final multivariate model. The global null hypothesis that at least one of the coefficients is not significantly different from zero is consistently rejected even at the 1% level as indicated by a very low p-value (<.0001) for the Likelihood Ratio (LR) Chi-Square. The predictive power of the model increases gradually from 66.7%, in step 1, as more variables enter the model, to 81.3% in step 9.

Each variable entering the model takes on the expected sign and maintains it throughout the process indicating a stable relationship between the explanatory variables and the dependent variable; although, as expected, the absolute values of the coefficients change each time a new variable enters the model indicating omitted variable bias in the previous steps. The variables' coefficients have the same interpretation as discussed under the Model A. Table 6.14b lists the odds ration point estimates for the variables and their corresponding 95% Wald confidence intervals.

It is noted that the odds ratio estimates from the model fitted using the stepwise selection procedure (Model C) are not significantly different, at the 0.05 level, from the corresponding estimates obtained from the Model A since the corresponding 95% Wald confidence intervals overlap and the point estimates lie within the lower and upper limits. The same is also observed for the variables' coefficients suggesting that the estimated WTP from the two models may not be significantly different from each other or that at least they are of the same order of magnitude.

The fitted Model C includes three variables that are insignificant at the 10% level. These variables are Score, Educ and Gender. Next we explore what happens when these variables are omitted and a new model fitted. The output for the fitted model (Model

C1) is summarized in Tables 6.14d to 6.14g.

The AIC and SC indicate that the model fits the data better than the previous model but the -2Log L indicates otherwise since AIC and SC penalize the previous model for having more variables. R^2 is slightly lower, despite a higher p-value for the Hosmer and Lemeshow Goodness-of-Fit Chi-Square indicating a better fit. The maximum likelihood estimates have the expected signs and are all significant at the 0.05 level. The odds ratio estimates are not significantly different from those of Model C at the 0.05 level.

6.2.3.1 Estimating WTP Values from Model C

Applying equations (7b), (9) and (10), to the fitted model, yields truncated mean, mean (or median), and mean WTP estimates of $69.04, $49.14 (see Table 6.14h), and $76.07 respectively. The quasi-confidence interval for the mean is NZ$29.00 to NZ$93.07. Equations (7b), (9) and (10) produce slightly lower WTP estimates from the fitted Model C compared to Model A; and higher compared to Model B except equation (9) which yields a lower estimate (see Table 6.17b for a comparison of WTP estimates from all the logit models).

Table 6.14b Odds Ratio estimates for logit Model C

Effect	Point Estimate	95% Wald Confidence Interval	
		Lower CL	Upper CL
MIncome	1.000	1.000	1.000
Score	1.390	0.904	2.138
Supports	15.147	1.845	124.365
Seed	0.985	0.979	0.992
Educ	0.919	0.810	1.043
Distance	0.986	0.973	1.000
Membership	2.535	1.022	6.284
Activity2	1.087	1.026	1.151
Gender	1.449	0.777	2.703

Table 6.14c Maximum likelihood estimates and model fit statistics for the stepwise selection procedure for logit Model C.

Variable	Step 0	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9
Intercept	-0.199	-0.974[a]	-0.2364	-2.7053[a]	-3.7309[a]	-3.0834[a]	-3.0615[a]	-3.2495[a]	-2.9543[b]	-3.225[a]
	(0.1322)	(0.2291)	(0.2909)	(1.0431)	(1.1397)	(1.1716)	(1.1587)	(1.1687)	(1.1836)	(1.2155)
Activity2		0.1015[a]	0.1246[a]	0.1031[a]	0.0854[a]	0.0895[a]	0.0903[a]	0.0845[a]	0.0864[a]	0.0831[a]
		(0.0241)	(0.0262)	(0.0268)	(0.0275)	(0.0282)	(0.0284)	(0.0290)	(0.0292)	(0.0294)
Seed			-0.0121[a]	-0.0126[a]	-0.0143[a]	-0.0147[a]	-0.0144[a]	-0.14[a]	-0.0147[a]	-0.0147[a]
			(0.00315)	(0.00326)	(0.00337)	(0.00342)	(0.00346)	(0.00347)	(0.00354)	(0.00354)
Supports				2.8327[a]	2.6945[a]	2.6462[b]	2.6356[b]	2.6105[b]	2.6565[b]	2.7178[a]
				(1.0492)	(1.0632)	(1.0661)	(1.0623)	(1.0706)	(1.0682)	(1.0742)
Score					0.5258[a]	0.4847[b]	0.4138[b]	0.3145[b]	0.3091	0.3296
					(0.2033)	(0.2069)	(0.2089)	(0.2175)	(0.2176)	(0.2196)
Distance						-0.015[b]	-0.0148[b]	-0.0154[c]	-0.0141[b]	-0.014[b]
						(0.00686)	(0.00692)	(0.00702)	(0.00698)	(0.00706)
Membership							0.8677[c]	0.8619[c]	0.9512[b]	0.9301[b]
							(0.4494)	(0.4526)	(0.4608)	(0.4632)
MIncome								9.448E-6	1.2E-05[b]	1.1E-05[b]
								(5.166E-6)	(5.49E-6)	(5.53E-6)
Educ									-0.0887	-0.0846
									(0.0638)	(0.0644)
Gender										0.3711
										(0.3179)
Model fit										
-2Log L	317.94	297.868	281.134	265.979	258.888	253.014	249.076	245.703	243.745	242.379
Improvement		20.072	16.734	15.155	7.091	5.874	3.938	3.373	1.958	1.366
R^2		0.1113	0.197	0.269	0.301	0.327	0.344	0.359	0.367	0.373
LR test		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
χ^2* (p-values)	<.0001	<.0001	<.0005	0.0119	0.0823	0.2654	0.4753	0.7505	0.884	0.9619
% Concordant		66.7	73.2	76.5	78	79	80	80.8	81.2	81.3
Hosmer and Lemeshow Goodness-of-fit Test (with 8 DF) Chi-Square 8.9419 Pr > ChiSq 0.3472										

Note: Standard errors are in parentheses. * Residual Chi-Square p-values.
[a] significant at 1% level. [b] significant at 5% level. [c] significant at 10% level.

Table 6.14d Model Fit Statistics for logit Model C1

Criterion	Intercept Only	Intercept and Covariates
AIC	319.940	261.863
SC	323.383	285.960
-2 Log L	317.940	247.863

Table 6.14e Analysis of Maximum Likelihood Estimates for logit Model C1

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-2.7580	1.1179	6.0865	0.0136
MIncome	1	0.000011	4.963E-6	5.2336	0.0222
Supports	1	2.7269	1.0754	6.4296	0.0112
Seed	1	-0.0130	0.00339	4.7282	0.0001
Distance	1	-0.0163	0.00694	5.5035	0.0190
Membership	1	0.9611	0.4451	4.6615	0.0308
Activity2	1	0.0942	0.0281	11.1987	0.0008

Testing Global Null Hypothesis: Beta = 0

Test	Chi-Square	DF	Pr > ChiSq
LR	70.0772	6	<.0001
Score	56.7691	6	<.0001
Wald	40.1962	6	<.0001
Hosmer and Lemeshow Goodness-of-Fit Test	3.9292	8	0.8635

Table 6.14f Odds Ratio Estimates for logit Model C1

Effect	Point Estimate	95% Wald Confidence Limits	
		Lower Limit	Upper Limit
MIncome	1.000	1.000	1.000
Supports	15.285	1.857	125.798
Seed	0.987	0.981	0.994
Distance	0.984	0.971	0.997
Membership	2.614	1.093	6.256
Activity2	1.099	1.040	1.161

Table 6.14g Association of predicted probabilities and observed responses for logit Model C1

Percent Concordant	80.3	Somers' D	0.607
Percent Discordant	19.6	Gamma	0.608
Percent Tied	0.2	Tau-a	0.302
Pairs	13208	c	0.803

6.2.3.2 Estimating WTP Values for Model C1

When equations (7b), (9), and (10) are applied to the fitted Model C1 to estimate truncated mean, mean (or median), and mean WTP, the results are \$61.65, \$45.55 (see Table 6.14h), and \$70.04 respectively with a 'quasi-confidence' interval of NZ\$30.02 to NZ\$93.15. Equations (7) and (10) produce WTP estimates higher than equation (9) as expected. WTP estimates from Model C1 are lower than the corresponding estimates from Model C.

WTP functions, for the ith respondent, and WTP probability functions, estimated from the fitted models C and C1 are respectively;

$$\begin{aligned} WTP_i &= -219.4 + 7.5E-4 * MIncome_i + 22.4 * Score_i + 184.9 * Supports_i - 5.76 * Educ_i \\ &\quad - 0.95 * Distance_i + 63.3 * Membership_i + 5.65 * Activiyy2_i + 25.2 * Gender_i \end{aligned} \quad (13a)$$

$$Pr(yes|Seed_i) = \{1 + \exp(-(0.722427 - (0.0147 * Seed_i))\}^{-1} \quad (13b)$$

$$\begin{aligned} WTP_i &= -212.2 + 8.5E-4 * MIncome_i + 209.76 * Supports_i - 1.25 * Distance_i \\ &\quad + 73.93 * Membership_i + 7.25 * Activity2_i \end{aligned} \quad (14a)$$

$$Pr(yes|Seed_i = \{1 + \exp(-(0.592093 - (0.013 * Seed_i))\}^{-1} \quad (14b)$$

Table 6.14h Transformed coefficients for the fitted logit Models C and C1

Variable	Coefficient Model C	Coefficient Model C1	Variable Mean	Trans[a] Coeff Model C	Trans Coeff Model C1	Trans Coeff *Mean Model C	Trans Coeff*Mean Model C1
Intercept	-3.225	-2.758	1	-219.4	-212.2	-219.39	-212.15
MIncome	1.1E-5	1.1E-5	53701	7.5E-4	8.5E-4	40.18	45.44
Score	0.3296		2.64	22.4		59.19	
Supports	2.7178	2.7269	0.9	184.9	209.76	166.4	188.79
Seed	-0.0147	-0.013	77.48				
Educ	-0.0846		5.25	-5.76		-30.21	
Distance	-0.014	-0.0163	34.46	-0.95	-1.25	-32.82	-43.21
Membership	0.9301	0.9611	0.16	63.3	73.93	10.12	11.83
Activity2	0.0831	0.0942	7.57	5.65	7.25	42.79	54.85
Gender	0.3711		0.51	25.2		12.87	
E(WTP) ($)						49.14	45.55

[a] Trans Coeff is transformed coefficient

6.2.4 Fitting a Linear Multivariate Model with Alpha Set at 0.05 (Model D)

Now we fit a model to the dataset where alpha is set at 0.05 to conform to the standard practice in economics and social sciences. This model will be one of the models providing “best estimates”. The SAS command used to generate the output is the same as the one used to fit Model C except that the “alpha = 0.05” option is included in the “proc logistic” statement and the ‘entry and stay’ conditions are removed. Tables 6.15a to 6.15e summarize the output of the logit regression procedure.

The AIC, SC, and -2Log L indicate that the model with covariates fits better than the ‘empty model’ (model with intercept only). The Residual Chi-Square test rejects the null hypothesis that the empty model is adequate. The fitted model with covariates has a Chi-Square of 11.1531 with 9 degrees of freedom and a p-value of 0.2654 indicating that the model fits the data well. The model R^2 of 0.3278 indicates that 32.78% of the total variations in the dependent variable may be explained in terms of explanatory variables included in the model. The Hosmer and Lemeshow Goodness-of-Fit Test with a Chi-Square of 2.2024, 8 degrees of freedom and a p-value of 0.9742 is a strong indication that the fitted model is adequate. The predictive capacity of the fitted model is good at 79%.

Table 6.15a Model Fit Statistics for logit Model D

Criterion	Intercept Only	Intercept and Covariates
AIC	319.940	265.014
SC	323.383	285.669
-2 Log L	317.940	253.014

Table 6.15b Maximum likelihood estimates and model fit statistics for logit Model D

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-3.0834	1.1716	6.9269	0.0085
Score	1	0.4847	0.2069	5.4854	0.0192
Supports	1	2.6462	1.0661	6.1609	0.0131
Seed	1	-0.0147	0.00342	18.4528	<.0001
Distance	1	-0.0153	0.00686	4.9873	0.0255
Activity2	1	0.0895	0.0282	10.0498	0.0015

Testing Global Null Hypothesis: Beta = 0

Test	Chi-Square	DF	Pr > ChiSq
LR	64.9257	5	<.0001
Score	51.3125	5	<.0001
Wald	38.0346	5	<.0001
Residual Chi-Square	11.1531	9	0.2654
Hosmer and Lemeshow Goodness-of-Fit Test	2.2024	8	0.9742
R-Square 0.2450	Max-rescaled R-Square 0.3278		

Table 6.15c Odds Ratio Estimates for logit Model D

Effect	Point Estimate	95% Wald Confidence Interval Lower CL	Upper CL
Score	1.624	1.082	2.436
Supports	14.100	1.745	113.941
Seed	0.985	0.979	0.992
Distance	0.985	0.972	0.998
Activity2	1.094	1.035	1.156

Table 6.15d Association of predicted probabilities and observed responses for logit Model D

Percent Concordant	79.0	Somers' D	0.582
Percent Discordant	20.8	Gamma	0.583
Percent Tied	0.2	Tau-a	0.290
Pairs	13208	c	0.791

Table 6.15e Partition for the Hosmer and Lemeshow Test for logit Model D

		YDC =1		YDC = 2	
Group	Total	Observed	Expected	Observed	Expected
1	23	1	0.61	22	22.39
2	23	3	3.11	20	19.89
3	23	5	5.65	18	17.35
4	23	8	7.98	15	15.02
5	23	9	10.43	14	12.57
6	23	12	12.00	11	11.00
7	23	15	13.46	8	9.54
8	23	16	14.77	7	8.23
9	23	17	16.42	6	6.58
10	24	18	19.59	6	4.41

The intercept and coefficients on Support, Seed, and Activity2 are significant at the .01 level, while distance and Score are significant at the .05 level. The variables in the model have the expected signs.

6.2.4.1 Estimating WTP from the Fitted Logit Model D

Applying equations (7b), (9), and (10) to the fitted model yields estimates of truncated mean, mean (or median), and mean WTP of NZ$69.26, NZ$49.53, and NZ$76.33 respectively. Equation (10) produces a higher estimate as expected. Models C and D yield similar estimates. The ‘quasi-confidence’ interval for WTP per household per year is NZ$34.12 to NZ$90.42. The parameters of the fitted logit model and their corresponding transformed coefficients were used to construct a WTP function and a WTP probability function as given below;

$$WTP_i = -209.75 + 32.97*Score_i + 180.01*Supports_i - 1.04*Distance_i + 6.09*Activity2_i \quad (15a)$$

$$Pr(yes|Seed_i) = \{1 + \exp(-(0.728065 - (0.0147*Seed_i))\}^{-1} \quad (15b)$$

A plot of predicted probabilities against the corresponding dollar Seed values generates a WTP probability curve as depicted in Figure 6.7. When the suggested bid amount is zero, we expect the probability of a “yes” response to be equal to or close to 1, assuming that the improvement is not a disutility to some respondents. The predicted probability of a “yes” response, derived from the fitted model, when the bid set at zero is approximately 0.674 indicates that some respondents are indifferent to the wetland improvement programme even when the programme costs them nothing. Respondents who are indifferent when the bid amount is zero include those who do not enjoy direct and indirect use value of wetlands in general; those who reside too far from Pekapeka Swamp and are unlikely to benefit from it in future; and those who have no concern for environmental protection.

The predicted probability of a “yes” response of 0.674 may also suggest that the WTP distribution in the population from which our sample was drawn from includes negative WTP values i.e. some respondents require compensation if the programme is implemented. However the negative values of WTP that may be estimated from the fitted model should not to be used as estimates of WTA as they differ from true WTA (because none of the respondents were asked a WTA question) and would grossly underestimate it.

An estimate of the sample median WTP may be estimated from the graph by reading off the Seed amount corresponding to Pr (yes) = 0.5. The Seed amount corresponding to Pr (yes) = 0.5 is approximately $50.00 and is close to the mean (or median) of $49.53 estimated using equation (9). The slight difference of about $0.47 may be attributed to the scale on the x-axis, which lacks sensitivity to small changes in the Seed value. The shape of the graph of the WTP probability function (Figure 6.7) when extended to envelop negative WTP values suggests that equations (7) and (10) overstate the mean estimates by excluding the checked area above the curve.

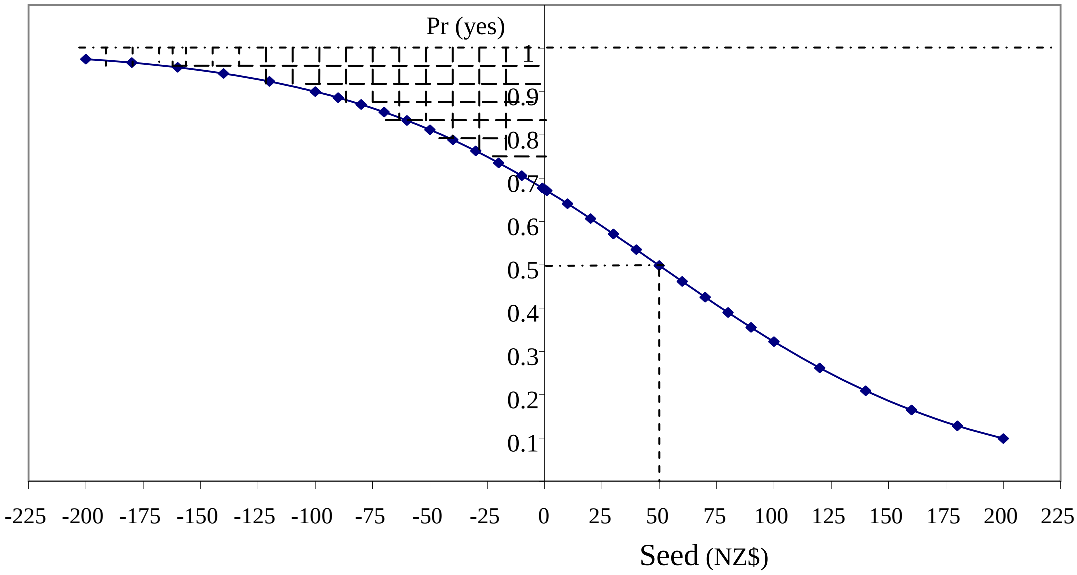

Figure 6.7 Graph of WTP function for Model D

6.2.5 Fitting a Semi-log Logit Model with Alpha = 0.05 (Model E)

The same procedure was followed as in Model D, with the exception that the variables MIncome and Seed were replaced with their natural logs (lnMIncome and lnSeed). The generated output is summarized in Tables 6.16a to 6.16e**.**

The model fit statistics for the semi-log model suggest that the fitted model is adequate. The lower AIC, SC, and -2Log L values for the model with covariates compared to the 'empty model' is a clear indication that the empty model is inferior. The Residual Chi-Square test for the empty model rejects the null hypothesis that the empty model is adequate. The fitted semi-log model with covariates has a Residual Chi-Square of 5.1415 with 8 degrees of freedom and a p-value of 0.7424 indicating that the model fits the data well. The Hosmer and Lemeshow Goodness-of-Fit Test, with a Chi-Square of 2.5329, 8 degrees of freedom and a p-value of 0.9602, also supports the conclusion from the above tests that the fitted model is adequate. Model R^2 of 0.3449 compares well with those of the other fitted models. At 79.9%, the model has a strong predictive capacity.

Only six variables enter the fitted semi-log model, and these are (level of significance is in parentheses); lnMIncome (.05), lnSeed (.01), Distance (.01), Supports (.01), Membership (.05), and Activity2 (.01). Distance and lnSeed have the negative sign as expected; lnMIncome, Supports, Membership, and Activity2 also have the expected positive signs.

Table 6.16a Model fit statistics for logit Model E

Criterion	Intercept Only	Intercept and Covariates
AIC	319.940	261.102
SC	323.383	285.199
-2 Log L	317.940	247.102

Table 6.16b Maximum likelihood estimates and model fit statistics for Model E

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-6.2393	2.7521	5.1399	0.0234
lnMIncome	1	0.5300	0.2310	5.2632	0.0218
Supports	1	3.0427	1.1349	7.1874	0.0073
lnSeed	1	-0.6655	0.1870	12.6654	0.0004
Distance	1	-0.0196	0.00756	6.7501	0.0094
Activity2	1	0.0828	0.0277	8.9605	0.0028
Membership	1	1.0578	0.4418	5.7325	0.0167

Testing Global Null Hypothesis: Beta = 0

Test	Chi-Square	DF	Pr > ChiSq
LR	70.8383	6	<.0001
Score	56.2575	6	<.0001
Wald	38.0839	5	<.0001
Residual Chi-Square	5.1415	8	0.7424
Hosmer and Lemeshow Goodness-of-Fit Test	2.5329	8	0.9602

Table 6.16c Odds Ratio Estimates for Model E

Effect	Point Estimate	95% Wald Confidence Interval Lower CL	Upper CL
lnMIncome	1.699	1.080	2.672
Supports	20.961	2.267	193.844
lnSeed	0.514	0.356	0.742
Distance	0.981	0.966	0.995
Membership	2.880	1.212	6.846
Activity2	1.086	1.029	1.147

Table 6.16d Association of predicted probabilities and observed responses (Model E)

Percent Concordant	79.9	Somers' D	0.600
Percent Discordant	19.9	Gamma	0.601
Percent Tied	0.2	Tau-a	0.298
Pairs	13208	c	0.800

Table 6.16e Partition for the Hosmer and Lemeshow Test for Model E

		YDC =1		YDC = 2	
Group	Total	Observed	Expected	Observed	Expected
1	23	1	0.43	22	22.57
2	23	2	3.13	21	19.87
3	23	7	5.95	16	17.05
4	23	7	8.16	16	14.84
5	23	9	9.64	14	13.36
6	23	12	11.22	11	11.78
7	23	13	13.13	10	9.87
8	23	16	14.69	7	8.31
9	23	17	16.77	6	6.23
10	24	20	20.87	4	3.13

For a semi-log model, equation (9) changes, since the natural log of Seed is an argument in the utility function, and becomes;

$$E(WTP) = \exp(1/\gamma)(\sum_{i=1}^{k-1}(\alpha + \beta_i \overline{X}_i) \qquad (9b)$$

6.2.5.1 Estimating WTP from the Fitted Semi-log Logit Model E

Applying equation (7) and (9b) to the fitted model yields estimates of truncated mean and mean (or median) WTP of $72.38, and $30.52 respectively; with a 'quasi-confidence' interval of the mean of NZ$24.58 to NZ$94.62. Equation (10) cannot be applied directly as it is, to the semi-log model. A graphical solution for the median WTP estimate is just above $30.00 and coincides with the estimate from equation (9b) (see Figure 6.8). The truncated mean estimate from equation (7) is higher than all estimates from the other models employing the same equation. A possible explanation for this observation is that the fitted semi-log model places higher probabilities on "yes" responses than any other model at high Seed values (see Figure 6.9). The estimated WTP and WTP probability functions are;

$$\begin{aligned} lnWTP_i &= -9.36 + 0.80 * lnMIncome_i + 4.57 * Supports_i - 0.03 * Distance_i \\ &\quad + 1.59 * Membership_i + 0.12 * Activity2_i \end{aligned} \qquad (16a)$$

$$\Pr(yes|lnSeed_i) = \{1 + \exp(-(2.274858 - (0.6655 * lnSeed_i))\}^{-1} \qquad (16b)$$

6.2.6 Comparison of Models D and E

Table 6.16f lists Models D and E's logit regression coefficients and their corresponding transformed values. Figure 6.8 presents the graphs of the WTP probability functions for the two models. The intercept of the semi-log model is above 0.9 indicating that the probability of a "yes" response to a zero bid is closer to 1 compared to 0.67 for the linear model, because the semi-log specification does not allow for negative values of WTP. At bid levels between (approximately) $12.00 and $106.00, the semi-log model predicts lower probabilities for a "yes" response than the linear model; and predicts higher probabilities outside this range.

Compared to the linear model (Model D), the semi-log model (Model E) performs better on the basis of the following goodness of fit statistics: AIC, -2Log L, R^2, χ^2, and % Prediction (see Table 6.17a). These results agree with Bowker and Stoll's (1988) findings. However, the linear model performs marginally better than the semi-log model based on the Hosmer and Lemeshow Goodness-of-Fit Test. The semi-log model produces the highest and lowest WTP estimates compared to the other models based on equations (7 or 7b) and (9 or 9b) respectively. Since the semi-log model may not be compatible with the economic hypothesis of utility maximization (Hanemann, 1984, 1989) and appears to provide extreme values, the linear model is preferred.

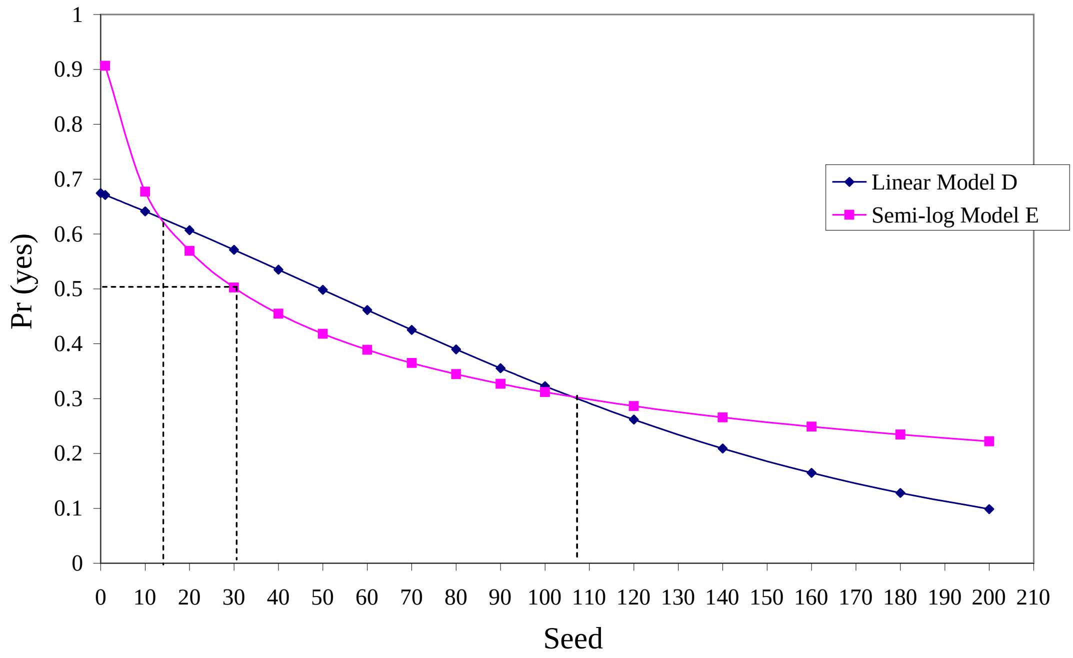

Figure 6.8 Graphs of WTP functions for Models D and E

Table 6.16f Transformed coefficients for the fitted logit models D and E

Variable	Coefficient Model D	Coefficient Model E	Variable Mean	Trans Coeff Model D	Trans Coeff Model E	Trans Coeff *Mean Model D	Trans Coeff*Mean Model E
Intercept	-3.0834	-6.2393	1	-209.76	-9.375	-209.76	-9.3754
lnMIncome		0.53	10.67		0.7964		8.49752
Score	0.4847		2.64	32.9728		87.0482	
Supports	2.6462	3.0427	0.9	180.014	4.5721	162.012	4.11485
Seed/lnSeed	-0.0147	-0.6655					
Distance	-0.0153	-0.0196	34.46	-1.0408	-0.029	-35.867	-1.0149
Membership		1.0578	0.16		1.5895		0.25432
Activity2	0.0895	0.0828	7.57	6.0884	0.1244	46.0895	0.94184
E(WTP) ($)						49.5282	exp(3.418) = 30.52

6.2.7 Importance of Model Selection

Model A has the largest R-square, lowest -2 Log L, and the highest predictive power (see Table 6.17a) implying that if the fitted model is to be used for prediction purposes, it is better to include variables that do not meet the 5% level of significance. However care should be taken to ensure that only variables that are expected (from economic theory) to have an influence on the dependent variable are included in the model. Models C1, D, and E meet the requirement that the variables included in the model are all significant at the 5% level.

Model C1 performs better than Model D in terms of all model fit statistics except the Hosmer and Lemeshow Goodness-of-Fit Test. This seems to suggest that merely running the forward stepwise regression procedure may not always produce the best fit and it may be necessary to try different combinations of variables.

Results from the different logit models (A, B, C, C1, D, and E) fitted to our dataset suggest that WTP estimates may be sensitive to model specification and the measure [truncated mean, mean (or median) and mean WTP] used to estimate the expected value of WTP from the fitted models (see Table 6.17b). For all the models, equation (9) consistently produces lower value estimates, compared to equations (7) and (10) except for Model B which may be affected by omitted variable bias. Estimates obtained from applying equation (9 or 9b) appear to coincide with the graphical solution for the median WTP suggesting that this equation might be the most appropriate when the intention is to estimate the median from the fitted model (see Figure 6.9).

The graphical solution for the median for models A, D, and C appear to be the same (approximately NZ$50.00). The simple univariate model (Model B) is clearly inadequate as the entire curve lies below Pr (yes) = 0.5 suggesting a negative median WTP. For models C1 and E the graphical solution for the median is around NZ$30.00 for both.

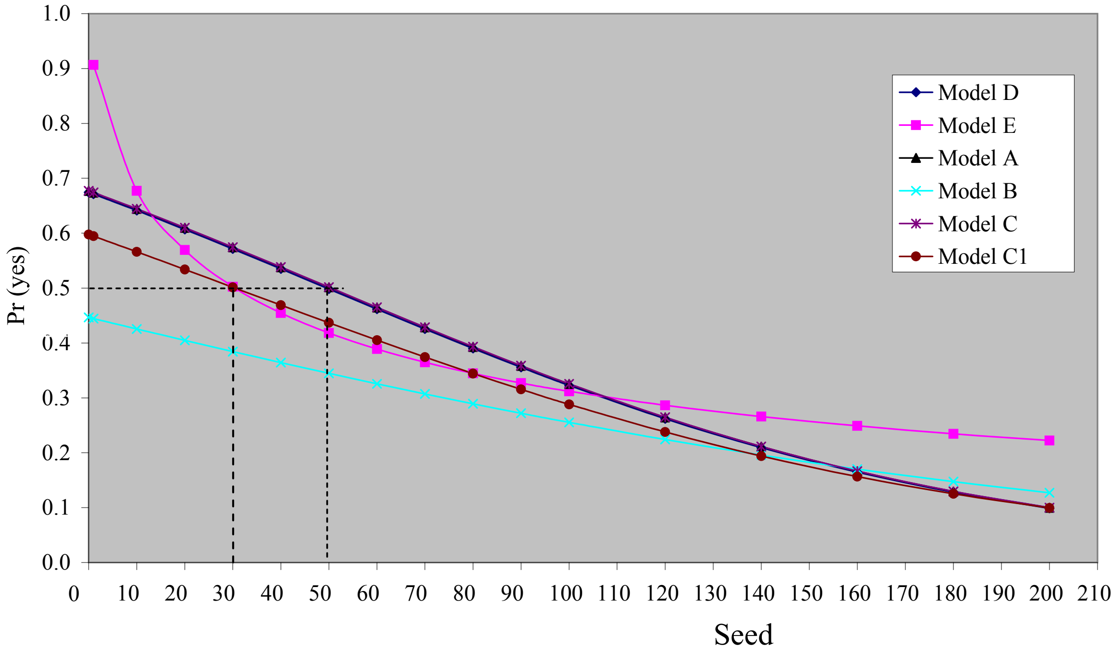

Figure 6.9 Graphs of WTP functions
Note: The graphs for models A, D and C coincide.

Table 6.17a Summary of model fit statistics

Test	Model A	Model B	Model C	Model C1	Model D	Model E
R^2	0.3774	0.0567	0.3732	0.3501	0.3278	0.3533
AIC	271.390	311.930	262.379	261.863	265.014	261.102
-2 Log L	241.390	307.930	242.379	247.863	253.014	247.102
χ^2 p-value	-	-	0.9619	-	0.2654	0.7424
% Predict[1]	81.8	58.7	81.3	80.3	79	79.9
H & L*	0.8275	0.5972	0.3472	0.8635	0.9742	0.9602

* Hosmer and Lemeshow Goodness-of –Fit Test (p-value). [1] % Prediction

Table 6.17b Summary of annual mean (or median) WTP estimates per household ($NZ\$_{2008}$)

WTP Estimation	Model A	Model B	Model C	Model C1	Model D	Model E
Equation (7)	69.74	47.18	69.04	61.65	69.26	72.38
Equation (9)	50.35	52.44	49.14	45.55	49.53	30.52
Equation (10)	76.89	69.13	76.07	70.04	76.33	-

6.2.8 Summary of Fitted Logit Models

Table 6.17c presents all the fitted logit models together to allow for model comparisons at a glance. Models A and C contain some variables that are not significant at the 10% level. These variable are, Score, Active, Age, Educ, Size, Gender, Employ, and Aware. Score enters Model D and is significant at the 0.05 level suggesting that the combination of variables selected in a model may influence the significance of the variables. Some previous studies have found that Age and Education are important factors in determining WTP (Lee & Han, 2002; Amirnejad *et al*., 2006).

Table 6.17c Summary of logit regression coefficients for the fitted logit models

Variable	Model A	Model B	Model C	Model C1	Model D	Model E
Intercept	-2.7106	0.4489[c]	-3.225[a]	-2.758[a]	-3.0834[a]	-6.2393[b]
MIncome	0.000011[c]		0.000011[b]	0.000011[b]		
lnMIncome						0.53[b]
Score	0.3125		0.3296		0.4847[b]	
Active	0.00349					
Supports	2.6865[a]		2.7178[a]	2.7269[a]	2.6462[a]	3.0427[a]
Seed	-0.0147[a]	-0.00856[a]	-0.0147[a]	-0.013[a]	-0.0147[a]	
lnSeed						-0.6655[a]
Age	-0.00517					
Educ	-0.0923		-0.0846			
Size	-0.1131					
Distance	-0.014[b]		-0.014[b]	-0.0163[b]	-0.0153[b]	-0.0196[a]
Membership	0.9482[b]		0.9301[b]	0.9611[b]		1.0578[b]
Activity2	0.0788[b]		0.0831[a]	0.0942[a]	0.0895[a]	0.0828[a]
Gender	0.3902		0.3711			
Employ	0.1171					
Aware	0.1632					

[a] significant at 0.01. [b] significant at 0.05. [c] significant at 0.1

The insignificance of Aware is rather surprising as we had expected that awareness of the existence of Pekapeka Swamp would have a strong influence on WTP assuming that respondents who indicate awareness probably reside close to the site, have had previous experience with the site, and/or are more likely to use the site in future. However the effect of Aware may be through Distance as we expect awareness to decline with distance, hence Distance may be a proxy for Aware.

To obtain parameter estimates of the WTP functions from the fitted models, the coefficients for each model listed in Table 6.16c are divided by the absolute value of the relevant coefficient on Seed. Table 6.17d presents a summary of the transformed coefficients.

Table 6.17d Summary of transformed coefficients for the fitted logit models

Variable	Model A	Model B	Model C	Model C1	Model D	Model E
Intercept	-184.3946	52.4416	-219.3878	-212.154	-209.7551	-9.3754
MIncome	0.0007		0.0007	0.0008		
lnMIncome						0.7964
Score	21.2585		22.4218		32.9728	
Active	0.2374					
Supports	182.7551		184.8844	209.7615	180.0136	4.5721
Seed						
Age	-0.3517					
Educ	-6.2789		-5.7551			
Size	-7.6939					
Distance	-0.9524		-0.9524	-1.2538	-1.0408	-0.0295
Membership	64.5034		63.2721	73.9308		1.5895
Activity2	5.3605		5.6531	7.2462	6.0884	0.1244
Gender	26.5442		25.2449			
Employ	7.9660					
Aware	11.1020					

6.2.9 Aggregation of Value Estimates from the Fitted Logit Models

To obtain an aggregate value of the restoration and preservation of Pekapeka Swamp, we may either scale up the sample value estimates by multiplying them by the total number of households in the Hawke's Bay region or by applying the population statistics on the estimated model.[28] The 2006 NZ census estimates the number of households in the Hawke's Bay at 54,618. Scaling up using this figure gives the estimated aggregate WTP for the whole region. The aggregate value estimates are listed in Table 6.18**.** The estimated aggregate maximum WTP (TEV) ranges between NZ$1.7 million to about NZ$4.2 million depending on the model and equation used for estimation. This range in value suggests that a researcher's choice of model specification and formula used to estimate values from the fitted model may have a significant impact on the results.

Table 6.18 Summary of Aggregate WTP estimates for Pekapeka Swamp ($NZ\$_{2008}$ million)*

WTP Estimation	Model A	Model B	Model C	Model C1	Model D	Model E
Equation (7)	3.809	2.577	3.771	3.367	3.783	3.953
Equation (9)	2.750	2.864	2.684	2.488	2.705	1.667
Equation (10)	4.199	3.776	4.155	3.825	4.169	

*Number of households in the Hawke's Bay is taken to be 54,618

Table 6.19 Summary estimates of WTP per hectare per year for Pekapeka Swamp ($NZ\$_{2008}$)*

WTP Estimation	Model A	Model B	Model C	Model C1	Model D	Model E
Equation (7)	41,606	28,147	41,189	36,780	41,322	43,179
Equation (9)	30,039	31,284	29,317	27,176	29,547	18,208
Equation (10)	45,866	41,245	45,385	41,780	45,538	

*Based on 91.55 hectares

6.3 The Open-ended WTP Model

The following analysis does not require a fitted model to estimate mean and median WTP as this can be calculated using simple arithmetic from the amounts stated by respondents in response to the open-ended valuation question.

[28] Scaling up by directly applying the sample mean and median estimates to the population assumes that non-respondents are not different from respondents; an assumption that may be easily challenged especially where the response rate is very low and the respondents are unlikely to reasonably represent the population. Some researchers have suggested that non-respondents be treated as zero valuations and the sample estimates adjusted accordingly to give a lower bound of the aggregate value.

6.3.1 Estimation of Mean, Median, and Aggregate WTP

The estimation of mean and median WTP for the open-ended contingent valuation format is simple and straight forward. The mean is calculated as the average of the stated maximum WTP amount by summing up household maximum WTP amounts and dividing the sum total by the number of respondents. The following formula was used to calculate the mean:

$$Mean\ WTP = \frac{\sum_{i=1}^{n} WTP_i}{n} = \frac{11060}{231} = \$47.88 \qquad (17)$$

This means that on average a typical household in the Hawke's Bay is willing to pay $47.88 per year for five years for the restoration and preservation of Pekapeka Swamp. The sample mean has a 95% confidence interval[29] of $40.59 to $55.16. The sample median WTP is NZ30.00. This corresponds to a value at which 50% of the respondents are willing to pay for the restoration and preservation of Pekapeka Swamp and is obtained by sorting WTP responses in ascending order and finding the WTP value stated by the 116th respondent. The mean is higher that the median because the sample WTP distribution is skewed to the right as reflected in Figure 6.10. Using the median as an estimate of the welfare benefits of the programme may understate the true benefits as it ignores or places little weight on the high values expressed by some respondents.

The sample mean and median WTP estimates may be used to estimate aggregate value estimates for the Pekapeka Swamp by scaling them up over the total household population of Hawke's Bay. Based on a household population of 54,618, the annual aggregate values, obtained by scaling up the mean and median, are NZ$2.615million (with a 95% confidence interval of NZ$ 2.217 million to NZ$3.013 million) and NZ$1.639million respectively (see Tables 6.18 and 6.19 for a comparison of aggregate and unit value estimates obtained from other models). The unit value estimates obtained using the mean and median are NZ$28,565 and NZ$17,898 respectively.

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[29] The confidence interval for the mean is calculated from the formula; $\$47.88 \pm 1.96 * \sqrt{s^2 / n}$. Where s^2 is the sample variance of WTPOE and n is the sample size.

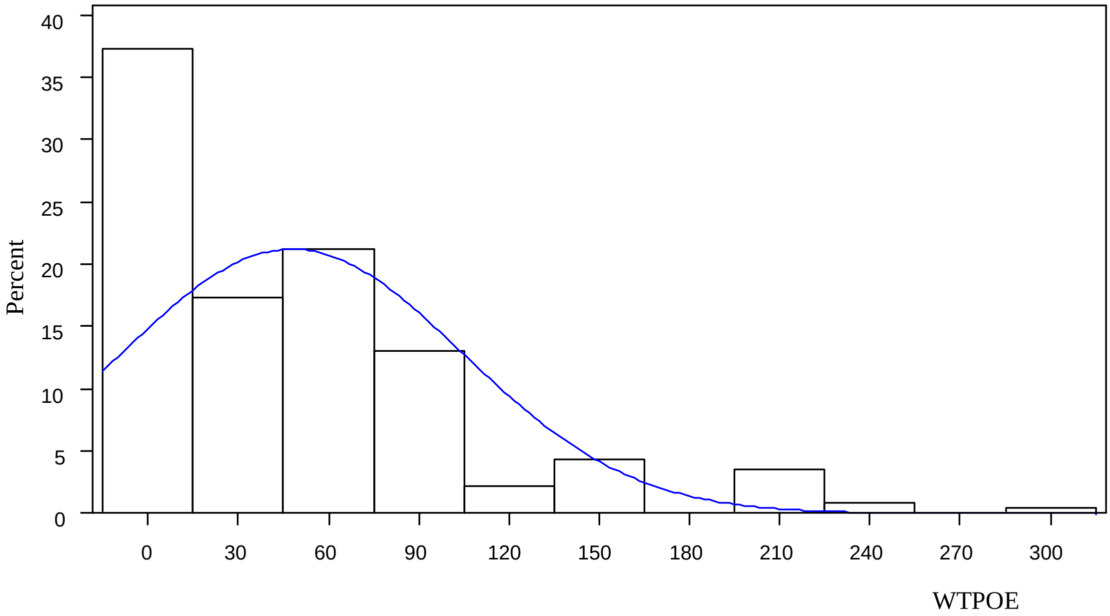

Figure 6.10 Open-ended WTP (WTPOE) distribution

6.3.2 Open-ended WTP Model Estimation

SAS command for OLS regression

```
proc reg data=sasuser.valid;
model WTPOE=MIncome Score Active Supports Age Educ Size Distance Membership Activity2 Gender Employ Aware /selection=stepwise slentry=0.3 slstay=0.05 details;
run;
```

WTP for the restoration and preservation of Pekapeka Swamp is modeled as a function of a number of variables that include: income, age, level of education, distance of residence from the site, and membership of an environmental organization. We experimented with both linear and semi-log WTP functions to estimate the best fit. The main objective was to identify important factors that influence respondents' open-ended WTP responses to the valuation question for the restoration and preservation of Pekapeka Swamp. An OLS forward stepwise selection procedure, invoked using the syntax above, was employed to fit the best linear model for the dataset. For the semi-log model, the same syntax is used but the model specification is changed to include lnDistance and lnMIncome. The depended variable in the semi-log model is changed to ln(WTPOE +1) so that we retain observations with zero WTP values which could be lost during the log transformation of WTP values (Bateman *et al*., 2006b).

6.3.3 The Fitted Open-ended WTP Linear model

The results of the OLS regression for the linear model are summarized in Tables 6.20 to 6.22. Table 6.20 presents a summary of the stepwise selection procedure in which the explanatory variables are entered in the model in the order indicated under column heading ‘Step’. The final fitted model has five explanatory variables after Gender is removed from the model in step 7 as it does not meet the ‘stay’ criterion of alpha = 0.05. Activity2 is entered first as it is the most significant variable and has the largest partial R-square of 0.1113 followed by MIncome at 0.0522. The five variables retained in the model are all significant at the 0.05 level. The column headed ‘Model R-Square’ shows what happens to the model R-square as explanatory variables enter the model and indicates an increase in the explanatory power of the model as additional variables enter the model.

Table 6.20 Summary of Stepwise Selection for open-ended WTP linear model

Step	Variable Entered	Number variables in model	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	Activity2	1	0.1113	0.1113	5.7728	28.69	<.0001
2	MIncome	2	0.0522	0.1636	2.3286	14.24	0.0002
3	Membership	3	0.0315	0.1951	5.0023	8.90	0.0032
4	Distance	4	0.0213	0.2164	0.6977	6.15	0.0139
5	Score	5	0.0159	0.2323	8.0068	4.65	0.0321
6	Gender	6	0.0111	0.2434	6.7210	3.29	0.0710
7	Gender(removed)	5	0.0111	0.2323	8.0068	3.29	0.0710

Maximum likelihood parameter estimates, their standard errors, Type II SS (partial sum of squares for the variables entering the model), F and p values, the model R-square are listed in Table 6.21. All the variables in the fitted model have the expected signs suggesting that the open ended WTP responses conform to economic theory. The coefficient on Distance has a negative sign indicating that willingness to pay declines with distance from the study site (Sutherland & Walsh, 1985; Pate & Loomis, 1997;

Bateman *et al*., 2006b). The model R-square of 0.2323, despite being lower than that of the corresponding linear logit model, is still reasonable. Analysis of variance results for the fitted model reveal that the probability of observing by chance an F value as large as 13.62 is very small i.e. less than 0.0001 and the model fits the data well (see Table 6.22).

Table 6.21 Maximum likelihood estimates and model fit statistics for open-ended WTP linear model

Variable	Parameter Estimate	Standard Error	Type II SS	F Value*	Pr > F
Intercept	-4.56619	11.97122	364.4	0.15	0.7032
MIncome	0.00034	0.000110	24039	9.60	0.0022
Score	9.24995	4.28984	11646	4.65	0.0321
Distance	-0.25606	0.11669	12062	4.82	0.0292
Membership	23.03401	9.41725	14986	5.98	0.0152
Activity2	1.95781	0.58104	28440	11.35	0.0009
R-Square	0.2323				

* F value = Type II SS/Error Mean Square (e.g. for Score F = 11646/2504.9 = 4.65

Table 6.22 Analysis of variance for open-ended WTP linear model

Source	DF	Sum of Squares	Mean Square	F Value*	Pr > F
Model	5	170545	34109	13.62	<.0001
Error	225	563605	2504.91247		
Corrected Total	230	734151			

* F value = Model Mean Square/Error Mean Square

The estimated WTP function from the fitted open-ended WTP linear model is:

$$WTPOE_i = -4.56619 + 0.00034*MIncome_i + 9.24995*Score_i - 0.25606*Distance_i + 23.03401*Membership_i + 1.95781*Activity2_i \quad (18)$$

6.3.4 Fitted Open-ended WTP Semi-log model

Results for the fitted semi-log model are summarized in Tables 6.23 to 6.25. As with the linear model, Activity2 is the most significant explanatory variable with a partial R square of 0.1979. Other variables entering the model are listed under ‘Variable Entered’ column in Table 6.23. The final model has six explanatory variables as Aware is removed in step 7. It should be noted that the dependent variable in the semi-log model is the natural log of open-ended WTP + 1 (WTPOE +1) as explained earlier.

Table 6.23 Summary of Stepwise Selection for Open-ended WTP* semi-log model

Step	Variable Entered	Number variables in	Partial R-Square	Model R-Square	C(p)	F Value	Pr> F
1	Activity2	1	0.1979	0.1979	56.8053	56.50	<.0001
2	Supports	2	0.0748	0.2727	32.3469	23.44	<.0001
3	lnMIncome	3	0.0380	0.3107	20.8890	12.53	0.0005
4	lnDistance	4	0.0267	0.3374	13.4244	9.12	0.0028
5	Membership	5	0.0230	0.3604	7.2898	8.09	0.0049
6	Aware	6	0.0088	0.3692	6.1767	3.12	0.0785
7	Aware(removed)	5	0.0088	0.3604	7.2898	3.12	0.0785

*Dependent variable is WTPOE + 1

The variables in the fitted semi-log model have the expected sign and are all significant at the 0.01 level. It is interesting to note that the parameter estimates of the semi-log model have much lower standard errors and higher F values compared to the linear model. The semi-log model, with an R-square of 0.3604 fits the data much better than the linear model. Also the higher F value of 25.36 with a p-value of <.0001 confirms the superiority of the semi-log model over the linear model in terms of model fit.

Table 6.24 Maximum likelihood estimates and model fit statistics for open-ended WTP semi-log model

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	-3.72890	1.64185	13.22741	5.16	0.0241
lnMIncome	0.54793	0.15226	33.20910	12.95	0.0004
Supports	1.50596	0.36234	44.29603	17.27	<.0001
lnDistance	-0.49361	0.17284	20.91469	8.16	0.0047
Membership	0.84699	0.29782	20.74095	8.09	0.0049
Activity2	0.10575	0.02089	65.67842	25.61	<.0001
R-Square	0.3604				

Table 6.25 Analysis of variance for open-ended WTP semi-log model

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	325.17222	65.03444	25.36	<.0001
Error	225	576.98039	2.56436		
Corrected Total	230	902.15261			

The WTP function estimated from the fitted open-ended WTP semi-log model is;

$$
\begin{aligned}
ln(WTPOE_i + 1) = -3.72890 + 0.54793 * lnMIncome_i + 1.50596 * Supports_i \\
- 0.49361 * lnDistance_i + 0.84699 * Membership_i \\
+ 0.10575 * Activity2_i \qquad (19)
\end{aligned}
$$

6.4 Comment on the Difference Between Open-ended Mean WTP and DC Mean WTP estimates

Mean WTP estimates from the fitted logit models are generally higher than the estimated mean WTP from the open-ended WTP model. However, the mean WTP estimates from the DC models and the open-ended model are not statistically different as the ‘quasi-confidence’ intervals overlap with the exception of the low median from the open-ended WTP model which falls outside of some confidence intervals for the means from the DC models.

Our finding is consistent with previous studies. Kealy, Dovidio, and Rockel (1988) find no significant differences between the means. Seller, Stoll and Chavas (1985), O’Conor, Johannesson, & Johansson (1999) report DC WTP means that are larger than open-ended WTP means and suggest that the possible explanation is that the overall effect of biases in the DC format inflate the WTP estimates; and open-ended estimates under-estimate the true WTP because of possible free-riding or expected cost effects which give respondents incentive to understate their WTP.

Cameron and Huppert (1988, p.1) “conclude that when referendum questions produce different value estimates than the other formats, elaborate explanations for the apparent discrepancies may not be necessary.” Bateman *et al*. (1995, p.177) concur with

Cameron and Huppert (1988) and express "doubt about the usefulness of simple comparisons between open-ended and DC results" but suggest that a combination of economic and psychological factors may explain the differences. Results from a study by Boyle *et al*. (1996), in which mean WTP estimates from DC and open-ended formats are compared, suggest that open-ended questions underestimate values while DC questions may lead to systematic overestimates. Wattage & Mardle (2007) cite several studies that have found that open-ended WTP bids tend to be lower than DC bid amounts.

6.5 Distance Decay and the Limits of Economic Jurisdiction for the Restoration and Preservation of Pekapeka Swamp

One of the problems encountered in non-market valuations is the determination of the population boundary over which the value of the benefits from a resource under consideration is applicable. Where there are identifiable users, such as fishing or gun licence holders, the normal procedure is to target the users and estimate a benefit value based on this population. For example, if we were to estimate the recreational value of waterfowl shooting at Pekapeka Swamp, our target population would be the members of the Pekapeka Shooters Association.

In this study we estimate total economic value for the wetland with the target population set to coincide with the political boundary. Some of the possible benefits of the restored wetland could be enjoyed anywhere in New Zealand if, for example, some one enjoys looking at the pictures showing wildlife and scenic views at the swamp from the comfort of their homes. Such benefits are not captured for residents outside Hawke's Bay. Ideally the boundary should be set where WTP declines to zero but unfortunately this information may not be available *a priori*. We attempted to set this boundary ex-post using distance decay functions estimated from the fitted models.

Distance decay functions for the fitted logit models D and E (the linear and semi-log stepwise selection models with alpha = 0.05) and the open-ended WTP linear and semi-log models will be estimated. To estimate the distance decay functions, first, the mean values of the independent variables except Distance or lnDistance are substituted into the respective models, and second, the WTP equations are valuated at the mean values of these variables by multiplying each coefficient by the respective variable mean and summing up the products to give a 'grand constant' (Pate & Loomis, 1997; Bateman *et al*, 2006b). This procedure results in a new WTP function with an intercept (equal to the 'grand constant') and Distance or lnDistance as the only explanatory variable. The WTP functions are given below.

$$Model\ D:\ WTP = 85.3952 - 1.0408 * Distance \quad (20)$$
$$Model\ E:\ lnWTP = 4.4329 - 0.0294 * Distance \quad (21)$$
$$WTPOE\ Linear\ Model:\ WTP = 56.6180 - 0.2561 * Distance \quad (22)$$
$$WTPOE\ Semi-log\ Model:\ ln(WTP+1) = 4.4089 - 0.4936 * lnDistance \quad (23)$$

Equations (20) to (23) are graphed in Figure 6.11 to highlight the effect of distance on average household WTP for the restoration and preservation of Pekapeka Swamp from the different models. To set the empirical boundary using the above equations, we need to estimate the distance that equates WTP to zero or where the distance decay functions cross the horizontal axis. Equation (20) for Model D gives an empirical boundary of about 82 km; equation (21) for Model E gives about 151 km (WTP falls below $1 at this distance and approaches zero around 406 km); and equation (22) for the open-ended linear model gives 222 km. For the WTPOE semi-log model, average WTP per household becomes insensitive to changes in distance after the 250 km distance approaching zero at a distance close to 7567 km suggesting a country wide boundary for the survey.

Apart from the WTPOE semi-log model, the above results seem to suggest that limiting the geographical boundary for the survey to the Hawke's Bay region was reasonable. Equation (23) predicts household average annual WTP values around NZ$5.35 at a distance of 250 km from the site implying small WTP values for the population excluded from the survey.

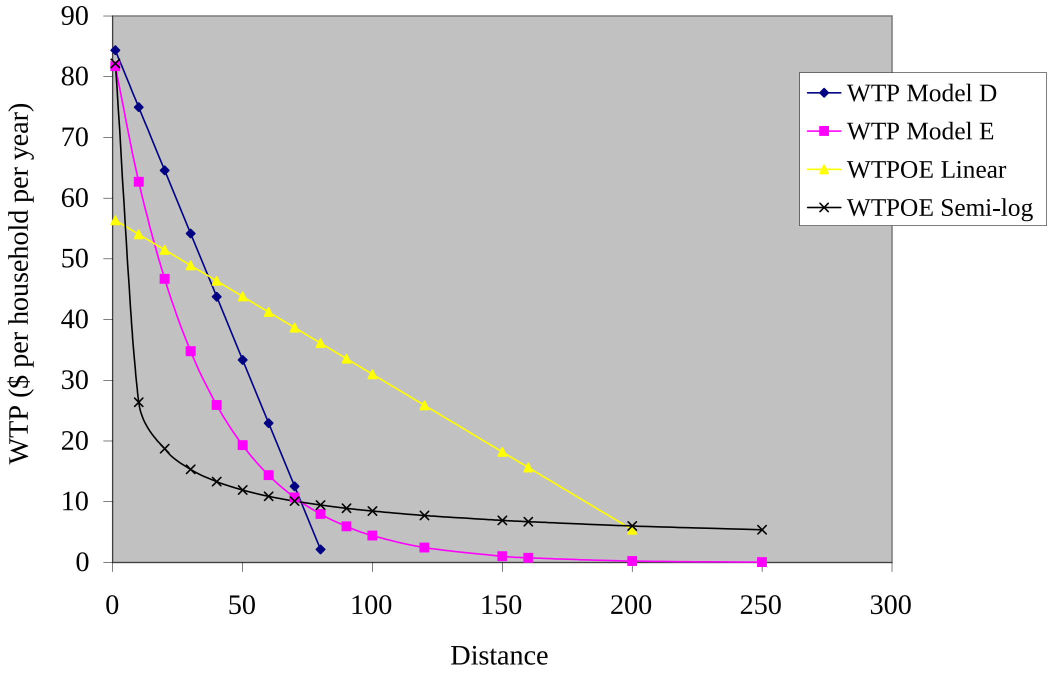

Figure 6.11 WTP-Distance decay

6.6 Aggregate Benefits, Present and Net Present Values: A Simple Cost Benefit Analysis

To estimate the present and net present values for Pekapeka Swamp, annual aggregate benefits and costs of the programme have to be discounted to a common point in time (2008) to determine the present value and net benefits. We assume that the costs presented in Tables 4.1 and 4.2 in Chapter 4 are the only costs incurred under the programme, and that the purchase price of the land acquired by HBRC reflects the true opportunity cost of that land i.e. forgone agricultural production. These assumptions simplify our task but may result in the under-estimation of costs. For example, schools and the community may have provided considerable free labor in replanting and landscaping and a monetary value for this is not included in the Tables.

The Treasury website lists public sector discount rates for cost benefit analysis with 8% set as the default discount rate for projects that are difficult to categorize; a risk free rate of 6.4% is stated as the current interest rate on NZ 10 year bond; and 3.4% as the real risk free rate (6.4% less inflation rate of 3%). For this analysis we will use discount rates of 3.4%, 6.4%, 8%, and 10% to investigate the sensitivity of the results to the discount rate used. Costanza, Farber, and Maxwell (1989) used discounts rates of 8% and 3% in their analysis.

Results of the analysis presented in Tables 6.26 and 6.27 below indicate both positive present value and net present value of benefits from the programme ranging from NZ$6.83 million to NZ$19.52 million, and NZ$5.05 million to NZ$18.20million respectively.

Table 6.26 Aggregate benefit estimates for Pekapeka Swamp over 5 years based on models D, E and the WTPOE model in $NZ\$_{2008}$ (million)

	TEV per year	TEV over 5 years	PV (r = 3.4%)	PV (r = 6.4%)	PV (r = 8%)	PV (r =10%)
Model D						
Equation (7)	3.78	18.91	17.71	16.77	16.31	15.77
Equation (9)	2.71	13.53	12.67	11.99	11.66	11.28
Equation (10)	4.17	20.84	19.52	18.48	17.98	17.38
Model E						
Equation (7)	3.95	19.75	18.50	17.51	17.03	16.47
Equation (9b)	1.67	8.35	7.82	7.40	7.20	6.96
WTPOE Model						
Mean WTPOE	2.62	13.08	12.24	11.59	11.28	10.90
Median WTPOE	1.64	8.19	7.67	7.26	7.07	6.83

Table 6.27 Net Present value of Pekapeka Swamp over 5 years in $NZ\$_{2008}$ (million)

		Discount Rate		
Model	3.4%	6.4%	8%	10%
Model D				
Equation (7)	16.39	15.27	14.69	13.99
Equation (9)	11.35	10.49	10.05	9.50
Equation (10)	18.20	16.98	16.36	15.60
Model E				
Equation (7)	17.19	16.02	15.43	14.70
Equation (9b)	6.49	5.89	5.57	5.17
WTPOE Model				
WTPOE (mean)	10.93	10.09	9.66	9.12
WTPOE (median)	6.36	5.76	5.45	5.05

The median of the open-ended WTP model provides the lowest present and net present values of NZ$6.83 million and NZ$5.05 million respectively, at a discount rate of 10%. Even with these most conservative estimates for the restoration and preservation programme of Pekapeka Swamp, the HBRC's policy programme for the Pekapeka Swamp still meets the economic efficiency criteria. The present value (NZ$18.20 million) and net present value (NZ$4.17 million) from Model D (obtained using equation 10) provide the highest values or upper bound at the discount rate of 3.4%. If the mean of the open-ended WTP model is used instead of the median, the lower bound estimate at the 3.4% level become NZ$12.24 million and NZ$10.93 million for the present value and net present value respectively.

CHAPTER 7

Summary, Conclusions and Recommendations

In this chapter we reflect on the material presented in previous chapters and assess how far we were able to meet the objectives of the thesis as outlined in Chapter 1. We also provide an overview of the results, comments, policy recommendation, and suggestions for future research.

7.1 Meeting the Objectives of the Thesis

7.1.1 Selection and Application of the CVM to the Case Study

In Chapter 2 we explored the theoretical foundations of non-market valuation techniques, welfare measures (compensating variation, equivalent variation, compensating surplus, equivalent surplus and the Marshallian consumer surplus) and the conditions under which each measure is applicable. We found considerable theoretical support for non-market valuation techniques suggesting that where these techniques are applied properly, they could provide results that are consistent with economic theory. Then, in Chapter 3 we discussed a number of non-market valuation techniques and highlighted their respective strengths and limitations. The contingent valuation method was found to be the most appropriate method for our study in terms of: its ability to measure total economic value which includes non-use value; low cost; the operational and administrative ease compared to other attribute based valuation methods; and, avoidance of interviewer bias. Also, non-market valuation literature suggests that the CVM is capable of providing results that are consistent with economic theory if designed and administered properly (Mitchell & Carson, 1989; Arrow *et al*., 1993; Bateman *et al*, 2002).

The main challenge encountered in applying the CVM to the case study was designing a survey instrument that would be capable of presenting the contingent scenario in an unambiguous manner, provide an incentive for respondents to participate, be ‘true telling’ in order to elicit appropriate responses, and avoid non-responses. Results from the analysis of responses indicate that this challenge might have been met with success for the following reasons:

a) A fairly good overall response rate of 46.13% was achieved. This response rate is within the acceptable range for contingent valuation surveys conducted by mail. Sutherland and Walsh (1985) argue that, if statistical tests show no significant difference between values reported by early and late respondents, they could tentatively conclude that their sample response rate of 61% could represent the population as well as would a higher response rate. The same argument was used by Walsh, Loomis, and Gillman (1984) to justify a response rate of 41%. Further, both sources state that the sample characteristics in terms of income, age, education, occupation, and household size were very close to the general population as reported in the census. Our study uses the same arguments to justify the acceptability of the overall response rate of 46.13% for our study.
b) Respondents' socioeconomic and demographic characteristics were in the main found to be closely aligned with the official population statistics. Some clear differences appear in income distribution because the study collected household income as opposed to personal income.
c) The declining proportion of "yes" responses with increasing bid amounts indicates consistency of responses with economic theory (downward sloping demand curve). This suggests that the questionnaire might have been incentive compatible.
d) Some respondents provided positive feedback indicating that they were able to relate the contingent market to their own situation.
e) The factors hypothesised to influence WTP were found to conform to the stated hypotheses providing a positive test for internal consistency (construct or internal validity) of the CVM as applied to the case study.

Overall the methodology appears to have been executed properly to provide value estimates that make economic sense. The value estimates from this survey are based on responses that appear to be valid although the extent of the effect of non-response bias and other biases inherent in the CVM is not known.

7.1.2 Estimating the Total Economic Value of the Restoration and Preservation of Pekapeka Swamp

The main objective of the study was to estimate the benefits (TEV) of the restoration and preservation of Pekapeka Swamp and to test if the programme meets the economic efficiency criterion that the potential benefits from the programme exceed costs, i.e. whether beneficiaries could potentially compensate the losers and still remain better off than they were before the change in environmental quality (Pareto improvement). Despite some respondents stating zero WTP in response to the open-ended valuation question, the survey results demonstrate considerable and significant financial commitment (WTP) of the surveyed households in the Hawke's Bay Region to restore and preserve Pekapeka Swamp.

WTP for the restoration and preservation of Pekapeka Swamp was modelled as a function of a number of factors that were hypothesised to influence household responses to the dichotomous choice and the open-ended valuation questions. Walsh, Loomis, and Gillman (1984) used stepwise regression to select among possible socioeconomic and taste measures. For the dichotomous choice question, we fitted six functional forms of the logit model to investigate how model specification influences value estimates. Responses to the open ended valuation question were analysed using OLS regression on a linear and semi-log specification of the model.

Using the DC bid functions estimated from the fitted logit models, expected WTP values ranging between NZ$30.00 and NZ$77.00 per household per year for five years were obtained (see Table 6.17b). The mean and median value estimates derived from the WTPOE model are NZ$47.88 and NZ$30.00 respectively, and lie within the range for DC estimates indicating convergent validity for the CVM as applied to our study. The range for aggregate WTP values (TEV) is NZ$1.6 million to NZ$4.2 million per year; and the unit value ranges between NZ$17,898 and NZ$45,866 per hectare per year. The median of the WTPOE model provides the lower bound for the unit value.

In a study of wetland values in coastal Louisiana, USA, Costanza, Farber and Maxwell (1989) obtained per acre present values (not including option and existence values) of US$2,429-6,400 (assuming a discount rate of 8%) to US$8,977-17,000 (assuming a discount rate of 3%). These values convert to NZ_{2008}$ per hectare values[30] of NZ$24,932-65,690 and NZ$92,142-174,489 respectively. Although our lower bound estimate is less than NZ$24,932, the range of our estimates overlaps with that of Costanza, Farber and Maxwell's (1989) estimates (assuming a discount rate of 8%). Our value estimates do not include any commercial values as no attempt was made to include any potential commercial benefits from the programme. Kirkland (1988) obtained per hectare values of NZ$3,345 ($NZ$_{2008}$ 5,773) for the preservation of the Whangamarino wetland and suggested that the value was affected by the high number of respondents stating zero WTP amounts. Costanza *et al*. (1997) estimated global average wetland values ranging from US$9,990 (NZ$16,827) to US$19,580 (NZ$32,980). These values convert to NZ_{2008}$ values of NZ$23,138 and NZ$45,349 respectively. Patterson and Cole (1999) estimated average NZ_{1994}$ per hectare value for New Zealand wetlands of NZ$34,163 which converts to NZ_{2008}$ per hectare value of NZ$46,975. Our estimates are very close to Costanza *et al*. (1997) and Patterson and Cole (1999) estimates.

<u>The net present value of the restoration and preservation programme based on models D, E, and, WTPOE (our "best estimates") ranges between NZ$5.05 million and NZ$18.20 million depending on the model and discount rate used. Benefit cost ratios range from 3.8 to 12.3 depending on the model and discount rate used.</u>

Annual total economic value estimates ranging from NZ$1.6million to NZ$4.2 million indicate that the restoration and preservation of Pekapeka Swamp is an important issue for the residents of Hawke's Bay because of the large potential benefits that may be delivered by the programme. The value estimates from this survey may be used in conjunction with other decision making criteria to enhance HBRC's policy decision-making process so that policy outcomes consistent with the regional community's preferences are achieved. The values may also be used to justify past and future expenditure under the Pekapeka management plans. For example, more funds may justifiably be allocated to replanting, landscape development and any other outstanding work that would quicken the delivery of outcomes. The aggregate annual values

[30] Costanza, Farber, and Maxwell's (1989) per acre values were first converted to per hectare values using a conversion factor of 0.4047 and then to per hectare NZ_{1983}$ values using an exchange rate of 0.6789. The Reserve Bank of New Zealand's CPI inflation calculator was then use to convert the values to NZ_{2008}$. RBNZ's CPI inflation calculator is available at *www.rbnz.govt.nz/statistics/0135595.html*

currently represent considerable lost access value for residents in the region. WTP estimates also suggest a possible alternative source of funding for the programme.

In the past, failure to appreciate the value of Pekapeka Swamp resulted in decisions that permitted the degradation of the swamp resulting in welfare lose to society. The study demonstrates that the CVM, when applied properly, may be used to provide important input into the policy decision-making process that delivers outcomes consistent with utility maximization.

Results of this study may be transferred to other wetlands in New Zealand using benefits transfer techniques. The benefits transfer may be in the form of adjusted or unadjusted unit values, or value functions in which the site specific variables estimates are substituted into the equation. However it must be born in mind that wetlands are a complex non-market commodity for which there are no market prices, and respondents may lack the experience of placing a value on the wetland. Therefore WTP estimates from this survey may not reflect all the value of the wetland.

For an accurate estimation of mean WTP, data from all the heterogeneous groups constituting the population of Hawke's Bay should be included. In our survey the non-response rate was high, and if non-respondents' preferences differ significantly from those of respondents, the value estimates may suffer from non-response bias and or self-selection bias. Financial and time constraints did not permit follow-ups on non-respondents after the second reminder to determine the reasons for non-response. An understanding of the attitudes and preferences of non-respondents is important especially where value estimates obtained from the survey are scaled up using the relevant population, as was done in this study.

7.1.3 Factors Influencing WTP for the Restoration and Preservation of Pekapeka

In a contingent valuation study of the Norfolk Broads, Bateman *et al*. (2000a) observe that the distance to the site and the respondents' socio-economic circumstances provide consistent drivers of responses both in terms of the probability of responding to the survey questionnaire; responding positively to the payment principle question; and the determination of the WTP amount. In our study, we observe that household income

(MIncome or lnMIncome), distance to the site (Distance or lnDistance), membership of an environmental organization (Membership), expression of potential future use of the restored wetland (Activity2), demonstrating value for the environment (Score), and attitude towards environmental improvement (Supports) provide consistent drivers of WTP for the restoration and preservation of Pekapeka Swamp.

The high significance of Activity2, a constructed index measuring the potential future use of the restored Pekapeka Swamp, demonstrates the importance of the use value component of WTP. The negative sign of the coefficient on Distance (or lnDistance) confirms the expectation that WTP declines as the distance from the site increases. The other variables listed above have a positive influence on WTP as expected.

7.2 Discussion and Critique of the Methodology

Non-market valuation literature provides evidence of increased reliance on the CVM as a valid and appropriate methodology for obtaining monetary value estimates of non-market goods such as ecosystems and ecosystem services (see Figures 3.1 and 3.2). To obtain valid and reliable value estimates the contingent valuation methodology should not be applied willy-nilly. There is need to follow prudent survey procedures such as the NOAA panel guidelines for value elicitation surveys (see Appendix 3), the Total Design Method (TDM) of Dillman (1978), Bateman *et al*.'s (2002) Manual, and Mitchell and Carson's (1989) CVM.

The non-market valuation literature we explored seems to indicate the non-existence of a set of binding or legal rules and principles that govern the conduct of researchers and the standard formulation and application of the various non-market methodologies in estimating monetary values of ecosystems and ecosystem services or non-market goods and services in general. In the field of natural sciences, research experiments are conducted under controlled conditions that can be repeated exactly by others to check on the results making it possible to test the accuracy of results from such experiments. The lack of hard and fast rules to guide the application of non-market valuation techniques in estimating economic non-market values limits the extent to which estimates from different valuation studies may be compared. However, as indicated earlier, literature providing guidelines on how to perform non-market valuation techniques is readily available but is not strictly binding. For example, the Total Design Method (TDM) of Dillman (1978) provides step-by-step details of how to conduct successful mail and telephone surveys. If all mail and telephone surveys were to follow these guidelines to the full, then it could be argued that it would be possible to compare results from a number of such surveys with a high degree of comfort.

To promote the acceptance of research results from non-market valuation surveys, researchers usually state, in their reports, that they followed Dillman's TDM (Stevens *et al*., 1991; Loomis & King, 1994; Zhongmin *et al*, 2003) or the NOAA panel guidelines (Bateman *et al*, 1995; Wattage & Mardle, 2007). However, the extent to which individual researchers follow the TDM, NOAA panel guidelines, or some other literature providing guidance, differs depending on the researcher's motivation, budget and the particular circumstances surrounding the research, making a comparison of research results from different surveys complicated.

We find conflicting evidence, from survey literature, on whether non-respondents differ significantly from respondents in terms of socioeconomic characteristics, attitudes towards environmental conservation, and their preferences. For example, Green (1991) finds small differences between early and late respondents but notes that late respondents had a less positive attitude towards the topic. Lankford *et al.* (1995) find no significant difference between early and late respondents but find some differences between respondents and non-respondents. Buse (1973) finds a significant difference between early and late respondents, and between respondents and non-respondents. Wellman *et al.* (1980) finds no significant difference between early and late respondents. Our study finds no significant differences between early and late respondents but no attempt was made to follow-up on non-respondents.

Unless a study involves sampling individuals with similar interests, such as anglers or hunters, non-respondents may have interests that are different from those of respondents resulting in self-selection and/or non-response bias. In our study the households are heterogeneous and we were worried that non-respondents could differ significantly from respondents. An analysis of early and late respondents somewhat allayed this worry as no significant difference was found between them. The number of follow-ups was limited to only two despite Dillman's (1978) advice for reasons already discussed earlier. Some comments from reluctant respondents seemed to suggest that follow-ups make the respondents feel like they are being harangued and they are surprised by the follow-ups as the first cover letter introducing the survey to the respondents clearly stated that participation was voluntary.

7.3 Recommendations and Conclusion

We tested HBRC's policy on the restoration and preservation of Pekapeka Swamp using economic efficiency criteria and found the programme to be Pareto efficient in that potential benefits from the programme outweigh costs by a factor ranging from 3.8 to 12.3 with our "best estimates" of net present value ranging between NZ$5.05 million and NZ$18.20. Considerable economic value is demonstrated by these value estimates and HBRC is encouraged to speed up the delivery of the services by spending more money in areas that support speedy delivery of activities which respondents expressed greatest interest in such as walking, and nature appreciation.

A large proportion of households indicated prior knowledge of the existence of Pekapeka Swamp (79.3%), and about 58% indicated that they would spend at least a day at the restored Pekapeka. Potential participation in wetland based recreational activities at the restored site is high but more could be done to increase public awareness of the site so that the households currently unaware of its existence have a chance to decide on what services to consume. The restoration programme for Pekapeka Swamp is a worthwhile cause for the residents of Hawke's Bay and should be pursued with increased vigour to ensure the timely delivery of economic benefits associated with the programme. Residents of Hawke's Bay demonstrate understanding and appreciation of the importance of wetlands. Only one respondent suggested that the wetland should be converted to agricultural land.

Annual household WTP estimates suggest that HBRC has a potential source of revenue for future funding needs of the programme but they would have to structure an appropriate levy instrument that would be acceptable to the majority of households in the region. In the event that HBRC goes the way of the levy, we would suggest the setting up of a special fund to be administered by a publicly appointed board as any direct association and control of the funds by HBRC may be met with resistance and protest.

Some respondents indicated interest in participation in water based recreational activities such as swimming, fishing and boating. Water quality at the swamp needs to be investigated to establish if it meets the health standards for these activities.
We suggest future research in the following areas:

1. Effects of non-response bias on value estimates

Our study did not explore the effect of non-response bias on the value estimates because of time and budgetary constraints. Further research needs to be undertaken to investigate the effect of non-response bias on the survey results.

2 Test for scope sensitivity

The validity of results from a contingent valuation survey may be tested using scope sensitivity. This may be achieved by varying the number of ecosystem services to be valued and the level of each ecosystem service to be provided. More complicated non-market valuation techniques such as conjoint analysis and choice analysis are required for this purpose.

3 Effect of limiting the population to a political jurisdiction

We estimated four distance decay functions from the models fitted to our dataset. These functions may be used to determine the relevant population within each empirical boundary. WTP per household may then be scaled up, using the estimated population to estimate the aggregate values for each boundary and compare these to aggregate value estimates for this study.

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