Non Market Value of Biodiversity on Agricultural Land by Rural Landowners: A Case Study

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ABSTRACT

The loss of biodiversity on agricultural land is of increasing concern, both in New Zealand and globally. In New Zealand, historically, that loss is largely a result of the clearing of lowland forests and the draining of wetlands for increased agricultural production. Biodiversity is a critical component of our natural environment and necessary for sustainable development, particularly for the ecosystem services (such as, soil stability, nutrient retention, and flood protection) it provides. However, it has too long been under-valued.

The aim of this research is to use a stated preference approach, choice modelling, to determine the non-market value rural landowners place on biodiversity on agricultural land. It employs different attributes for biodiversity, and a payment vehicle of an annual contribution, for a 10-year period, into a council designated fund to which farmers can apply for funding to take actions to enhance indigenous biodiversity on their land. The focus of this study is the Waikato Region, due to its diversity of native flora and fauna and the pressures placed on it from the region's strong agriculture based economy. An online survey was used to survey rural landowners in the region. Usable responses were obtained from 146 respondents, three-quarters of whom operate their own farm and two-thirds of whom have indigenous biodiversity present on their farm.

A latent class model was used to estimate non-market values, since revealed attribute non-attendance (or avoidance) had taken place. The results highlight the importance to farmers of ecosystem services provided by indigenous biodiversity, as those attending to all attributes were willing to pay toward maintaining current actions ($43.90/year for 10 years) or, for increasing actions to enhance ecosystem services ($59.65/year for 10 years). In contrast, however, they were willing to accept an annual payment ($49.22/year for 10 years) toward controlling possums and other pests. Other results were not clear-cut, making recommendations difficult. Perhaps a future study could investigate whether society as a whole places value on indigenous biodiversity being present on agricultural land, and whether there is a willingness, by society, to pay for this.

Keywords: choice modelling, biodiversity, non-market valuation, agriculture, latent class model, Waikato region, attribute non-attendance.

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LIST OF ABBREVIATIONS

AIC	Akaike Information Criterion
ANA	Attribute Non Attendance
AVC	Asymptotic Variance-Covariance
CE	Choice Experiment
BIC	Bayesian Information Criterion
CM	Choice Modelling
CVM	Contingent Valuation Method
DV	Direct Value
ECLCM	Equality Constrained Latent Class Model
HPM	Hedonic Pricing Method
IIA	Independent Irrelevant Alternatives
IID	Independent and Identically Distributed
IV	Indirect Value
LCM	Latent Class Model
NZLT	New Zealand Landcare Trust
PV	Passive Value
RPS	Waikato Regional Policy Statement
TEV	Total Economic Value
TCM	Travel Cost Method
WRC	Waikato Regional Council
WTA	Willingness to Accept
WTP	Willingness to Pay

Chapter 1

1 Introduction

1.1 Background

Biodiversity is a critical component of our natural environment, playing a pivotal role in sustainable development and increasing human wellbeing, livelihoods and cultural integrity (Czajkowski, Buszko-Briggs, & Hanley, 2009). The definition of biodiversity frequently referred to in the literature (Christie, Warren, Hanley, Murphy, & Wright, 2004; Czajkowski, Malgorzata, & Hanley, 2008; Department of Conservation & Ministry for the Environment, 2000; Nunes & van den Bergh, 2001) has evolved from the term biological diversity, originating from Article 2 of the Convention on Biological Diversity at the United Nations, Rio de Janeiro 1992 Conference on the Environment and Development:

> "Biological diversity, means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part of; this includes diversity within species, between species and of ecosystems" (Convention on Biological Diversity, Article 2, 1992).

The uniqueness and importance of New Zealand's biodiversity can be clearly illustrated by the high percentage of species that are endemic to this country. This uniqueness is demonstrated by the numbers of endemic species present on six islands in the Hauraki Gulf being greater than the number of endemic species in the whole of the British Isles (Department of

Conservation & Ministry for the Environment, 2000). New Zealand's unique biodiversity extends to its species boasting the world's only flightless parrot (the kakapo), a bird with nostrils at the end of its beak (the kiwi) and distinctive ecosystems like the kauri forests of the North Island and the braided river systems of the South Island (Department of Conservation & Ministry for the Environment, 2000).

Society overall considers itself better off, the greater the level of biodiversity it has (Biological Diversity Advisory Committee, 2005). The literature suggests that biodiversity provides numerous anthropocentric benefits, one of these being increased human wellbeing or utility (Christie et al., 2004; Christie, Hanley, Warren, Murphy, et al., 2006; Yao & Kaval, 2009a). Today's society has been left with the unintended consequences of decisions that have resulted in the loss of biodiversity (Bennett, 2003). Examples of these decisions are the clearing of lowland forests and draining of wetlands for agriculture, and the harvesting of timber from long standing native forests. This loss of biodiversity has resulted in society losing the wide range of ecosystem services that biodiversity provides. Examples of these ecosystem services include flood protection, nutrient retention for water quality, and recreational services, which are all provided through biodiversity.

Biodiversity typically goes unrewarded by market forces due to missing markets and the opportunity cost of protecting biodiversity, which typically falls to the landowner and provides a deterrent for investing in biodiversity on the land (Hanley, Banerjee, Lennox, & Armsworth, 2012). The loss of biodiversity and the ecosystem services it provides, highlights a gap between the market value and the economic value of these services (Fromm, 2000). This gap has led to a decline in biodiversity internationally, with the widespread disappearance of natural ecosystems and habitats across the globe (Barbier, 2007). Internationally, landuse change is driven by relevant rates of return from one landuse to another, and the significance of biodiversity is not widely appreciated; it is often, therefore, difficult to quantify in monetary terms the values gained from maintaining biodiversity. Without an accurate monetary value it is difficult for biodiversity to be accounted for in the decision making process. A typical example of this is where the landowner has to choose between foregoing a profitable land conversion or intensification in favour of biodiversity conservation (Hanley et al., 2012). It is recognised by the Convention on Biological Diversity, that economic valuation of biodiversity and biological resources is an important tool (Pearce, Moran, & Biller, 2002), and the Convention encourages society to consider economic, social and cultural measures when valuing biodiversity. It is argued by Christie et al. (2004), that the measurement of the economic values of biodiversity is a fundamental step in conserving the biodiversity resource. In assigning an economic value to biodiversity, it can be directly compared with other landuse options.

1.2 Biodiversity on agricultural land in New Zealand

New Zealand is not exempt from biodiversity loss. Some 82% of pre-human New Zealand was covered by indigenous forest (North Island 96%, South Island 72%) and this figure has now dropped to 24% of indigenous forest cover with a resulting loss of biodiversity (Ewers et al., 2006). The loss of biodiversity as described by Ewers et al. (2006), has been associated with the establishment of other landuses, such as planting of exotic forests, horticulture, agriculture and urbanisation, along with economic growth and the development of infrastructure such as roads and rail. Land classified as 'unimproved' in 1960, covered an estimated 53% of the total agricultural area, compared with only 8% categorised as mature or regenerating native scrub or bush in 2002 (Moller et al., 2008). Moller et al. (2008) argued that these statistics illustrate a six to seven fold reduction of native habitat within farms between 1960 and 2000. This has caused the further loss of habitat for indigenous species at scales unprecedented since the original deforestation that occurred during settlement by colonial farmers (Meurk, & Clarkson, 2008).

The systems in place supporting agriculture in New Zealand today can be associated with what is referred to globally as industrial agriculture. This is where the farming system has an increased reliance on the purchase of inputs. These inputs (such as fertilisers, feed and agri-chemicals) represent a resource substitution in the form of capital for land and labour. The farming system also relies on the use of organisational features characteristic of a business firm, to ensure the maximisation of yields per hectare (Jay, 2005). Jay describes Waikato dairy farming and the organisation of the New Zealand dairy industry as reflecting these characteristics. Farms and farm management are seen as being closely linked to the industrial process of milk production, which depends on the highly specialised scientific infrastructure of pasture, live stockbreeding and welfare, together with capital-intensive technology for milking and milk control. Many of the processes associated with industrial agriculture involve management practices that cumulatively undermine the survival of indigenous habitats and species (Jay, 2005b; Perrings, 2010).

The decline of indigenous vegetation in the Waikato region is typical of how indigenous biodiversity has declined since the coming of the European to New Zealand in the 1840's. Since European settlement, indigenous vegetation has been steadily reduced in the Waikato Region with coverage now limited to 26% of the total former area (approximately 620,833 ha) (Waikato Regional Council, 2013d) and only 18% of lowland forest remains (Leathwick, Clarkson, & Whaley, 1995). Wetlands in the region have been reduced to make up less than 20% of the area they once covered (Leathwick et al., 1995). Nationally, the coverage of wetlands is now only 250,000 hectares or 10% of their original area and indigenous forest has reduced from 23 million hectares to 6.5 million hectares today (Ausseil, Dymond, & Weeks, 2011).

1.3 Problem Statement

Loss of biodiversity on agricultural land is an increasing problem, both in New Zealand and worldwide. This results in the loss of the accompanying ecosystem services on which society depends, including the supply of water, pollination of plants, soil stabilisation and sediment control, nutrient cycling of raw materials, and the provision of recreational and cultural services. Biodiversity loss imposes cost on society due to the role it plays in sustaining the functions of these ecosystems. In addition to the loss of ecosystem services, there is the loss of habitat for unique fauna and flora many of which are endemic to New Zealand. These losses result in a net welfare loss to society.

Local, Regional and Central Government policy in New Zealand is increasingly requiring biodiversity in the agricultural landscape to be retained, with Government agencies now expecting the landowner to pay for the maintenance of biodiversity on private land. This leads to the trade-off in the benefits of production against the benefits of conservation (Perrings, 2010), with interconnected forces characteristically generating too little biodiversity conservation and too much biodiversity loss (Hanley et al., 2012). Intervention is therefore required to encourage biodiversity conservation on private agricultural land. However, a knowledge gap exists around the actual value of biodiversity on private agricultural land.

1.4 Aim

The aim of this research is to use a choice modelling approach to determine the non-market value rural landowners place on biodiversity on private agricultural land.

1.5 Objectives

1. To identify what components of biodiversity are important when valuing biodiversity on private agricultural land.
2. To design a model to determine the non-market value of biodiversity on private agricultural land.
3. To apply a choice experiment to a selected case study area.
4. To establish the non-market value of indigenous biodiversity on agricultural land for rural landowners.

1.6 Limitations

The complexities of the biodiversity resource, presents limitations on the ways it can be described and the attributes used to measure its preservation. Stated preference valuation methods predominantly require the respondent to make value based judgements on the goods in question. The model used imposes a further limitation. The Latent Class Model (LCM) divides the population into classes, where the preferences in each class are assumed to be homogeneous, but characterised by the heterogeneous preferences across each class. The preferences of each class are limited to the key design attributes provided in this study.

In terms of policy application, while the welfare estimates can be used to inform agencies of the allocation of financial resources, these should not be regarded as absolute. Agencies should base their decisions on a range of criteria as to how they determine the allocation of resources to preserve biodiversity on privately owned agricultural land. Some of these criteria may include social, recreational, scientific, cultural, equitable criteria, political acceptability and the public perception of biodiversity.

1.7 Thesis outline

The remainder of the thesis is organised as follows:

Chapter 2: This chapter provides a review of the literature on valuing biodiversity both in New Zealand and overseas. The components of biodiversity, their role and importance are also discussed. This chapter also includes a review of economic theory and the current practices used for non-market valuation for biodiversity.

Chapter 3: This chapter provides a comprehensive description of the Waikato region, the area selected for this case study.

Chapter 4 : This chapter sets out the methodology used in this research.

Chapter 5: The results of the non-market valuation study are presented here.

Chapter 6: The results are discussed, in relation to how the Waikato region and the wider effects from these findings will be discussed.

Chapter 7: The final chapter outlines the conclusions and recommendations of this study.

Chapter 2

2 Review of the Literature

2.1 Biodiversity Components

The development of robust quantitative indicators for valuing biodiversity is one of the challenges faced by policy makers; this challenge extends to identifying the components of biodiversity that are most appropriate for non-market valuation. However, there are several common themes outlined in literature (Christie et al., 2004; Christie et al., 2007; Czajkowski et al., 2009; Swift, Izac, & Van Noordwijk, 2004) which focus on the lack of understanding by the general public of an ecologist's perspective of biodiversity indicators as described earlier in the definition of biodiversity. The challenge faced by researchers is in identifying a quantifiable indicator for biodiversity. There is no single approach to measure biological change, which contributes to the lack of understanding of biodiversity and the general reliance of the public use of anthropocentric preferences, which has undermined valuation exercises (Christie et al., 2004; Jacobsen, Boiesen, Thorsen, & Strange, 2008). These preferences refer to the public's perceptions and values such as, cuteness of plants or animals, rarity of plants or animals and charismatic relationship with plant animals. When surveying a series of focus groups "over half the participants could not remember having come across the term biodiversity before" (Christie et al., p. 354) or had "little knowledge of the concept of biodiversity" (Lindereman-Matthies & Bose, 2008, p. 732). It is therefore fundamental to ensure that meaningful components are selected to value biodiversity. Patterson & Cole

(1999a) described an anthropocentric approach when referring to Costanza et al. (1997), whereby an individual has a limited knowledge of overall ecological processes. This is referred to in the literature (Christie et al., 2004; Czajkowski et al., 2008; Martin-Lopez, Montes, & Benayas, 2008) as the 'cuteness concept', where a greater value is placed on species for which there is a ready association.

When reviewing the literature, Christie et al. (2006) identified over 21 different concepts as being used by ecologists to describe and measure biodiversity and these are shown in Table 1. These groupings were acknowledged as a way of identifying a meaningful set of attributes, which describe variation in biological diversity in the agricultural landscape.

From an ecologist's perspective biodiversity is described as a link to different levels of genus, species, ecosystems and habitats, and its value can be defined in a number of ways (Christie et al., 2007; Swift et al., 2004). However, there are obvious difficulties around identifying and counting genus (Christie et al., 2004). Ecologists consider that, one of the simplest methods of measuring biodiversity is to measure the numbers of species present within a defined area. The general public, however, may not share the same familiarity with all species, with over 75% of participants defining biodiversity as the diversity of plants and animals, neglecting the other components that make up biodiversity, such as the diversity between species and habitats and the ecosystems they support (Lindemann-Matthies & Bose, 2008).

Table 1 Biodiversity concepts described by Christie et al. (2004)

Measures of Biodiversity: the units that ecologists use to measure biodiversity		21 concepts that ecologists use to describe and measure biodiversity	
Measures of biodiversity	Units of biodiversity	Species richness	Christie, et al. (2004) concluded that it was not appropriate to value the "Measures of biodiversity", but these measures could be used to describe the levels of condition of the biodiversity concepts.
		Individual groups of biota	
		Equitability	
		System naturalness	
	Scale factors	Alpha	
		Point	
		Genetic level	
		Community levels	
		Gamma	
		Epsilon	
Biodiversity concepts: ecological and anthropocentric concepts of biodiversity			
Biodiversity concepts	Ecological Concepts	Keystone Species	Species interaction within a Habitat
		Umbrella Species	
		Flagship species	
		Ecosystem Health	Ecosystem processes
		Ecosystem Function	
	Anthropocentric Concepts	Endangered species	Rare, unfamiliar species of wildlife
		Rare species	
		Charismatic Species	Familiarity of species of wildlife
		Cuteness	
		Familiar species	
		Locally important species	

Source: Christie et al.(2004, p. 44)

Three main components have been shown by Christie et al. (2004), Christie et al. (2007) and Czajkowski et al.(2009) to be a critical part of the valuing of biodiversity. These are species diversity, habitat diversity and ecosystem services, each of which will be discussed in more detail in the subsections which follow.

2.1.1 Species diversity and rarity

Species diversity is seen as the most commonly used indicator used for practical purposes, however, this does not provide a full description of biological diversity. Species diversity is referred to as being one of the recognised components of biodiversity that is associated with a variety of living organisms, for example; bacteria, algae, fungi, plants and animals. Species diversity can also be simply the variety of species. Recent studies have shown that no pattern or fixed relationship needs to exist between species and the stability of ecosystems. The ecosystem's longevity may instead be linked to the prevalence of a number of organisms or groups of organisms often referred to as 'keystone species' (Nunes & Van den Bergh, 2001; Patterson & Cole, 1999a).

Species diversity is seen as an important component for valuing biodiversity, reflecting the values which society place on the presence or absences of different organisms. Society assigns 'values consciously or unconsciously to different organisms' (Christie et al., 2007, p. 346), and this is referred to as the 'cuteness concept' as referenced earlier. Closely linked to this, is the association the public has with flagship species or charismatic species that are easily related to by the community or have a distinctive profile or that can be associated to a local identity (Christie et al., 2004; Christie et al., 2007; Czajkowski et al., 2008). Examples of New Zealand species investigated as to their "iconic status" (Burns et al.,2006) were Tui, Northern Rata, Bellbird, Mahoenui Giant Weta, North Island Brown Kiwi, Kokako, Duvaucel's gecko.

The general public's preference for individual species can be influenced by charismatic or anthropocentric factors that have little value from an ecologist's perspective (Christie et al., 2004; Christie et al., 2007; Czajkowski et al., 2009). As economic values are defined as being anthropogenic, the use of species as a means to value biodiversity is shown on its own to be insufficient. Research has shown (Christie et al.,2004;Jacobsen et al.,2008) that species valued by society are not necessarily rated as having the most importance. This has shown to be evident when comparing the existence value of species diversity with the protection of endangered species in a specific habitat type. According to the Jacobsen et al. (2008) study, using iconic species for valuing biodiversity habitat affects the values of species that policy makers consider worth preserving.

Locally important species can be shown to be more important in valuation studies due to the perception that people place a greater value on what they are able to see, and whether they are able to directly experience the benefits that these species provide, from conservation actions they may have undertaken (Christie et al., 2004). A species becomes iconic in a number of ways; for example, it could represent an element of oddity, endemism, rarity or have some cultural significance to Maori (Burns et al., 2006). For example, the Tui or Fantail is likely to have a greater value when compared to a common Waxeye. Birds that have won Forest and Bird's annual bird of the year competition can be viewed in this manner. Examples of previous of winners of this accolade include, the Tui (2005), Fantail (2006), Grey Warbler (2007), Kakapo (2008), Kiwi (2009), Kakariki (2010) and Pukeko (2011) (Forest and Bird, 2012).

Species rarity is also an attribute that contributes to the assigned value of a species within the biodiversity of an ecosystem or habitat (Christie et al., 2007). The rarity of a species is a strong driver, worldwide, of conservation and biodiversity management plans and policy actions. There are apparent difficulties in using rarity to value biodiversity, because it may occur for a variety of reasons and should not necessarily be awarded a higher conservation status by right (Christie et al., 2007; Jacobsen et al., 2008).

An Australian study referred to by Jacobsen (2008) concluded that due to the species being iconic, respondents were likely to attach greater value than if it was just an endangered species. It has been demonstrated, that when more information is provided in a questionnaire on an environmental good, such as emphasising that a particular species is 'rare or endangered', you will tend to get a greater willingness to pay (WTP) to preserve when compared to just referring to it as being 'common species'.

2.1.2 Habitat

The valuation of habitats is shown to be of practical importance to decision makers, by providing an understanding of the different values expressed by communities for changes to environmental quality. Changes to habitat quality and quantity (whether good or bad) are viewed as factors that influence policy makers' decisions around long term management of biodiversity (Christie et al., 2006; Christie et al., 2007). The value of biodiversity has been shown, in previous valuation studies referred to by

Christie et al. (2004), to be linked to natural areas, which have high levels of outdoor recreation or, linked to an individual species. Christie et al. (2004), Christie et al. (2006) and Nunes & Van den Bergh (2001), highlight the problems of valuation studies that value natural habitats, as such studies assign a value to the preservation of a particular species and the area needed to preserve the habitat the species supports. This results in studies unknowingly linking biodiversity value to natural habitat conservation, leading respondents to believe that the implementation of a conservation policy will result in increased biodiversity. This problem is emphasised by the public having difficulty in differentiating between preserving species and enhancing species, and their interactions within a habitat (Christie et al. 2004; Christie et al., 2006).

Valuation surveys of natural habitat identified by Nunes & Van den Bergh (2001) can be shown to focus on a wide range of different habitats such as wetland, terrestrial and coastal habitats. The mean WTP estimates per household of these surveys ranged from US$4 to US$242 depending on the habitat selected in the study. Valuation studies of forest biodiversity and wetland habitat described by Barbier (2011), and Garcia, Harou, Montagne & Stenger (2007), are typical examples of habitat types that are frequently valued. These studies assessed the value of beneficial goods and services that habitats provide to society.

The biodiversity concept for reasons described earlier is complex for respondents, which led to Macdonald & Morrison (2010) substituting the term biodiversity for the term habitat, to enable the necessary information to be conveyed to survey participants. The study showed firstly, that valuation of biodiversity is possible using habitat types and different scenarios of habitat loss. Secondly, it is possible to provide linkages to the diversity of species supported by these habitats, to enable participants to link value to a particular habitat. This approach provides an alternative framework for valuing biodiversity that is used by Christie et al. (2004), Christie, Hanley, Warren, Hyde, et al. (2006) and Nunes & van den Bergh (2001), who viewed habitat values as being an important component that should be part of the cost benefit analysis.

2.1.3 Ecosystem services

Biodiversity is recognised as an important part of maintaining the viability of ecosystem services, which are defined by Groot et al. (2010, p. 25) as "the direct and indirect contributions of ecosystems to human well-being". It is known that society interacts with ecosystem services as part of everyday activities, and takes advantage of the tangible benefits biodiversity provides. This can result in environmental degradation and total loss of biodiversity (Salles, 2011; Schneiders, van Daele, van Landuyt, & van Reeth, 2012). The value of these ecosystem services can be proven to be directly measurable for the contribution to societal welfare they provide (Bateman, Mace, Fezzi, Atkinson, & Turner, 2011). These values are classified into use and non-use values, which are characteristics of non-market environmental goods and can be applied to the neo-classical valuation model, which is explained further in the next section.

Ausseil, Dymond, Kirshbaum, Andrew & Parfitt (2013) reference a range of economic valuation studies that have valued ecosystem services in New Zealand. These studies illustrate the importance of ecosystem services to resource management decisions and the economic value of these services to society. An example of this value of ecosystem services, is the estimated value the Waikato Regional Council (WRC) placed on the Waikato region's ecosystem services in 1997 of approximately $9.4 billion (Waikato Regional Council, 2013b). The context of the components of this example is described further in Chapter 3.

It is widely described in the literature (Christie et al., 2007; Elmqvist et al., 2010; Patterson & Cole, 1999a; Swift et al., 2004) that there are a wide range of functions and services that ecosystems provide society, and these are detailed in the table shown in Appendix 1. Hart, Rutledge, Vare, & Huser (2013) have refined the services presented in this table, to identify specific ecosystem services that fit the New Zealand context. This is based on the work of the Millennium Ecosystem Assessment (MEA) (2005) and is presented in Table *2* . This high-level classification includes 17 ecosystem services that form part of the MEA, well referenced in literature, and several additional services that are viewed as being important from a New Zealand perspective.

Table 2 High-level ecosystem services framework in a New Zealand context

Provisioning Products obtained from ecosystems	Regulating Benefits from regulation of ecosystem processes	Cultural Non-material benefits obtained from ecosystems
Biochemical, natural medicines & pharmaceuticals	Air Quality Maintenance	Aesthetic Values
Food & Fibre	Biological Control	Cultural Heritage Values
Freshwater	Climate Regulation	Cultural Diversity
Fuel	Erosion Control	Educational Values
Genetic Resources	Human Disease Regulation	Inspiration
Ornamental Resources	Pollination	Knowledge Systems
	Storm Protection	Recreation & Ecotourism
	Water Purification	Sense of Place
	Water Regulation	Spiritual & Religious Values
		Social Relations
Supporting Services necessary for the production of all other ecosystem services		
Nutrient & water cycling		Provisioning of habitat
Primary production		Soil formation & retention
Production of atmospheric oxygen		

Source: Hart et al.(2013, p. 8)

In considering the complexity of the ecosystem services listed in Table 2, Christie et al. (2004) argue that it is probable that the public would have a limited understanding of many of the issues affecting these services, and therefore, attempting to value ecosystem services is problematic. This is primarily due to stated preference methods requiring participants to use value based judgments to value a particular good or service (Christie et al., 2004). In accepting the difficulties associated with using ecosystem services as a component in biodiversity valuation exercises, Perrings (2010) described this attribute as being critical for the motivation of biodiversity conservation for society over the past 20 years.

The key ecosystem services associated with the agricultural business model, shown in Table 2, can be classified in four groups of services with similar functions in an agricultural context. These groups are explained in the MEA and have been used by Sandhu, Warratten, & Cullen (2007) and Sandhu, Crossman, & Smith (2012) to describe the services they provide in an agricultural context and are described below.

Regulating services

- Ecosystems regulate essential ecological processes and life support systems through bio-geochemical and biospheric processes.

Provisioning goods and services

- This includes food and services for human consumption, including food production, raw materials, genetic and ornamental resources. The key goods and services are produced in agricultural landscapes and are consumed partly by the supporting and regulating services.

Cultural services

- Cultural services are considered to contribute to the preservation of human health and well-being, through providing recreation, aesthetics and education. Agriculture provides for these services through conserving or enhancing indigenous vegetation and landscapes, or by planting shelter belts and preserving the cultural and heritage value of the landscape.

Supporting services

- Support services are required to maintain the production of other ecosystem services. Supporting ecosystem services may be in the form of pollination, biological controls, carbon accumulation, soil formation, control of pest and diseases and mineralisation of plant nutrients. Within agriculture these services support the production of food, fibre, feed and wood. By inhibiting these supporting ecosystem services, substitution is needed from external imports, which is the case in agriculture, where many of the supporting ecosystem services have been replaced by inputs or technology to sustain production.

The farm processes within the agriculture sector are strongly dependent on a healthy functional ecosystem for waste disposal, maintaining soil health, pollination and maintaining hydrological processes, to name just a few (Swift et al., 2004). It is argued by Sandhu et al. (2012) that greater recognition of ecosystem services within agriculture is needed to lessen the extent of biodiversity loss, as the degradation of a healthy functional ecosystem results in the loss of the very ecosystem services utilised by agriculture. Ecosystem services within agriculture are of high value to the farm and the value of these services can be used to measure economic trade-offs in a productive landscape. Such changes would be considered by the landowner to be improved land practices that would have otherwise come at the landowner's expense, through the introduction of artificial inputs (Swift et al., 2004).

The concept of ecosystem services is well established overseas, with it being incorporated into decision making processes in the United Kingdom, to ensure that the value of ecosystem services and its benefits are given equal weight, when measured against other goods and services (for example, health care, education, etc.) that define social wellbeing (Bateman et al., 2011). The Proposed Waikato Regional Policy Statement (2010) (RPS) for example has recently introduced ecosystem services as a new component of the RPS, with objective 3.7 describing an aspiration goal of recognising and maintaining or enhancing ecosystem services in the Waikato Region. The importance of ecosystem services within the RPS is demonstrated by the term appearing 49 times and being considered relevant to 27 of the 62 proposed policies (Hart, Rutledge, & Greenhalgh, 2012).

2.2 Value of biodiversity

Biodiversity loss imposes costs on society due to the role biodiversity plays in sustaining the functions of ecosystems service (Hanley et al., 2012). It is argued by Perrings (2010), that the value assigned to biodiversity reflects the social preferences over the different ecosystem services that biodiversity provides. Economic valuation of biodiversity is viewed by the Convention on Biological Diversity as being a critical component in valuing biodiversity on private land, and is considered a fundamental step towards conservation (Christie et al., 2007).

The key characteristics of biodiversity are its public good attributes, from its non-excludability and non-rivalry qualities. The non-excludable trait exists, as it is impossible to stop anyone from ‘consuming or enjoying’ the good. The non-rival quality exists, as the enjoyment of biodiversity by someone does not reduce the amount of biodiversity available to others (Hanley, Shogren, & White, 2007). For example, it is not possible for a landowner who protects and enhances an area of remnant native forest or wetland on their property, to stop neighbouring properties enjoying an increase in bird life. Alternatively the neighbour's increased enjoyment does not reduce the farmer's own ability to enjoy the presence of this bird life.

This creates a problem for the supply of biodiversity. No private individual will obtain sole benefit of the public good which they have created or made accessible, and there will be insufficient incentive to produce additional biodiversity voluntarily. Users can effectively utilise the public good without contributing to its maintenance or enhancement. This is referred to as the 'free rider problem', causing landowners to have little incentive to protect biodiversity if they are unable to encourage others to contribute to the benefits they enjoy (van Putten, 2008). These characteristics contribute to biodiversity being characterised as a good with poorly defined property rights, resulting in over exploitation and unregulated use (Jones-Walters & Mulder, 2009; Nijkamp, Vindigni, & Nunes, 2008). To address this issue, it is seen as being fundamental to place a value on biodiversity in order to provide some market incentive to establish priorities for related projects, such as landuse change or intensification of agriculture activities (Nijkamp, et al*.,* 2008; Patterson & Cole, 1999a; Pearce et al., 2002).

Known problems exist in assigning a value to biodiversity that fairly reflects society's values. These problems are:

- the interpretation of the word 'value', from the perspective of an economist compared to an ecologist (Freeman, 2003),

- the economic and ecological measures of value (Bell, 2011; Freeman, 2003).,
- how society interacts with biodiversity and the resultant changes in welfare (Nijkamp et al.,2008).

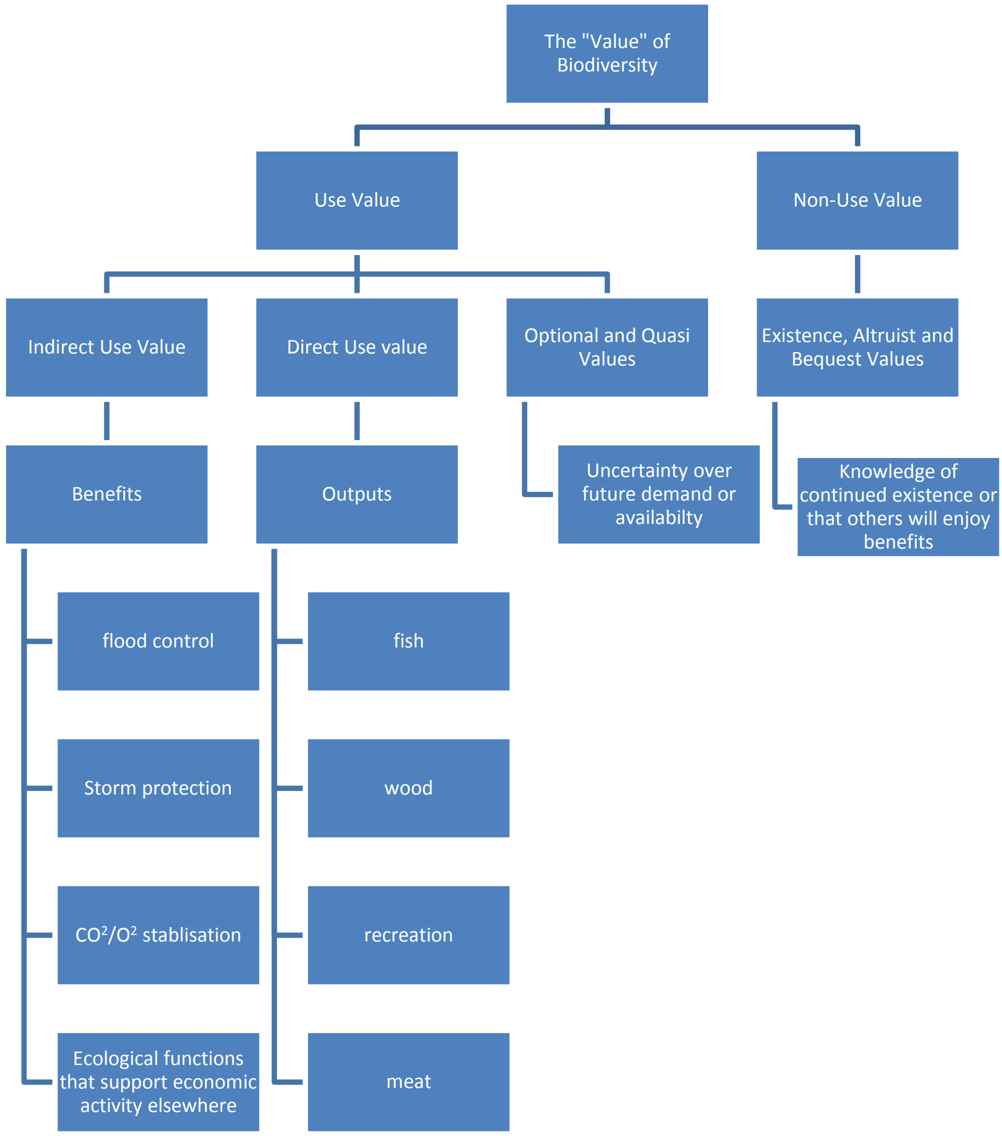
The differences in interpretation of value between ecologists and economists, is wide ranging, with ecologists referring to value as an item that is wanted, worthy of esteem in its own way or, has a quality containing intrinsic value. The ecologist is shown to lack respect for the social practices and human inclination which directs resource use. The economist, however, refers to value as an impartial or appropriate equivalent in money or commodities, and tend to disregard the bio-physical and ecological processes that support ecosystem services (Bell, 2011; Freeman, 2003). This contradiction in views fundamentally affects how a monetary indicator for biodiversity is obtained, when defining its value. The economic and ecological measures of value at times challenge each other, as the value society places on ecosystem functions, structures and processes, contrast considerably from the actual value of those ecosystem characteristics (Farber, Costanza, & Wilson, 2002).

The theoretical basis of the economic valuation of biodiversity is shown to be associated with the monetary variation of compensation of how individuals might be directly or indirectly affected by a change in the quantity or quality of that biodiversity (McDonald & Patterson, 2008; Nijkamp et al., 2008; Nunes & Van den Bergh, 2001). This perspective is recognised by Nijkamp et al. (2008) and Patterson & Cole (1999a) as being fundamentally anthropocentric and restricted to short term experiences of instrumental value, which is commonly formed around incomplete ecological knowledge. By considering how individuals perceive things, it may be that something has value only if it contributes to the welfare of an individual or individuals, as Nijkamp et al. (2008, p. 222) state "goods do not have a value per se, but their value is related to people's perceptions." Core to this argument are the relevant concepts and perceptions of value and how value is interpreted, when considering biodiversity.

2.2.1 Total Economic Value

When valuing non-market environmental goods and services, the Total Economic Value (TEV) is used. This is defined as the sum of the direct (DV), indirect (IV) and passive values (PV) and is usually expressed as DV+IV+PV= TEV. The TEV is usually characterised by the change in well-being from a policy or project (Bateman et al., 2002; Christie et al., 2004; McDonald & Patterson, 2008). TEV is recognised as not being straightforward and free from debate. The success of TEV in practice has been based on several legal cases, most notably the Exxon Valdez Alaskan oil spill disaster; however, questions are often raised about the ability to capture the actual value of natural resources. The components that make up TEV, from a biodiversity perspective, are shown in Figure1.

Figure1 Biodiversity Value



Source: Biological Diversity Advisory Committee (2005, p. 5)

The key underlying concept of TEV is that the total is the sum across all categories of values, such as use and non-use values, which is regularly referred to and supported in literature (Ansink, Hein, & Hasund, 2008; Christie et al., 2004; Elmqvist et al., 2010; Farber, Costanza, & Wilson, 2002; McDonald & Patterson, 2008; Nijkamp et al., 2008; Patterson & Cole, 1999a; Pearce et al., 2002).

Within biological diversity, both use and non-use values are important when valuing the welfare changes of individuals that form the concept of TEV. The TEV of a species or habitat is argued by Nijkamp et al. (2008) as originating from a blend of use and non-use values as shown by the different categories in *Figure1* (indirect use value, direct use value, optional and quasi value and existence, altruist and bequest values). Coupled to this are the reasons why individuals perceive certain aspects of an environment as important, which is evident in the psychological values used to establish a supposed quality or view of an environment (Nijkamp et al., 2008). Overall it is argued by Jones-Walters & Mulder (2009), that the TEV is fundamentally difficult to account for when accounting for the economic value of biodiversity in a dynamic landscape.

The view that value is part of the ecological function of biodiversity fits into two fundamental categories of value; production value (use value) or individual or societal value (non-use value). Production values are seen as being part of the production and cost functions of market-allocated goods, such as, the use of ecosystems for forestry and agriculture. Individual values (non-use value) of biodiversity, are part of the individual utility, such as, the recreational or aesthetic values biodiversity provides, and is discussed in the next section (Fromm, 2000).

The ecological importance of biodiversity, as a component of the TEV, is important due to specific relationships within biodiversity that effect the TEV. Fromm (2000) describes these relationships as:

- the relationship between species and their habitats,

- the relationships of biotic and abiotic components of an ecosystem
- the relationships between the ecological functions of ecosystems and the interaction with the ecosystem services to human welfare.

To ensure that the economic values of the environment can be accounted for, different types of valuation meanings have been developed to capture economic values. For example, the optional value is used to describe the future potential use of ecosystem services or biodiversity, where uncertainty exists regarding its preservation. Existence values are frequently referred to as non-use values, where an individual derives value from simply knowing that the biodiversity exists or, that other individuals have access to it. Closely associated with this is the bequest values, where there are concerns shown for inter-generational and altruistic values that are associated with inter-generational wealth (Pascual et al., 2010). The methods for valuing non-market environmental goods and services are progressively being refined and are described in the next section.

Non-use or passive use values are seen as being anthropocentric values, as their existence depends on society valuing a resource. Where biodiversity is concerned, these mirror the notion that society derives value from knowing that biodiversity exists, and that it is being protected so that future generations can have access to it or know of its existence (Patterson & Cole, 1999a). An example of this is the preservation of a threatened species in a conservation area, affecting the welfare of individuals living a great distance from that conservation site. These individuals can derive satisfaction from knowing that there has been an improvement in biodiversity for both present and future generations, even if they will not directly benefit from it (Nijkamp et al., 2008).

Non-use values relate to markets that do not routinely exist. These values relate to moral, religious, cultural, heritage and other values, such as, the value of a particular wildlife species or habitat. Non-use values of biodiversity are viewed as being difficult to capture and are the subject of controversies concerning their economic importance (Christie et al., 2004; Salles, 2011).

2.3 Valuation Techniques for Non-Market Environmental Valuation

There are a range of different approaches for establishing the economic and monetary value of biodiversity. In order to value the environment, different types of measurement methods have been developed to enable individuals to obtain values that are neglected by the market (Elmqvist et al., 2010). These approaches are referred to as market price information, or simulating individual's preferences, using a range of non-market valuation methods (Nijkamp et al., 2008). These methods can be either revealed preference or stated preference methods.

Methods from the literature that will be considered and discussed here are:

- travel cost
- hedonic pricing
- contingent valuation
- choice modelling.

2.3.1 Revealed preference approach

The revealed preference approach is centred around the preferences of individuals as demonstrated by the choices they make in existing markets. These preferences can be sourced from real, market based information (Nijkamp et al., 2008). The preferences for environmental goods are usually revealed indirectly by purchasing decisions (such as price paid or quantities purchased) to which the environmental good is related in some way. Such preferences can be viewed as being secondary, as they are not bound by individuals' expressed responses to questions equating to their WTP or willingness to accept (WTA) a change in environmental quality (Nijkamp, 2008).

These methods rely on a surrogate market that provides a 'behavioural trail' to ascertain the environmental value of interest. These values depict real behaviours, (as opposed to hypothetical behaviours from the stated preference techniques) and therefore decision makers have more certainty with their outcomes (Pearce et al., 2002). Revealed preference techniques are based around the non-use values (existence values) like knowing about the existence of a recreational area such as a forest park in the region. These values can be separated into non-consumptive use values (for example, tramping) and consumptive use values (for example, hunting) (Spangenberg & Settele, 2010).

The key difference between revealed preference methods and stated preference methods is that the stated preference approach depends on data from carefully phrased survey questions examining the choice individuals would make for "alternative levels of an environmental amenity" (Boyle, 2003b, p. 260) or their intended behaviour. Revealed preference relies on data that records people's actual choice or revealed behaviour. A method for using revealed preference methods to estimate non-use values is yet to be developed, therefore the estimation of non-use values can only presently be determined by stated preference methods.

Historically, biodiversity was valued using revealed preference techniques and an example of this is the Travel Cost Method (TCM). The TCM looks at how different individuals respond to the monetary differences in travel costs incurred to view or experience that environmental good (in this case a habitat or a particular species). How they respond to changes in travel cost gives an indication of how they value that environmental good, thereby estimating how they would respond to changes in price. The usual assumption is that the number of visits to a site is related to the size of the travel cost. However, TCM has limited application to value things other than parks and charismatic species (Pearce et al., 2002). For example, the Kapako, Kiwi and other bird species present in the Maungatautari Ecological Island, or the large Kauri trees of Waipoua forest, such Tane Mahuta, which can provoke travel behaviour. However, in general this technique has limited application in term of biological resources (Pearce et al., 2002).

An alternative revealed preference technique is the Hedonic Pricing Method (HPM), which is based on the theory that "goods are valued for their utility-bearing attributes or characteristics" (Rosen, 1974, p. 34) and is considered by Pearce et al. (2002) to be founded on thorough economic theory that is capable of producing effective estimates of economic benefits. There are, however, a number of known limitations with this method. These are described by Pearce et al. (2002) as relating to the methods dependence on the assumption of a freely functional property market, coupled with the reliance of individuals to obtain perfect information and the flexibility to purchase a property containing features that they value, therefore indicating their demand for those specific characteristics. The HPM would only have application to a limited number of biological resources that would fulfil these characteristics, along with it being difficult to obtain accurate data to describe their value.

2.3.2 Stated preference approach

An alternative approach to revealed preference is the stated preference approach, which is considered by Spangenberg & Settele (2010) to be the most frequently used approach for valuing ecosystems, identified in economic literature. Stated preference techniques involve surveying participants being likely to be affected by a change in resource use and asking them about their preference for change. It is described by Bennett & Adamowicz (2001, p. 37), as "people's responses to questions, regarding their willingness to pay for hypothetical situations". The technique is used for valuing non-market environmental values and is labelled by Bennett (1999), as being able to quantify a person's willingness to bear a financial payment in order to achieve a (non-financial) environmental improvement, or to avoid potential environmental harm.

There are two commonly used stated preference techniques for valuing non-market environmental values; these are the Contingent Valuation Method (CVM) and Choice Modelling (CM). CVM is the most well-known stated preference technique. Both these techniques rely on well-designed surveys and the ability of people to state preference by being able to place one object above or below another, in a given context (Boyle, 2003a). CVM involves the presentation of a single trade-off scenario, to survey participants, to obtain information on the strength of people's preferences. This method is often used to value a single good, which in the context of biodiversity could extend to a recreational experience, a change in an environment or habitat that is associated with an attribute. In comparison, CM involves providing survey participants a "more detailed and repeated resource use scenario to collect data about choice" (Bennett, 2006, p. 1). This results in the researcher obtaining a more substantial amount of statistical data, which can be extrapolated for use in circumstances beyond the immediate data source.

The common feature between the two methods is the use of an attribute to assign value to a good. There is, however, an inherent difference between CVM and CM in the way that each method uses attributes to do this. For example CVM asks respondents how much they are willing to pay for a hypothetical environmental goal, through the use of one question, and CM puts forward a number of repeated choices to the respondent, from which he or she must choose his or her preferred choice (Bennett & Adamowicz, 2001). Supporters of CM argue that the choices presented in a CM questionnaire are “incentive compatible and can be designed in a way to provide realistic frames of reference for respondents” (Bennett, 2006, p. 2).

Bennett (2006) highlights issues surrounding the validity of non-market valuation techniques, when using a stated preference approach, and the controversy that can be attributed to inherent bias towards overestimating environmental values. Historically, this has also been the case with the CVM. Bennett (2006) refers to the Exxon Valdez case, where the technique was challenged, along with the value estimates the CVM produced, following the awarding of environmental damages against the company in the Exxon Valdez Alaskan oil spill disaster. This resulted in the investigation of an alternative stated preference, non-market valuation technique, which led to CM emerging as a suitable environmental valuation tool.

The main advantages of using CVM are, firstly, it has the ability to estimate use, passive-use and optional values, and, secondly, it is capable of being applied to a wide range of issues. However the disadvantage of this method is the continual discrepancies between stated values (how much you say you are prepared to pay) and the actual value (how much you would pay if you really had to), frequently referred to as ‘strategic bias’ (Christie et al., 2004). Also ‘protest votes’, where respondents deliberately misrepresent their preferences in order to influence the decision to favour their point of view, has shown to dramatically alter the respondents maximum WTP or minimum willingness WTA a change in the good being valued, when using CVM method (Bennett, 1999; Champ et al., 2003; Hanley, Mourato, & Wright 2001).

CM has historically been used in commercial marketing, to estimate the demand for products and in transport economics, when investigating the demand for alternative transport modes. The objective of a CM exercise, referred to by Bennett (2006), is to estimate the preferences of goods and services that are not being bought and sold in markets. This is seen as being applicable to the undertaking of estimating preferences for non-market environmental goods and services (Bennett, 2006).

The remainder of this study will focus on CM, as it is considered to be the most suitable method to obtain non-market values for biodiversity on farmland. The CM technique enables the researcher to mould different attributes together, to provide an understanding of the different preferences of the attributes presented, rather than the single sample scenario under a CVM exercise. Introducing cost into one of the attributes enables the researcher to determine the WTP for one scenario over another. The ability of the CM to mould attributes together enables the researcher to frame complex trade-offs to generate a richer more diverse set of results. This characteristic of CM is more effective for determining the utility that a respondent would derive from a particular attribute.

2.4 Choice Modelling

CM is described as being a structured method of data generation, that relies on carefully designed choice tasks that help reveal factors which influence a choice. CM is a stated preference method using the random utility model (RUM) that is consistent within the economic field developed by McFadden (1973). A CM survey requires careful design and selection of the attributes appropriate to address the relevant choice trade-offs. The underlying theory behind this assumes that the respondent will choose an alternative choice that will yield them the highest utility (Bennett & Adamowicz, 2001; Hanley, Wright, & Adamowicz, 1998).

CM also has the distinct advantage of allowing the researcher to "value" attributes as well as situation changes (Adamowicz, Boxall, Williams, & Louviere, 1998). This can be utilised to determine compensating amounts of goods affected, by say, a proposed policy change. CM enables the examination of values of a particular attribute and inputs of a choice of functional form on welfare measures. The researcher is able to observe and model how respondents' change their preferred option when responding to changes in attributes. It allows the researcher to determine trade-offs between attributes, against respondents' willingness to give up some amount of an attribute in order to achieve more of a preferred attribute (Bennett & Adamowicz, 2001).

2.4.1 Advantages of using CM

CM enables the researcher to understand the respondents' preferences regarding the attributes presented, rather than having to present a specific scenario as under CVM, and it has been shown to outperform CVM in applied analysis (Adamowicz et al., 1998; Bennett & Adamowicz, 2001; Boxall, Adamowicz, Swait, Williams & Louviere, 1996; Hanley et al., 1998; Rolfe, 2006b). CM has specific advantages when analysing behavioural predictions and these are presented as follows:

- Provide the researcher the opportunity to control stimuli, as opposed to lower levels of control, associated with real market values (Bennett & Blamey, 2001).

- Have the ability to control the design matrix yield, to enable greater statistical efficiency in eliminating co-linearity between attributes. This enables the researcher to fairly estimate non-use values (Bennett & Blamey, 2001).

- Provide for the development of a more robust model due to the ability to apply a wider range of attributes that would not be found in real markets (Bennett & Blamey, 2001).

- Enable the introduction of new attributes in a comparatively straight forward manner (Bennett & Blamey, 2001).

- Provide a rich statistical output, allowing the researcher insight into whether additional factors, other than described scenarios, affect the value estimates of respondents (Rolfe, 2006b).

- Require respondents to consider complementary and substitution effects during the choice processes. This enables the problem of protest bids to be minimised, with selected resource interests being hidden within the pool of available goods (Rolfe, 2006b).

- Provide a more realistic method for respondents to trade off opportunity costs. The importance of this is that the WTP attribute is only one of several attributes and can therefore be 'deemphasised' in importance. CM enables a variety of opportunity costs to be introduced into the exercise rather than only partly as a WTP mechanism (Rolfe, 2006b).

- Enable the researcher the ability to analyse and compare choice experiments, allowing the testing of differences in framed choices between participants and resultant variations (Rolfe, 2006b).
- Value individual attributes that make up an environmental good such as the biodiversity of a forest or a wetland as well as situational changes (Adamowicz et al., 1998; Boxall et al., 1996).
- Avoid the "yea-saying" problems of dichotomous choice design in CVM, as the participants are not faced with the all or nothing choice in a CVM. Participants have the opportunity of choosing one or two environmental alternatives or the status quo, of which there are numerous opportunities repeated throughout the CM (Boxall et al., 1996; Hanley et al., 1998).
- Use attributes and levels of specific choice situations to enable the experimental design process to reflect different states of the environment (Boxall et al., 1996).

2.4.2 Limitations of Choice Modelling

There are some apparent weaknesses with CM for determining non-market environmental values. These are described, as cognitive burden, framing issues, incentive compatibility and technical complexities (Bennett & Blamey, 2001). Other known issues resulting from task complexity are respondents who demonstrate lexicographic preferences and attribute non-attendance, both of which violate the continuity axiom. Each will be explained in the paragraphs which follow.

The complexity of tasks that a CM respondent is faced with during a CM exercise can often be overwhelming. This can cause respondents to simplify decision-making strategies, resulting in unexpected variance (Hanley et al., 1998). A CM exercise requires respondents to understand attribute options, and how those attribute levels may vary across different combinations of attribute sets, and how they can be applied to different choice sets. This task complexity and cognitive burden is significantly greater than that experienced using CVM (Bennett & Blamey, 2001).

CM is affected by framing. Framing refers to the way in which respondents are made aware of the environmental good under consideration, and the array of substitutes available. The issue of framing can be overcome by ensuring the researcher encompasses goods that are strong substitutes, and complements a particular choice set in an attempt to pressure respondents to consider budget limitations in relation to that cost. A well know problem regarding CM, as described by (Bennett & Blamey, 2001), is the complexity involved in the questionnaire design, and the analysis of the data, as compared to the CVM method. This complexity is reflected in the experimental design and structure of the choice sets (Bennett & Blamey, 2001).

One of the complexities in valuing biodiversity, well documented in literature, is described by Saelensminde (2006) as the issue of lexicographic preferences existing within stated preference methods. Lexicographic preferences occur where a respondent consistently chooses the alternative that is best in respect to only one attribute, such as price, while ignoring all other attributes (Sælensminde, 2006). Lexicographic preferences are considered by Hanley, Splash & Walker (1995) to be an expression of a particular ethical belief and do not form part of a prior view on biodiversity; particular where the respondent is viewed as showing a particular ignorance towards biodiversity. Lexicographic preferences are known to be present amongst respondents when valuing biodiversity within stated preference methods (Veisten, Navrud & Valen, 2006).

It has been described in literature (Alemu, Morkbak, Olsen & Jensen, 2011; Kehlbacher, Balcombe, & Bennett, 2013; Kragt, 2013; Lagarde, 2013; Scarpa, Gillbride, Campbell, & Hensher, 2009) that respondents, for various reasons, do not consider all attributes. This is commonly referred to as 'Attribute Non-Attendance' (ANA) and not accounting for this can result in biased estimates of WTP (Kragt, 2013).

When respondents ignore attributes it infers their behaviour is inconsistent with the underlying concept of random utility theory and the resultant WTP (Kehlbacher et al., 2013). This theory is based on consumer behaviour, where individual preferences are considered to be complete, monotonic and continuous. Trade-offs are expected to be made by the respondent between all attributes which describe each alternative and the most preferred alternative is chosen (Scarpa et al., 2009). When this does not occur and respondents choose to ignore attributes, it implies non-compensatory behaviour has occurred, as no matter how much an attribute level improves, this improvement will fail to compensate for decreases in levels of other attributes, and the attribute itself is ignored by the respondent (Alemu et al., 2011; Campbell, Hutchinson, & Scarpa, 2006; Scarpa et al., 2009).

2.4.3 The CM technique

The CM approach is a survey-based method that depends on information from respondents' WTP for an improvement in an environmental good or alternatively, reflects their choice preferences regarding changes in a hypothetical scenario. The environmental good can be described as a bundle of characteristics and the levels they may display (Lancaster, 1966). For example, a forest could be described in term of its size, species diversity, age, and recreational opportunities (Bateman et al., 2002). To describe an environment in terms of its attributes, such as the forest example, is difficult as the utility received from the forest in a given state depends on a range of intangibles which are difficult to measure.

The focus here will be to examine the CM technique in the context of the environment. The basic application of CM here is to effectively determine these preferences, benefits and costs of a change in environmental quality.

The CM exercise usually contains seven design and methodological stages (Bennett & Adamowicz, 2001;Bennett, 2006; Rolfe, Alam, Windle, & Whitten, 2004). These are presented in Table 3.

Table 3 Design and methodological stages of choice modelling exercise

1	**Characterise the decision problem**
2	Identify and describe the attributes and levels
3	Development of an experimental design
4	Design and development of the questionnaire
5	Conduct the survey and collect the data
6	Analyse the data
7	Interpret the results for policy analysis

Adapted from: Bennett & Adamowicz, (2001),Kragt & Bennett, (2008), Rolfe, (2006b) and Rolfe & Bennett, (2006).

Each of these stages forms a critical part of the methodology of the CM exercise. A detailed description of how stages one to five was undertaken in this research is described in Chapter 4, while Chapters 5 and 6 present the analysis of the data and interpretation of the results.

2.4.4 Attribute selection

The selection of attributes is critical in describing the decision problem at hand. Attributes need to be meaningful to respondents (the population of interest) and policy makers/researchers, to ensure that they are identifiable and relate to the problem (Bennett & Adamowicz, 2001; Rolfe et al., 2004). The number of attributes selected needs to be minimised, to prevent the effect of cognitive burden on respondents. Cognitive burden results from the use of large numbers of attributes reducing the reliability of data. Appropriate attribute levels or ranges are a key part of the CM experiment design along with consideration of how the attribute levels and alternatives are presented as choice sets to respondents (Rolfe et al., 2004).

The 'do nothing' or status quo option is a critical level in the choice experiment development, so too is the inclusion of a financial attribute with respect to analyses regarding environmental outcomes. CM enables the linkage of monetary cost to one of the attributes, allowing for the estimation of the willingness to pay for one scenario over another. CM enables policy makers, to determine what amounts the public are willing to pay to move from the "status quo" bundle of attributes, to specific policy objectives identified in the alternative attribute choices. Attribute levels can be expressed either qualitatively or quantitatively and this is a key consideration. For example, a biodiversity attribute for endangered species may be quantitatively expressed in terms of numbers of species present or, alternatively, it could be expressed as a qualitative level such as slowing down the rate of decline of species loss (Bennett & Adamowicz, 2001). Providing the appropriate payment vehicle is critical to ensure that the prices being offered complement the level of the attributes. Regarding the financial attributes, careful attention must be paid to levels (prices). Prices too low will always be accepted and prices too high will always be rejected, translating to a very small or zero co-efficient in both scenarios (Bateman et al., 2002). A payment vehicle for the financial attribute is necessary to estimate welfare changes. This payment vehicle could, for example, be local government rates or levies or a central government tax. As part of the CM design, it is critical that the payment vehicle is realistic or believable. To avoid bias, the choices should inform respondents that such a payment would be required, should the proposed solution become implemented (Bennett, 1999).

When determining the number of attributes to incorporate in a study design, a choice is made between describing trade-offs accurately, therefore requiring more attributes or minimising choices and experimental design complexity (Rolfe et al., 2004). Selecting attributes for biodiversity CM has its unique challenges, which is discussed in more detail in the next section.

2.4.5 Experimental and Questionnaire Design

Experimental design is the third part of designing a choice modelling experiment. The complexity of the experimental design is linked to the numbers of attributes and levels. The greater the number of attributes and levels per attribute, the more complex the design (Bateman et al., 2002). Several methods can be used to statistically account for the different attributes and levels; these are full fractional, fractional factorial, blocking and efficient designs.

Full fractional design involves presenting respondents all possible combinations of attributes in the CM questionnaire. As the numbers of attributes and levels increase so does the size of the full factorial, which results in the total number of choice sets required to be presented to respondents, exceeding the ability of the respondents to cope with the large numbers of choice sets presented to them (Bennett & Adamowicz, 2001; Kragt & Bennett, 2008).

Fractional factorial is one method of addressing this issue, where a subset of all possible combinations is selected. This results in an "orthogonal experimental design that enables attributes to be statistically independent from one another ” (Kragt & Bennett, 2008 p. 15). The alternative to address a large number of choices is to segment the choice tasks into blocks. This will ensure each respondent is only exposed to alternatives of one block of the choice tasks (rather than all the choice tasks in the experiment). This approach, however, requires a large enough sample size to generate the data necessary for this model to work (Bennett & Adamowicz, 2001).

Researchers have more recently suggested, from a statistical perspective, that experimental designs, which form a critical part of stated preference tasks, should convey the maximum amount of information about the parameters of the attributes relevant to a particular choice task. This cannot be guaranteed with an orthogonal fractional factorial design (Hensher, Rose, & Greene, 2005). Orthogonal fractional factorial designs are generated so that statistical independence can be achieved with the attributes, although the statistical efficiency of the design is generally not considered.

Rose, Bliemer, Hensher, & Collins (2008) highlight the more recent shift that has taken place in CE toward the use of efficient (non-orthogonal) designs. Efficient designs are a type of design that attempts to reduce the asymptotic standard errors of parameter estimates (which are the square roots of the diagonal components of the asymptotic variance-covariance AVC matrix). This improves the reliability of the parameter estimates and enables the analyst to reduce the sample size required for obtaining suitable levels of consistency in parameter estimates. This reduction of standard errors for parameter estimates has created a class of experiment designs that are referred to as 'efficient designs' (Bliemer, Rose, & Hess, 2008). The efficient component of the design is one that is referred to as producing data to enable the estimation of parameters with the lowest possible standard error (Choice Metrics, 2012). D-Efficient designs are one type of design that is part of this class. The d-error is described by Rose et al. (2008), as a measure of design efficiency to differentiate between designs, where the assumption is made that if the d-error is low, the (co)variances of the parameter estimates are also low. D-efficient designs minimise the elements of the AVC matrix, therefore improving the accuracy of parameter estimates for a design.

A key characteristic of an efficient design is that the analyst requires a prior knowledge of the utility functions in order to generate the components of the AVC matrix. This results in the necessity of undertaking a pilot survey to obtain parameter values which play a critical part in defining the level of efficiency of a design. With the absence of exact parameter values, estimated parameter values are likely to be required during the design phase. Therefore, it is common for the analyst to make certain assumptions as to what values to use, in order to generate the efficient design (Bliemer et al., 2008).

Regarding the questionnaire, CM questions have evolved from conjoint methods and are increasingly being used in environmental economics, to value changes in natural resource quality. Choice methods differ from conjoint methods because individuals are asked to choose from bundles of (environmental) goods, which are described in terms of attributes. When constructing each choice set, Bennett & Blamey (2001) observe that it is important to ensure that each choice task has as much realism associated with it as possible. The question should mimic the decision that one would make when choosing one choice over another. The researcher needs to ensure that the attributes are constructed in a manner that is consistent with actual behaviours associated with the perceived policy problem. A CM survey is structured, and according to Bennett (1999) and Bennett & Adamowicz (2001), is usually presented in the following format:

1. An introduction of the issue under investigation
2. The framing of the environmental good under consideration
3. Statement of the issue
4. Statement of a potential solution
5. Providing the choice of 'choosing not to choose'
6. Introduction of the choice sets
7. Presentation of the choice sets
8. Follow up questions to explore motivations behind the decisions
9. Socio-economic and attitudinal data collection to assist in verifying data and checking how well the sample represents the population of interest.

These key steps are required when designing a CM questionnaire, once the attributes and levels have been determined. Each step forms a necessary component in extracting behaviours from the survey group in order to identify the trade-offs that each individual makes between each attribute, to determine the utility they derive from particular attributes (Mogas, Riera, & Bennett, 2005).

2.4.6 Theoretical Basis of Choice Modelling

CM, from an economic perspective, is based on the application of Lancaster's theory of value (Lancaster, 1966), combined with random utility theory (Hanley et al., 1998). Relative utility is defined by economists as the well-being or the satisfaction of what a respondent will choose when deciding on what choice will provide the greatest utility over the other alternatives presented (Bennett, 1999). An element of uncertainty associated with an individual's choice behaviour is made up of two parts; deterministic without error from the perspective of the individual, and stochastic from the perspective of the researcher (Holmes & Adamowicz, 2003). The first is the component that is observed or chosen by the respondent, which can be modelled and is treated as deterministic. The unobserved component is not included in the model, and is treated as stochastic. The utility (U) and the contribution of alternative j is expressed as:

$$U_j = V_j + \varepsilon_j \qquad (1)$$

(Hensher et al., 2005)

Where V_j denotes the deterministic (observable) utility change, while ε_j represents the stochastic (unobservable) change in utility. The observable utility represented as V_j, can be used as an approximation of the true change in utility of an individual. The influence of the environmental good's attributes to a person's observed utility is conveyed in the linear form (Yao & Kaval, 2009b). This can be expressed as:

$$Vj = \beta_{0j} + \beta_{1j} f(\mathcal{X}_{1j}) + \beta_{2j} f(\mathcal{X}_{2j}) + \beta_{3j} f(\mathcal{X}_{3j}) + \cdots + \beta_{\kappa j} f(\mathcal{X}_{\kappa j}) \quad (2)$$

(Hensher et al., 2005)

Where β_{0j} indicates the Alternative Specific Constant (ASC), representing the role of all unobserved sources of utility, β_{1j} is the parameter estimate associated with attribute X_1 and alternative $_j$. (Hensher et al., 2005). Modelling constants or ASCs explains any variation in choices that cannot be explained by either the attributes or the social economic variables (Bennett & Adamowicz, 2001). The explanatory variables, which are represented here by the attributes of the goods in question, are represented as $f\,(\ldots)$ (Yao & Kaval, 2009b). An attribute, such as habitat, can interact with other explanatory variables, such as price, and may be entered into the right hand side of the equation. To obtain the observed change in utility V, the total observed benefits from the different combinations of attributes are needed. Equation (2) shows that the estimate of V_j is dependent on the functional form of the explanatory variable, levels of attributes and the extent of the relative contribution of each attribute to the observed sources of relatively utility (Hensher et al., 2005; Yao & Kaval, 2009b).

The influence of the random component makes it difficult to predict an individual's preferences. The random component enables one model of choice options in a probabilistic form, where the likelihood that individual *i* prefers *j* over the other (*n*-1) options in the choice set. This can be expressed as the probability that the utility linked with option j, exceeds all other options. This conditional probability can be expressed as:

$$\mathrm{P}\ (i|\boldsymbol{C}) = \boldsymbol{P}[\boldsymbol{V}_{\mathrm{ij}} + \in_{\mathrm{ij}}) > (\boldsymbol{V}_{\mathrm{ij}} + \in_{in}), \mathrm{all\ n} \in \mathbf{C}] \quad (3)$$

where *C* is the complete the choice set (Hanley et al., 1998; Rolfe et al., 2004).

Assumptions must be made about the distribution of the random component. To obtain the observed change in utility V_j the total observed benefits from the different combinations of attributes are needed. Equation (3) shows that the estimate of V_j is dependent on the functional form of the explained variable levels of attributes and the coefficient estimates. The Multinomial Logit Regression (MNL) is the common model used for this, and is expressed in equation (4):

$$P_i\ (j) = \frac{\exp(X_i \beta_j)}{\sum_{k=1}^{J} \exp(X_i \beta_k)} \quad (4)$$

(Rolfe et al., 2004; Yao & Kaval, 2009b, p. 6)

Where $P_i\ (j)$ represents the probability that an individual i chooses the j^{th} alternative from J number of alternatives. $P_i(j)$ is a function of the individual characteristics of $(\mathcal{X}_i)$ and k unknown parameters (β_k). Equation (4) can be estimated by means of a MNL, assuming that choices are consistent with the independence of irrelevant alternatives (IIA) and are homogeneous (Yao & Kaval, 2009b).

To accommodate response heterogeneity within CM, a Latent Class Model (LCM), a semi-parametric variant of MNL, is used. The LCM assumes a discrete distribution of tastes in which individuals are sorted into numbers of different classes, characterised by homogenous classes through heterogeneous preferences across each. Heterogeneity is referred to as the variations in tastes and valuations, risk aversions or ambivalence of an individual (Washington, Congdon, Karlaftis, & Mannering, 2009). The underlying theory of the LCM is that individual behaviour depends on observable attributes and on unobserved attributes that cause latent heterogeneity.

The LCM assumes that the population of respondents can be divided into a set number of classes, or groups of individuals, that have different preferences. These groups, however, differ from each other, but all members of the same group share the same parameters (Lagarde, 2013). The analyst assumes that individuals have some probability of belonging to a certain class (Greene & Hensher, 2003). Where it is suspected that ANA has taken place through respondents attributes processing strategies, an Equality Constrained Latent Class Model (ECLCM) can be applied (Kragt, 2013). In an ECLCM, the attribute coefficients are constrained to zero and the class membership is estimated within the model, rather than utilising predetermined classes as in a standard LCM (Campbell, Hensher, & Scarpa, 2011; Kragt, 2013; Scarpa et al., 2009). The preferences within an ECLCM are assumed to be homogenous within each class but vary between classes.

The utility (U_{ijt}) that an individual, i derives from choice alternative, j in choice situation t. The observable attributes are represented by X_{ijt} while the factors that are unobserved by the analyst are represented by ε_{ijt}. This can be shown as:

$$U_{ijt} = \beta_c' X_{ijt} + \varepsilon_{ijt} \quad (5)$$

(Kragt, 2013)

within the model a class specific parameter vector β_c' can be estimated. The probability of choosing alternative j is conditional on that individual belonging to a certain class, c:

$$\Pr(j_{it}|c) = \frac{\exp(\mu_c \beta_c' \mathbf{X}_{ijt})}{\sum_{q=1}^{J} \exp(\mu_c \beta_c' \mathbf{X}_{iqt})} \quad (6)$$

(Kragt, 2013, p. 726)

Where (μ_c) is a class specific parameter, the error terms are assumed to be independent and identically distributed (IID) across each individual and the classes within a type I extreme value distribution and scale factor (Φ). The class probabilities can be described by logit formula:

$$\Pr(c_i) = \frac{\exp(\phi \gamma_c' \mathbf{Z}_i)}{\sum_{s=1}^{C} \exp(\phi \gamma_s' \mathbf{Z}_i)} \quad (7)$$

(Kragt, 2013, p. 726)

where Z_i is a vector of choice invariant individual-specific characteristics, γ_c' is the vector of the parameters to be estimated in the model, and C is the total number of classes specified by the analyst.

To account for ANA, classes where ANA is suspected by the researcher have the coefficients set as zero. Respondents, whose choice strategies match the specific pattern of non-attendance, will therefore be assumed to have a greater probability of belonging to that class. The model assumes class probability of the probability of non-attendance, from respondent's observed choices.

2.4.7 Accounting for trade-offs between attributes

In each CM set, respondents have indicated their preferred alternative. This needs to be combined with the data showing the attributes selected and the social demographic data of the individual (Bennett & Adamowicz, 2001). Modelling estimation procedures state that the probability of choosing an alternative increases as the levels of preferred attributes in that alternative rise and the levels of undesirable attributes fall. This can be shown as:

status quo : $V_1 = \beta_1 A_1 + \beta_2 A_2 + \beta_3 A_3$

alternative 2: $V_2 = ASC_2 + \beta_1 A_1 + \beta_2 A_2 + \beta_3 A_3$

alternative 3: $V_3 = ASC_3 + \beta_1 A_1 + \beta_2 A_2 + \beta_3 A_3$ (8)

(Bennett & Adamowicz, 2001)

Where each β is the co-efficient associated with each attribute, and each A is the level associated with each particular attribute. Each ASC accounts for the average of all unobserved sources of utility attributed to that attribute.

Two different value estimates result from the choice modelling application. These are referred to by Rolfe (2006a) as being the value of the alternatives relative to each other, and the marginal value associated with a change in a single attribute, which is commonly referred to as part-worths.

The β coefficients estimated from the model are used to estimate the rate respondents are willing to trade-off one attribute against another (Bennett & Adamowicz, 2001). This can be shown as:

$$\text{Part-worth} = -(\beta_{\text{non-marketed attribute}}/\beta_{\text{monetary attribute}}) \quad (9)$$

(Bennett & Adamowicz, 2001)

The strength of CM is its ability to provide estimates of many different alternatives from one application. When a monetary element is included in the analysis, the trade-off can be referred to as the implicit price; which is the amount of money the respondent is willing to pay to receive more of a particular environmental attribute (Bennett & Adamowicz, 2001).

CM can estimate the changes in welfare resulting from the scenario of either making a respondent better or worse off, as a result of the change. This is referred to as the compensating surplus, and is described by Rolfe (2006a) as the change in income that will result in an individual's acceptance to move from the status quo to a defined alternative. This is equivalent to an individual's WTP for an enhancement of an environmental quality. For a loss in environmental quality, the necessary change in income to maintain a positive utility will infer a willingness to accept (WTA) therefore the welfare measure is compensating rather equal. Bennett & Adamowicz (2001) express this as:

$$CS = -(1/\beta_{monetary})\,(V_1 - V_2) \quad (10)$$

CS = compensating surplus

V_1 = utility associated with an alternative option

V_2 = utility associated with the status quo option

$\beta_{monetary}$ = is the parameter associated for monetary payment.

In completing the analysis the researcher can measure the change in welfare of respondents, using either a 'state of world' approach or a 'model of alternative' in assessing this change (Bennett & Adamowicz, 2001). 'State of world' is referred to where one alternative is offered and the difference is obtained between the wellbeing (utility) achieved by an individual under the status quo and some other alternative. This approach considers the marginal value of a change away from the existing situation. The 'model of alternative' approach is usually applied to recreation sites, where the status quo contains several alternatives along with the improved state, therefore welfare measures examine the utilities 'with' and 'without' the improvements, together with the probabilities of choosing each alternative (Bennett & Adamowicz, 2001).

From this summary, it can be shown that the CM technique has its apparent advantages and disadvantages. This approach, however, is fundamentally suited to the non-market valuation of complex environmental goods, such as biodiversity. CM is able to examine trade-offs between different sets of action involved in the management of biodiversity, therefore acting as a support tool for decision makers. The flexibility of this technique enables the estimation of welfare measures that offer a framework for decision makers around the maintenance and enhancement of biodiversity on rural land. Therefore, discrete choice experiments provide a suitable methodology for obtaining non-market values of native biodiversity on farmland.

2.5 Review of non-market valuation studies of biodiversity

Past non-market valuation studies in New Zealand have explored the linkage between biodiversity, habitat, and ecosystem services and the benefits derived from specific actions taken in enhancing or preserving these attributes. These studies have examined how biodiversity improvements have affected the values derived by households. The majority of these studies have used the CVM, CM or Benefit Transfer as the method for obtaining welfare estimates of the survey population.

Examples of studies that have applied the CVM to value biodiversity enhancement through tree planting programmes on both public and private land, of both regional and national level, are those done by Kaval, Yao, & Parminter (2007), Kaval, Yao, & Scrimgeour (2009) and Yao & Kaval (2008). These studies have shown that undertaking biodiversity enhancement works by planting additional native trees has a greater value to households on public land compared to private land. In addition to this, households showed a strong willingness to support native biodiversity enhancement in showing a median WTP of between $59 and $119 for planting on public land, as compared to $30 to $55 on private land (Yao & Kaval, 2008). The demographics of participants likely to take part in these planting programmes were likely to be self-employed, show a willingness to volunteer and were more likely to pay more if they were urban based.

The CVM was also used to value a specific habitat over an alternative landuse. Kirkland (1998) found that the New Zealand household mean WTP per year to preserve the Whangamarino wetland was $6.60-$12.70. While Nideble (2008) established a mean WTP to preserve the Pekapeka swamp from agricultural development was $30.52 and $76.89 per household annually for five years. The outcomes here demonstrated a significant WTP shown by the respondents to restore and preserve this habitat. However, Nideble (2008) outlined the importance of adopting a recognised survey methodology to obtain valid and reliable WTP when using the CVM. Other CV studies such as Kerr & Cullen (1992) and Lock (1992) can be associated with biodiversity and are based around pest control (possums in particular) and how much the household is willing to pay annually for controlling this pest.

Patterson & Cole (1999a) used the benefit transfer method to assess the values derived from ecosystem services on a national basis. A subsequent study by Patterson & Cole (1999b) examined the estimated value of ecosystem services in the Waikato Region. This study established the value derived from ecosystem services, showing that forest, lake and wetland ecosystems contribute the most value in terms of the services they provide. These studies are worth noting, as it was the first time a valuation exercise was done on ecosystem services in New Zealand.

The use of the CM method in valuation studies involving biodiversity in New Zealand is diverse. Some of the recent CM based environmental valuation in New Zealand can be linked to several common themes, such as enhancement of biodiversity (Kaval et al. 2009; Yao, 2012; Yao et al., 2014; Yao & Kaval , 2009b), pest control (Bell, 2011; Kerr & Sharp, 2007; Kerr & Sharp, 2008), ecosystem services (Baskaran, Cullen, & Taskatsuka, 2009) and waterways and water quality (Baskaran, Cullen, & Collombo, 2010; Kerr & Sharp, 2003; Tait, Baskaran, Cullen, & Bicknell, 2011).

An example of a CM study involving biodiversity is where Yao & Kaval (2009b) examined the welfare benefits of funding incentives to enhance biodiversity on private land through the planting of native trees. A critical aspect of a study involving non-market valuation of biodiversity was to establish a hypothetical market. In establishing a hypothetical market in this instance, Yao et al. (2014) viewed it as critical that this market contain levels of improved utility from the status quo that are ecologically feasible and perceived as believable by participants. Yao & Kaval (2009b) achieved this by choosing a set of attributes that would influence the preferences in behaviour towards biodiversity enhancement by respondents. The outcomes of this study highlighted the interest there is amongst landowners to participate in biodiversity enhancement, in particular localised government initiated programmes utilising tree planting on private property. The study established that the respondent would be better off in terms of welfare if such a programme was implemented on residential properties. This is highlighted, by part worth values of $120 for providing native trees to plant and $112 for providing a mixture of exotic and native trees to plant. Yao & Kaval (2009b) describe a limitation of this study as being how the choice modelling scenario and bid design instrument was developed. These were based on expert opinion, the type of information being sought by Councils and focus group meetings with respondents, rather than utilising an experimental design methodology such as full factorial or D-efficient design.

Kaval et al. (2007), Kaval et al. (2009), Yao (2012) and Yao et al. (2014) used CM to investigate which factors influence individual WTP for biodiversity enhancement and the proximity of individuals to planted forests and their corresponding WTP for biodiversity enhancement. The results showed that in large planted forests, biodiversity enhancement is valued, and native fauna has a greater value than exotic fauna. Respondents indicated that they would be willing to pay more for the enhancement of native fauna through an increase in income tax. The overall outcomes of this CM study are acknowledged as being consistent with previous work by Yao & Kaval (2008) and Yao & Kaval (2009), in terms of how much NZ households would be willing to pay for biodiversity enhancement on private land. Furthermore, the study showed that the public still values habitat enhancement for threatened species.

A critical part of the Kaval et al. (2009) study was that it used CM to determine the most preferred attributes for a biodiversity enhancement programme. In describing biodiversity according to its attributes, Kaval et al. (2009) identified that changes in these attributes were likely to result in a change in value. This was achieved by establishing a hypothetical, council supported tree-planting programme. In addition to this there were well-being questions to examine whether life satisfaction would change because of increasing native flora and fauna in the immediate area and in public parks or reserves. Although no WTP amounts were presented here, the outcomes demonstrated that that 90% of respondents were willing to pay an additional amount annually, as part of their rates, to a native tree planting programme.

Bell (2011) and Kerr & Sharp (2007, 2008), used the CM method to value a range of attributes relating to different states of an environment affected by pest and weed invasions, as part of a series of studies commissioned by the Ministry Agriculture and Forestry and Biosecurity New Zealand (MAFBNZ) on the value of biosecurity for biodiversity. To investigate weed and pest control in biodiversity, Bell (2011) selected a variety of environmental attributes that described different environmental states of a fresh water lake that participants might value differently. Participants had to determine how acceptable the different states of the environment were (i.e. the levels of weeds and pests present), and the level of utility they wanted to derive from the environment, through a list of policy choices.

Kerr & Sharp (2008) used CM to estimate community preferences and values linked to the impact of wasp invasions on native species in the South Island. The CM technique enabled them to understand the values the community placed on the effect of wasp invasions on native species and the resultant states of the ecosystem. This was dependent on the management strategy selected. CM enabled the use of attributes to link possible alternative environmental states, which became the basis for the framing of choices. The valuation aspect focused on the changes in utility associated with the changes in services from the natural environment, and the changes in the utility that the public attached to indigenous biodiversity. It was considered that the community derived both direct use and non-use benefits from any improvements made to the natural resource as a result of the wasps being controlled or reduced. CM enabled Kerr & Sharp (2008) to understand the values that the community placed on the effects of wasp invasions on native species.

To estimate the values linked to enhanced levels of ecosystem services in pastoral agriculture, Baskaran et al. (2009) used CM to value the impacts of agriculture on four key ecosystem services, air quality, water quality (pollution), water quantity (depletion) and scenic landscape. This CM exercise investigated incentives to encourage change within farming practices that would bring about improvements within these ecosystem services. An important aspect of this study was the four ecosystem services selected, on the basis that decisions by policy makers can affect these services, either directly or indirectly. This provided an element of realism to the survey, as did the quantitative levels, which provided a perception of future policy options. Using policy relevant attributes provided an element of realism to the survey ensuring the problem could be easy related to and identifiable, as discussed in previous sections.

CM was used to establish welfare estimates for the external effects of agriculture on the quality of streams and rivers in Canterbury in the Baskaran et al. (2009) study. This study investigated the attitudes towards aspects of agriculture and agricultural environmental policy that can influence the value of change in waterways. The outcomes presented here highlight the difficulties in setting resource management objectives for resources with poorly allocated property rights, which is a characteristic of biodiversity.

Internationally, CM has been successfully used to value biodiversity. In Australia CM has been used to value biodiversity, with a recent study by MacDonald & Morrison (2010), illustrating how CM can be used to value biodiversity using different habitats. An earlier Australian CM study by Blamey et al. (2000), estimated the benefits of increased agricultural productivity against the environmental costs of vegetation clearance in areas containing endangered species and unique ecosystems. Overall, CM has been used internationally to value a range of biodiversity attributes such as familiarity of species (Christie et al., 2006), species rarity (Czajkowski et al., 2009), habitat (Birol, Karousakis, & Koundouri, 2006; Brey, Riera, & Mogas, 2007; MacDonald & Morrison, 2010) and ecosystem services (Bateman, Mace, Fezzi, Atkinson & Turner 2010), which has seen CM become the preferred stated preference (SP) method for non-market valuation studies (Christie, Hanley, Warren, Murphy, et al., 2006).

CM can be used to contribute to efficient design of policies relating to different management interventions for habitat improvements in wetlands (Birol et al.,2006), forest management (Brey et al.,2007) or a range of habitats (MacDonald & Morrison, 2010). Brey et al. (2007) demonstrated the positive preferences held by the public for utilising forests for recreational activities, while MacDonald & Morrison (2010) illustrated the differences in WTP towards different habitats. However, when intervention is necessary, as outlined by Birol et al. (2006) and Brey et al. (2007), policy makers need to account for preference heterogeneity that is shown to be present for public goods, such as forest and wetland habitats.

Christie, Hanley, Warren, Murphy et al. (2006) and Czajkowski et al. (2009) used a wide range of attributes to value the diversity of biodiversity. These studies used ecosystem services, familiarity of species, and habitat quality to encompass this. The uniqueness of these studies was that they attempted to value the diversity of biodiversity rather than estimating the value of a biological resource, such as habitats, or species. Christie, Hanley, Warren & Murphy et al. (2006) used two SP methods to achieve separate outcomes. CM was used to estimate the value the public places on different attributes of biodiversity, while CV was used to value different policy programmes. The conclusions of both studies showed that the public place a positive value on biodiversity. However, the outcomes can be different, with Czajkowski et al. (2009) describing the public as showing concern in achieving a particular biodiversity outcome, and how this outcome can be achieved, while Christie, Hanley, Warren, Murphy et al. (2006) describe the public as being unconcerned in terms of how much biodiversity is actually protected.

In avoiding the use of a management-action focus (which is criticised by Czajkowski et al., 2009), the Czajkowski et al. study avoided describing any biodiversity change in terms of species richness or, in terms of being iconic. The approach instead, described the complex changes in biodiversity in utilising attributes described by ecologists, but adapted to what was considered valued by the general public. This made it difficult in presenting the results of each policy as part of each choice scenario, and problematic in separating each of the different components of biodiversity. Bateman et al. (2011) criticised the SP approach for valuing ecosystem services, as its methodology can be effective where respondents have a clear understanding of their prior preferences for the goods. However, problems can occur where there is a lack of understanding of the good (such as with ecosystem services) and the use of SP to value indirect use and pure non-use values.

A wide range of non-market valuation studies have been undertaken that have valued biodiversity in some manner. While not all have been mentioned, the aim of this discussion was to highlight the outcomes and questions that these studies raise and the criticisms associated with them.

2.5.1 CM method addresses the needs of valuing biodiversity

Non-market valuation studies, which value biodiversity, have shown that the concept of biodiversity is a challenging term regarding its understanding by respondents. This is one of the complexities that CM studies are faced with when collecting survey data. For reasons described earlier, it can be said that the public generally has limited understanding of biodiversity (Lindemann-Matthies & Bose, 2008, p. 11). CM studies have addressed this issue by adapting the information presented to households, when collecting data. Christie et al. (2004) addressed this problem by providing a PowerPoint presentation (explaining the complexities of biodiversity) to survey participants.

The importance of establishing the current level of local knowledge on biodiversity is shown in the Blamey, Rolfe, Bennett & Morrison (2000) study, where a wide range of complex issues and situations faced by regional communities concerning biodiversity, were investigated. There were two components to this issue. First, establishing the current level of local knowledge around the environmental systems and the loss of endangered species and threatened ecosystems, and second, the complexity of comparing the costs to welfare, for the loss of jobs and incomes from agriculture. The researchers faced the task of incorporating important environmental and social trade-offs, while selecting meaningful attributes to determine non-use values of vegetation. The keys to addressing these issues were in the attribute selection and in developing a questionnaire tailored to the community's level of knowledge specific to the environmental challenges faced by the community. The outcomes of this study demonstrated that CM could be used to aid in the decision-making processes of a challenging issue, where welfare costs and biodiversity loss are being traded against each other (Blamey et al., 2000).

2.5.2 Selection of attributes to value biodiversity

To value a complex good such as biodiversity, attribute selection is critical to ensure that "biological diversity" is valued, as opposed to "biological resources", which frequently occurs (Christie et al., 2006). Literature reviewed by Christie et al*.* (2004) showed that the majority of studies claiming to value biodiversity, have instead valued a biological resource such as a particular species or habitat. Such studies have tended to value the totality of the resource, rather than the value of the attributes that contribute towards the diversity of the resource. The attributes selected by Christie et al. (2004) are often referred to in other CM studies which value biodiversity, such as Czajkowski et al. (2008) & MacDonald & Morrison (2010). Czajkowski et al. (2008, p. 6) refers to the studies of Christie et al. (2004; 2006) as one which "skilfully identified a meaningful set of attributes to describe variation in the biological diversity of agricultural landscape".

The choice experiment (CE) that presented to respondents, was framed around asking the respondent to identify the preferred policy option from a list of four. The CE design used four biodiversity attributes, plus a payment vehicle, with each containing attributes describing different policy options. The attributes are listed below:

- Familiar species of wildlife
- Rare, unfamiliar species
- Habitat quality
- Ecosystem processes
- A price term was included as the method to pay for each of the policies offered (Christie et al., 2004, p. 64).

The success of this approach influenced the methodology that Czajkowski et al. (2008) used in selecting meaningful attributes to value biodiversity. These attributes were representative of any potential changes in biodiversity, while at the same time remained understandable and were easy to convey to respondents. Each attribute had three different levels, one being the status quo and then two others based around a biodiversity improvement. These improvements ranged from a minor improvement for biodiversity regeneration, to a substantial improvement in the levels of biodiversity present. The level of improvements of biodiversity stated on the choice task, were based around the overall levels of protection that could be given to biodiversity in the region, these being the "status quo" an "extension of the national park" and "other form of protection" (Czajkowski et al., 2008, p. 11).

Biodiversity attributes that were used by Czajkowski et al. (2008) were:

- Natural ecological processes
- Rare species of fauna and flora
- Ecosystem components

The approach taken by them to value biodiversity, demonstrates that valuing biodiversity is successful when using carefully selected attributes that describe the complexities of biodiversity. This approach to valuation shows valuing multi-level changes in biodiversity is possible.

2.5.3 Payment vehicles used in choice modelling studies investigating biodiversity

A common feature of NZ CM valuation studies, such as Baskaran, Cullen, & Colombo (2009), Bell (2011), Kerr & Sharp (2008) and Yao & Kaval (2009b) is the use of annual increases in Local Authority (Council) rates as a payment vehicle for the environmental improvement. The payment of rates to Councils under the Local Government (Rating) Act 2002 is the preferred funder for Councils to fund biodiversity projects, compared with other options available to Councils for raising revenue. The rating of land is effectively a tax based on the capital or land value throughout the district or region. It can either be set by imposing a targeted rate for a specific project or by a general rate that goes into a pool of money to fund a wide range of activities (Department of Internal Affairs, 2011). Internationally, payment vehicles commonly use annual increases in central government taxation or general taxation as opposed to LA rates. This is because biodiversity enhancement programmes are generally paid through taxation, and participants have indicated that taxation was their preferred payment option (Christie et al., 2006).

Council can raise funding for biodiversity through other legislation such as the Biosecurity Act (1993), which places legislative responsibilities on Regional Councils to manage and control plant and animal pests. Property owners in New Zealand pay local rates for biodiversity conservation and enhancement provided by their Local Councils. Yao and Kaval (2008) use the example of property owners in the Waikato in 2007, who were prepared to pay annual biosecurity rates of $19 to $272 to fund pest control primarily possums in the Waikato Region.

2.6 Summary

Biodiversity plays a critical role in the agricultural system, with some components of the agricultural system having interdependence on biodiversity through the unique ecosystem services that biodiversity provides. The complexity of biodiversity as a good, from its non-excludability and non-rivalry qualities, creates problems for its supply. In breaking down the intricacies of biodiversity, three components have been selected in this research. These are habitat, locally important species and ecosystem services, which have been featured in previous non-market valuation studies for biodiversity.

The significance that biodiversity plays in sustaining the functions of ecosystem services, suggests that loss of biodiversity would impose changes to welfare, as a result of the loss of ecosystem services that society depends upon. The characteristics of the biodiversity resource exposes its vulnerability to over exploitation and unregulated use. Therefore, to address this vulnerability, it is seen as being fundamental to place a value on the biodiversity resource. The absence of a market value for biodiversity, historically, has seen little protection for the maintenance of biodiversity on private land, where it is difficult for the decision maker to account for its value. To address this absence of value, non-market valuation techniques can be used to rectify this, with the aim of maintaining and enhancing biodiversity on privately owned land.

Existing research demonstrates that CM can be used to value non-market environmental goods, such as biodiversity. Many studies have explored the linkage between the benefits derived from biodiversity by the public. Many of these studies have valued a single component of biodiversity such as a habitat, or a species, and the welfare attributed to its enhancement or preservation. This study builds on previous studies, which have valued several components of biodiversity that form part of the biodiversity good. The advantage of using the CM technique to value biodiversity, is that it enables the respondent to make the trade-offs between the different components of biodiversity, therefore providing a richer and more diverse set of results. The CM technique will establish values for different management actions that aim to maintain or enhance biodiversity, therefore assisting policy makers to allocate financial resources more efficiently. Specifically, the study aims to add to previous valuation studies, by using CM to examine the preferences of a sample of agricultural landowners in the Waikato, towards contributing to a fund from which they can apply to receive funds for undertaking work to maintain and/or enhance biodiversity on their land. This study aims to investigate farmers' preferences towards contributing to the fund, based on their preferences for various actions regarding biodiversity enhancement. The next chapter provides a detailed description of the area of study for this research, namely the Waikato region. Then Chapter four presents, in detail, the method used for the study.

Chapter 3

3 Case study Description

The Waikato region was chosen for this study due to the diversity of native flora, fauna and birds found here, and the pressures placed on it from the region's strong agriculture based economy. The region's mild, moist climate, fertile soils and topography support these features. Indigenous ecosystems are recognised in the region to be both nationally and internationally important, with three of the six internationally significant wetlands in New Zealand (Ramsar sites[1]) located here. These sites include the Whangamarino Wetland which is recognised as second largest bog and swamp in the north island, the Kopuatai peat Dome, recognised as the largest unaltered restiad peat bog in New Zealand, and the tidal flats of the Firth of Thames/Tikapa Moana (Department of Conservation, n.d.).

The Taupo Volcanic Zone covers the southern part of the region, the top of Mount Ruapehu and includes the pumice lands and geothermal features. Land use in this area is made up of beef, cattle and sheep grazing, dairying, plantation and conservation forestry. The Waikato Lowlands and Hauraki Plains, make up the central part of the region, which includes large areas of wetlands, peat soils and the Hinuera formation. A large part of these areas have been drained for pastoral farming, however the region's most

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[1] The Convention on Wetlands (Ramsar, Iran, 1971), is an intergovernmental treaty to binds member countries to maintain the ecological character of wetlands recognised for their international importance. These sites are referred to for their importance as Ramsar sites.

significant remaining wetlands are located in this area. These are the Whangamarino Wetland and the Kopouatai Peat Dome (Waikato Regional Council, 2010).

The western and central hill country covers the length of the Waikato's west coast. This area includes an extensive cave and karst system. There are large tracts of indigenous forest within this area that are important for soil and water conservation and stock grazing. The areas of plantation and conservation forestry are the main uses for the central hill country (Waikato Regional Council, 2010). The eastern ranges (the Kaimai and Coromandel ranges) are largely volcanic and clad with bush. The Coromandel Peninsula is made up of thick volcanic rock on top of older sedimentary rock (greywacke), sandstone and argillite mudstone (Waikato Regional Council, 2010).

Loss of biodiversity within the region, however, has been extensive, with only 26% of the region remaining in native vegetation. Much of this remaining vegetation is fragmented into thousands of small compartments, situated primarily on hill country. Indigenous forests, scrub and wetlands that used to occupy the lowlands have been removed or drained to make way for intensive agriculture. Therefore, a substantial proportion of the region's indigenous biodiversity is located on private rural land and its survival is largely dependent on the decisions of individual landowners. The size, shape and linkages with other habitats, influence the long-term survival of biodiversity in the region (Waikato Regional Council, 2013a).

3.1 Land use change in the Waikato Region from 1840

The decline of indigenous vegetation in the Waikato Region is typical of how indigenous biodiversity has declined since pre-human New Zealand. Since European settlement from the 1840s, indigenous vegetation has been further reduced, so that only 26% of the original remains today (approximately 620,833 ha) (Waikato Regional Council, 2013d). Wetlands in the region have been reduced to less than 20% of their original size, with less than 1% of wetlands remaining in the Waipa District (Leathwick et al., 1995). Overall, total natural vegetation cover until 1995 had been reduced to less than 15% in most areas, with Waipa and South Waikato at less than 10%. Furthermore, Ewers et al. (2006) have shown that during the 1997 – 2002 period, the rate of deforestation nationally has continued with 2344 ha of native forest destroyed in total.

The most depleted ecosystems in New Zealand are described by Yao & Kaval (2009b) as occurring on private agriculturally productive areas, as can be found in the Waipa and Matamata Piako Districts, where agriculture forms a major part of the district's land use. The Middle Waikato basin is another example of a lowland area that was once covered with coniferous forest such as Kahikatea (*Dacryarpus dacrydioides*) forest, and extensive sedge dominated wetlands, both of which were cleared to support intensive agriculture. The Middle Waikato Basin area encompasses 83,000ha, much of the Matamata Piako and Hauraki districts and is largely fertile alluvial floodplains, well suited for agriculture (Norton & Mile, 2001).

3.1.1 Rural land use today

Dairy farming is the most important agricultural land use in the region in 2012-13, the Waikato was home to more than 1.14 million dairy cows or 24% of the country's total dairy cows and more than 3,553 herds (Livestock Improvement Corporation & Dairy NZ Incorporated, 2013). Cows within the Waikato produce 22.8% of the country's total milk solids. The most significant dairying areas in the Waikato are the Matamata-Piako, Waikato and Waipa Districts, accounting for 50% dairy farm exports. Intensification of dairying within the region is increasing, with the average stocking rates of cows per hectare rising from 2.7 cows in 1996/97 to 2.94 in 2012/13. There is a strong owner operator component within dairy farming, with farms often having no other employees. Data show that 28.7% of the dairy farming business units in the Waikato Region in 2012/13, were owner operated (Livestock Improvement Corporation & Dairy NZ Incorporated, 2013). Beef and cattle and sheep farms are two other important agricultural sectors in the Waikato. The region accounted for 13.4% of the country's beef cattle and 5.9% of the country's sheep. Livestock farms (other than diary) have an even stronger owner operator component, with over 80% having no other employees (Ashraf & Phillips, 2012).

Forestry is a significant component of rural land use with 547,400ha of plantation forests located in the central North Island, encompassing much of the Waikato and Bay of Plenty Regions, with an additional 20,000ha on the Coromandel Peninsula. Forestry and logging operations are mainly concentrated in the South Waikato and Taupo areas (Ashraf & Phillips, 2012). Overall 52% of the land use today in the Waikato region is classified as pastoral farming, with exotic forestry being the other major land use, making up 14 % of the region's land. Indigenous Vegetation makes up 26% of land use and the extent and scale of these different land uses are shown in Figure 2.

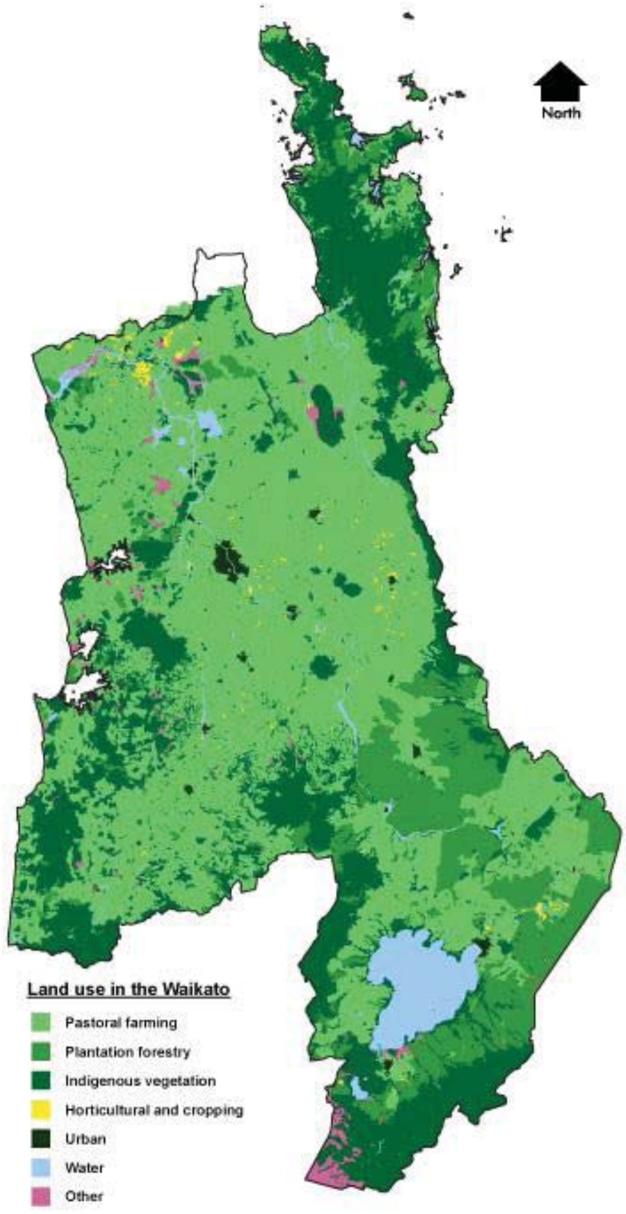

Figure 2 Land uses in the Waikato Region

Source: Waikato Regional Council (2013c)

Figure 3 Waikato Regional and District Council Boundaries

Source: Waikato Regional Council (2014b)

3.2 The Region today

The Waikato region is the fourth largest region in New Zealand, covering most of the central North Island, and is approximately 25,000 square km. *Figure 3* shows the district boundaries, from the Bombay hills and Port Waikato in the north to Mokau on the west coast, and across to the Coromandel Peninsula on the east coast. The southern boundary extends to the slopes of Mt Ruapehu and to the Kaimanawa Range. The region has several nationally important natural features, including the country's largest lake, Lake Taupo, and the longest river, the Waikato River, which contains an extensive hydroelectricity system of eight dams. The region has one regional council, one city council, Hamilton city council, and 10 district councils, of which three lie across the regional boundary (Waikato Regional Council, 2012). The extent of the boundaries of these agencies is shown on

Figure 3

The Waikato has a strong economic base contributing 10% of the country's Gross Domestic Product to the year ending June 2010 (Waikato Regional Council, 2012). The Waikato is considered New Zealand's primary dairy-farming region, with 29.9% of the country's dairy herds located in the region (Livestock Improvement Corporation & Dairy NZ Incorporated, 2013). Soils in the region are considered highly productive and are fundamental to enable the region's strong agricultural based economy. The most productive soils in the Waikato are found between Hamilton and Cambridge and around Matamata and Reporoa (southern part of the Rotorua district) (Waikato Regional Council, 2014a). There are also a number of other industries, which contribute to the region's economy, such as; coal mining, hydroelectricity generation, timber milling and pulp and paper manufacturing.

3.3 Regional biodiversity

The event of large-scale clearance of vegetation in the region since 1840 has resulted in a dramatic reduction in the types of habitat present today. Wetlands also have been subject to extensive development, resulting in only 25% of their original 110,000 ha, remaining (Department of Conservation, 2012; Waikato Regional Council, 2013d). The region is made up of seven distinctive ecosystems, three of which are commonly found on the agricultural landscape. These are native forest and scrub ecosystems and wetland ecosystems. Other important ecosystems types in the Waikato include, beach and dunes, marine and estuarine ecosystems ,geothermal ecosystems and karst ecosystems[2] (Waikato Biodiversity Forum, 2006).

Much of the native forest and scrub ecosystems are present on hillsides that are regenerating back into native forest. Forests provide habitat for many native bird, reptile, frog and bat species. The highly fragmented forest or scrub habitats are a common feature of the agricultural landscapes of the region and have been largely reduced from their original size. This has resulted in the extinction of some animals and plants, locally, while others are classified as extremely rare (Department of Conservation, 2012).

[2] Karst ecosystems form in limestone when water dissolves carbonate-containing rock and have unique ecological features and process such as limestone. These ecosystems are located from Port Waikato to Mokau and include glow-worm caves and a variety of sculptured pools, caves, arches gorges, disappearing stream, springs and unusual rock formations.

Wetland ecosystems dominate the lowland basins of the Waikato and Hauraki Plains, with a large proportion of the country's wetlands present in the Waikato (Department of Conservation, 2012). Fresh water wetlands in the Waikato include peat domes, moderately fertile wetlands (containing kahikatea, manuka, or sedges) and raupo/harakeke (flax swamps). These fresh water wetlands provide habitat for threatened plants and animal species that include the giant cane rush, the Australasian bittern and the Giant Kokopu (Waikato Biodiversity Forum, 2006). Freshwater lakes and rivers in the Waikato provide valuable habitat for indigenous fish and invertebrates (Waikato Biodiversity Forum, 2006).

Natural populations of rare native species that exist in the Waikato, these include:

- Archey's frog (in the Whareorino Forest and in the Coromandel Ranges)
- Te Aroha and Moehau stag beetles
- Mahoenui Giant Weta and Mercury Island Tusked Weta
- the shrub *Hebe scopulorum*, the Giant Cane Rush *Sporadanthus ferrugineus*, and the Swamp Helmet Orchid *Anzybas carsei*
- one of the largest areas of karst landscape in New Zealand one of New Zealand's three most important coastal stretches for shorebirds
- one of New Zealand's largest whitebait fisheries and largest eel fishery

Source : Waikato Biodiversity Forum (2006, p. 23)

3.3.1 Community's perception of biodiversity

The Waikato Regional Council periodically surveys people living in the Waikato to ascertain the community's awareness of and attitudes and actions toward environmental issues, and what they value about living in the Waikato Region. Native biodiversity is one of these issues that formed part of the survey undertaken in 2013. When asked the public's perception about our native biodiversity, 49% of respondents expressed some level of concern with the state of native bush and wetlands on private property. The rural population showed an interest in undertaking environmental action either on their own property or within their community, with 24% showing a willingness to plant trees, plants and be involved in wetland and gully restoration. Nine per cent indicated they were likely to fence off native bush, river or streams (Versus Research Ltd, 2013). Trinh & Kaval (2005) showed that approximately 45% of farmers in the Waikato indicated that it was important to have a piece of native bush on their farm, and as part of this study indicated that 47% indicated a preference for no native bush on their farm.

This shows that generally farmers show a preference for no native bush on their farm, and are reluctant to fence off native bush or be involved in wetland and gully restoration. There are a small number of rural based landcare groups registered in the Waikato Region with the Waikato Regional Council. Thirty-six landcare groups[3] operate in the Region as rural based voluntary community groups, undertaking work to enhance locally

[3] A total of forty-two groups are registered with the Waikato Regional Council, however eight of these groups were considered to be urban or coastal based therefore have been excluded from the total number registered.

significant natural resources on public or private land (Ritchie, 2011). These groups are actively focused on forest, stream, wetland and lake habitats, undertaking activities such as planting, pest and animal control, weed control and fencing. It is recognised that the work of community groups is vital, as much of the enhancement and restoration of biodiversity (on public and private land) in the Waikato would not occur without the support, interest and participation of community groups and interested individuals (Waikato Biodiversity Forum, 2006).

3.3.2 Ecosystem services within the region

Ecosystem services are of particular economic and ecological importance to the Waikato region. Four key services highlighted by Hart, Rutledge, Vare, & Huser (2013) to be of greatest importance to the region in terms of the services they provide, are associated with food provision (in-terms of milk production), water provision (in terms of water yield), water purification (in terms of nitrate leaching and sedimentation) and erosion regulation (in terms of sediment eroded). All four services have interdependence with agriculture, as either an output and input or an environmental externality. The service of food provision is a key activity in the region, with the foodstuffs produced being agricultural based, including dairy products, sheep meat, beef, pork and venison. Water provision is another service, which relates to the quantity of water in rivers and underground. Water in rivers and ground water is provided for as an ecosystem service, which is accessed by society for agricultural purposes (stock drinking water, farm irrigation) and for water supply to homes. The service of water purification is described by Hart et al. (2013) to be directly affected by agricultural activities from the runoff and/or leaching of nitrogen and phosphorus into waterways. Erosion regulation is the outcome ecosystems have on soil retention, as it is desirable to retain productive soils from being eroded and lost. Agricultural activities would likely be situated on these soils and retaining them is beneficial to the agricultural system. Retention of productive soils prevents sedimentation of waterways (a water purification service).

Ecosystem services are recognised as providing direct and indirect services to the region. These services contribute immense value to the Waikato region. An example of this was the value Patterson and Cole (1999b) attributed to the ecosystem services of waste treatment and disturbance regulation (storm protection, flood control) in the Waikato region, estimating their value at $629 million, and $498[4] million respectively, with wetland ecosystems being a major contributor to this. Wetlands as an ecosystem type was valued at $1,211 million collectively for the Waikato, for the services such as waste treatment and disturbance regulation. While the hydrological component of a wetland for water supply services was valued at $470 million, the value attributed to disturbance regulation by wetland is $447 million. Overall, the value of wetland ecosystems was estimated at $39,777 per hectare, which emphasises the value this habitat has in terms of the ecosystem services they provide to the region.

[4] Of the $498 million, $51 million was made up of other ecosystem types such as, Mangrove, Estuarine, Forest, Lake and Scrub/Shrubland/Tussock.

To further highlight the value of ecosystem services in the Waikato region, the Gross Regional Product in 1997 for the Waikato economy was estimated to be $9,883 million and the estimated value of the all the ecosystem services within the region in 1997 to the community was $9.4 billion (Patterson & Cole, 1999b). These values came in the form of services such as water purification, waste treatment, nutrient cycling, as listed in Appendix 1. Patterson & Cole (1999b) calculated the land-based proportion of the ecosystem services in the region at $7.2 billion or 75% of the region's GDP for 1997. Overall, the importance of ecosystem services within the region is greater than the national average due to the large proportions of ecosystems such as lakes, rivers, wetlands, estuaries and the values per hectare these provide (Waikato Regional Council, 2013b).

3.4 Legislation

The significance of biodiversity on private land is recognised in a number of Government initiatives. This includes legislation, such as, the Resource Management Act 1991 (RMA), the Forest Amendment Act 1993, policies and strategies such as the New Zealand Biodiversity Strategy, Department of Conservation and Ministry for the Environment (2000) , and a Ministerial Advisory Committee report, entitled "*Bio what?*" (Trinh & Kaval, 2005). The RMA however, is the main piece of environmental legislation in New Zealand for establishing the planning framework in defining roles and responsibilities of different agencies for protecting, managing and maintaining biodiversity on private land.

The principle purpose of the RMA is to promote the sustainable management of natural and physical resources (excluding minerals). The use, development and protection of these resources is undertaken in such a way as to sustain their potential to meet the foreseeable needs of future generations and safeguard the life-supporting capacity of water, soil and ecosystems, 'avoiding, remedying, or mitigating any adverse effects of activities on the environment' (RMA, Section 5, 1991). Section 6 (c) of the RMA requires those exercising functions and powers under the RMA (namely district and regional councils) to recognise and provide for 'the protection of areas of significant vegetation and significant habitats of indigenous fauna' (NZ Planning Institute, 2013). The district and regional councils have specific roles and responsibilities for managing biodiversity under the RMA. These come about through setting policies for maintaining and enhancing ecosystems, and setting objectives, policies and methods for maintaining biological diversity under section 30 and 31 of the RMA (NZ Planning Institute, 2013). Under the RMA it is implied that resource users will 'avoid, remedy or mitigate' the adverse environmental effects from development (Jay, 2005a).

3.4.1 Conservation covenants

Conservation covenants are an alternative option available to landowners to protect biodiversity on their property and can be entered into with the Department of Conservation, Queen Elizabeth II National Trust or local authorities (Davis & Meurk, 2001). A covenant is a legal document that relates to a specific area of native bush or wetland. The landowner maintains ownership of the land, while the covenant is registered against the legal title of the property, which is usually in perpetuity. Owners of Maori land are able to protect areas by placing them under a Nga Whenua Rahui kawenta.

The covenanted land is managed by both parties in accordance with the covenant, with financial assistance usually provided to the landowner for surveying, legal, and fencing costs. Rates relief are made available to the landowner on application to the local authority for the covenanted area (Davis & Meurk, 2001). Conservation covenants are placed on the land at the time of subdivision or can be volunteered by the landowner at any time. Covenants for protecting biodiversity are usually created under three statutes, these are:

- The Reserves Act 1977
- The Queen Elizabeth the Second National Trust Act 1977 (QEII)
- Te Turi Whenua Maaori Act 1993 (Part 17)

3.5 Summary

The Waikato region has a strong agricultural based economy, coupled with an environment that supports a diverse range of native flora and fauna. The region is located from the central to upper North Island, and stretches from the west to the east coast. The temperate moist climate and fertile soils have enabled agriculture to flourish since European settlement from the 1840's. Since this period, there has been a steady decline in indigenous vegetation so that only 26% remains today. Much of the indigenous biodiversity is located on private rural land, and its management is largely dependent on the decisions made by individual landowners.

The dairying component of the region's agricultural sector produces 22.8 % of the country's total milk solids from 24% of the country's dairy cows. This industry has a strong linkage to the ecosystem services, particularly around land and water, which is demonstrated by the immense value wetland ecosystems are shown to exhibit. The interdependency that exists between ecosystem services associated with wetlands and agriculture highlights the need for increased maintenance and enhancement of such areas on farms. An earlier study showed that community perceptions on biodiversity indicate that less than half of farmers show an interest in biodiversity being present on their farm.

The current state of biodiversity in the region, coupled with the pressures of agricultural intensification to extract more value out of the land for production, leaves the biodiversity resource under continual threat. In order for the biodiversity resource to improve, measures are required to maintain and enhance this resource, which often come at the expense of the landowner. One measure would be to establish a contestable fund, that farmers would contribute to annually, which they then could apply to for funding for biodiversity works on their property.

The next section sets out the research methodology, which was used to undertake this non-market valuation study, to determine how much farmers are willing to contribute annually into a contestable fund, for maintenance and enhancement works on biodiversity.

Chapter 4

4 Research Methodology

4.1 Choice Modelling Methodology

This chapter shows the methodology and design of this choice modelling experiment, which is based on the format used by Bennett & Adamowicz (2001), with supporting information from Bateman et al. (2002), Hensher et al. (2005) and Hoyos (2010). This chapter is made up of three key parts, selecting the attributes and the subsequent focus group discussions, the design of the experiment and finally the design of the survey.

4.1.1 Characterising the decision problem

As described earlier in chapter 2, the first step in undertaking a choice experiment is to identify the impending problem. This study aims to estimate the value to landowners of biodiversity on privately owned agricultural land, by how much they are willing to contribute annually into a fund, from which they can then apply for funding for the maintenance and enhancement of the quality of that biodiversity. It is acknowledged that the landowner is increasingly required to assist in the maintenance, enhancement and protection of biodiversity, and to date has received no direct financial reward.

The value the landowner attributes to works that maintain or enhance the biodiversity resource, can be reflected in the level of utility they receive for that component of biodiversity. This can be shown in several different ways. Firstly, the amount of money the landowner is willing to-contribute in order to maintain or enhance the biodiversity on farmland. Therefore implying how they are willing to contribute annually for improved levels of biodiversity on their farm. Secondly, the part-worth of each attribute will describe to agencies, how much farmers will contribute annually to see improvements in specific components of native biodiversity on rural land. To measure this change in welfare a do nothing option has been used as a constant base. This enables welfare estimates to be expressed for improvements made to biodiversity components against the additional costs of a hypothetical payment paid annually for 10 years.

4.1.2 Attribute definition and level selection

The next part in the design stage of the choice experiment, aims to define the attributes and levels describing alternative policy options to improve biodiversity on agricultural land. Cleland & Rogers (2010, p. 5) refer to previous literature in determining criteria for selecting attributes. These are:

- "attributes should be relevant - that is, a given set of attributes should (1), reflect public interests, (2) have a sound scientific basis, and (3) provide useful information to end-users
- Attributes should not be causally prior – that is a given attribute should not be viewed as an 'upstream' condition that has to be satisfied before changes can occur elsewhere."

Prior to the focus group discussion, key stakeholders (involved in setting policy on biodiversity for the Waikato Regional Council (WRC), and Federated Farmers policy advisors representing the interests of their members), were consulted to obtain their views on possible attributes and levels, which could be used in a CE to value biodiversity. The outcome from these discussions contributed to the information regarding attributes and levels. Establishing a list of relevant attributes prior to the focus group meeting, has shown to increase the relevance of the exercise to participants (Bennett & Adamowicz, 2001; Boyle, 2003a).

4.1.2.1 Focus group discussion

A focus group is referred to as a planned discussion with around five to ten participants, guided by a facilitator, held in a neutral nonthreatening environment. Participants are encouraged to share opinions and attitudes regarding the topic in hand and are viewed as being an essential prerequisite to any questionnaire development in non-market valuation studies (Cleland & Rogers, 2010; Rolfe et al., 2004).

A focus group discussion took place that involved a facilitator and six members from the Waikato Biodiversity Forum, who are considered knowledgeable about biodiversity in the Waikato region. The Coordinator of the Waikato Biodiversity Forum was selected to facilitate the focus group discussion, based on her experience in working with rural landowners in the Waikato region on biodiversity and having previous experience in facilitating group discussion. This enabled the discussion to flow fairly amongst the group. The facilitator was briefed on the topic, the issues around the topic and the format that the focus group was going to take. A number of key potential attributes were identified from the literature review and interviews with stakeholders. This list was circulated to the focus group prior to the meeting and the group was asked to rank each component in terms of importance to biodiversity on agricultural land. A series of six questions related to biodiversity on agricultural land and the current policy approaches was also provided to the group to aid discussion. This enabled group members to share their opinions and to ensure the attributes selected remained meaningful to respondents, which appropriately characterised the issue of biodiversity loss. From the list of components, the group reached a consensus on the top three attributes that best defined biodiversity.

To control the choice task complexity of the CE design, a decision was made to limit the selection to three attributes (plus a payment vehicle) that appropriately describe the components of biodiversity on agricultural land. This will enable the avoidance of cognitive difficulties that are known to exist within the CM approach, which occur where respondents are required to make choices between large numbers of attributes and levels. Presenting respondents with a large number of choice sets may lead to irrational choices, increase of random errors and significant numbers of inconsistent responses (Hanley et al., 2001). To account for this, CM exercises typically use between four and six attribute choices to reduce the effect of cognitive burden for the respondents (Cleland & Rogers, 2010). A decision was made to limit the number of attributes to three in this CE. This was viewed as being consistent with other CE non-market valuation studies that value biodiversity, such as Czajkowski et al. (2009) and Kerr & Sharp (2008). In addition to this, the focus group regarded three attributes as sufficient to cover the components of biodiversity while remaining meaningful to rural landowners.

Key issues that were discussed by the focus group members were:

- different components of biodiversity
- problems faced with biodiversity on agricultural land
- preferred management options as a response to improve biodiversity
- selection attributes and their level

The group identified the fundamental problem threatening biodiversity on rural land in the Waikato, was the lack of legal protection for native biodiversity on private land and the lack of appreciation and value the landowner places on this resource. There was consensus amongst the group that there is a lack of understanding regarding this resource and landowners decisions are generally based around maximising gross returns when the problem of development versus protection is confronted. Other issues of concern regarding native biodiversity were the lack of industry support, the scale of the problem of fragmentation of the biodiversity sites, lack of time and resources and lastly, that there is often no biodiversity left on the property.

The group recognised the most critical component of biodiversity was ecosystem services; however, they wondered whether the landowners would know this term. It was agreed that this term could be relabelled "nature's provisions" with an explanation of what these may be in an agricultural landscape. Follow up discussions with farmers, however, resulted in "ecosystem services" being used as it was a term they knew, and they were concerned the "nature's provisions" would not be fully understood in how it related to biodiversity.

Habitat was recognised as an important component, which the group viewed as supporting the unique ecosystems within biodiversity. Unique ecosystems were a component presented on the list to the focus group, which some of the group ranked in their top three. This component was renamed unique habitat, because of some of the unique characteristics that can be associated with habitat. Due to ecosystem services having already been selected as a component, the focus group agreed that this component had already been covered.

There was extensive discussion around the use of species and how this component could be framed. The group agreed that species should be a component, but did not necessarily agree on whether it should be framed as 'native birds', 'threatened species' or 'rare species'. Agreement was reached in using the term "locally important species" to enable the attribute to remain meaningful to respondents, while still being able to characterise the issue.

The attributes, definitions and levels that were agreed on are shown in Table *4*. In defining the attributes, levels are needed to describe existing and future policy approaches for managing biodiversity. The focus group was also used to help decide on the levels that should be used for each attribute.

4.1.2.2 Attribute levels

To ensure that the respondents were able to relate to the attribute levels, the focus group agreed that the levels be expressed qualitatively, which was reinforced when discussed with Federated Farmers. This approach is supported by Christie et al. (2004), in referring to the use of qualitative levels as being relatively common to describe environmental goods in this manner.

The general purpose for attribute levels is to ensure that they encompass a range of alternatives that respondents are familiar with and that the researcher can relate too. Levels need to stimulate actual or hypothetical trade-offs between 'goods' that the respondent is willing to pay for (Blamey, Louviere, & Bennett, 2001). The trade-offs in the case of this research, were considered by the focus group to be improvements in the different attributes of biodiversity. An example of these is the attribute 'Locally Important Species' and the agreed levels being "Maintain Current State, Increase Populations". Following the meeting, it was recognised that amendments were required to these levels, to enable them to clearly establish the trade-off between the improvements in biodiversity being offered. These and the other levels were changed a little for the final survey.

It is common practice in CM to include a standard constant 'do nothing' or 'opt-out' option, to avoid forcing a choice onto the respondent that may bias estimates of demand, affecting the WTP (Blamey et al., 2001; Christie et al., 2004). The focus group agreed that the "do nothing" option, should be used as the status quo, to reflect the current approach, should a respondent consider no additional actions are needed to enhance biodiversity.

Table 4 Attribute definitions and levels

Attribute	**Definitions**	**Levels**
Habitat	Habitat is the places where groups of species live together	Do nothing, Fencing stock Fencing and weed control
Locally important species (incl. birds)	Species that are likely to be present particularly birds on biodiversity on private land	Do nothing, Possum control Possum and other pest control
Ecosystem services	Ecosystem services, that nature provides for free	Do nothing Maintaining current actions to protect ecosystem services Increasing actions to enhance ecosystem services
Cost to you	Annual payment over a 10 year period through a targeted regional rate	$0, $50, $100, $150, $200

4.1.2.3 Payment vehicle

In Chapter 2 it was described how Councils fund biodiversity enhancement on private land, via contestable funds which are financed through rates or third parties grants. There was little debate from the focus group around the payment vehicle being an annual rate. However, there was discussion on whether the payment should be a one-off payment or an annual payment over a finite timeframe. Payment over a timeframe was considered to be more plausible, in undertaking biodiversity enhancement works, than a one-off payment. A timeframe of 10 years was considered realistic, to enable the utility derived from biodiversity enhancement projects to be recognised. This was reinforced in follow-up discussions with Federated Farmers representatives and is supported by Boyle (2003a).

The type of payment was also discussed as to whether it should be stated as a Targeted Council Rate, which would infer a fixed payment to be used specifically for biodiversity enhancement or alternatively, a council rate, which could mistakenly be considered to be part of the general rates that councils collect. The general rate calculated on either land or capital valuation of the farm property (depending on the local council), is set annually (Department of Internal Affairs, 2011).

Different payment levels were discussed by the focus group and follow-up discussions with Federated Farmers. During the meeting, the focus group suggested \$100 and \$200, due to the likely cost of undertaking meaningful work to improve biodiversity. It was viewed that a payment option of less than a \$100, when the landowner is already paying in excess of \$5,000, would not seem unreasonable. To maximise the plausibility from the respondent's perspective, Blamey et al. (2001) supported this realism of the payment, therefore the group considered payment increments of \$50 as being a suitable range for the attribute levels. Rose & Bliemer (2009), considered having a wider level range as being likely to result in choice tasks with dominant alternatives, while using too narrow a range leads to alternatives that are hard to distinguish. In addition, units should be equally spaced to maintain statistical properties (Blamey et al., 2001).

Following the initial pilot survey, the name of the attribute was changed on the choice set to 'Cost to You', although the explanation of how the payment was to be made was explained as a 'Council targeted rate paid annually over ten years'. The focus group highlighted during the discussion, that existing funding for biodiversity which comes from general rates, if distributed over the region, would equate to 10 cents per property. There is also an existing targeted rate to assist in funding high valued biodiversity projects that form part of the region's natural heritage. However, it was accepted that there is currently no funding directly available to assist individual landowners to protect Significant Natural Areas, identified on WRC website, on their land (Waikato Regional Council, 2013e).

The questionnaire was tested on a selection of farmers, who own farms, which include some element of biodiversity. The survey was also circulated to the Waikato executive of the Federated Farmers, as a precursor to the main survey that will go out to its membership in the Waikato Region. Participants were contacted by phone or in person and asked if they were willing to participate in this pilot survey. Following this initial contact, the survey was distributed via email, which contained a link to the survey. The email invited participants to complete the survey and contained a range of questions, to enable feedback to be given. Respondents were asked to comment on the readability of the survey and were thanked for their participation.

Feedback respondents gave enabled the survey to be further refined, particularly around explanation of how to complete the choice scenarios and the credibility of the hypothetical choice scenarios from a farmer's perspective. Reference to how the payment may occur, how it may be distributed, and what the payment could be used for, was explained in more detail when introducing the choice scenarios at the beginning of section 2. Communicating the purpose of the survey and other important administrative information was shifted from the first page of the survey, to the invitation email to make the survey more inviting to the participant.

4.2 Experimental design

The experiment design is the plan for formulating a CM exercise and can be viewed as a matrix of values. An efficient design, is as 'statistically efficient as possible in terms of predicted standard errors of the parameter estimates' (Rose & Bliemer, 2009, p. 591) with more creditable parameter estimations.

The D-efficient design minimises D-error, which is derived from the AVC matrix. The lower the d-error, the greater the efficiency of the design. Providing prior parameter estimates for the CE helps to create a design where the D-error is as low as possible (Bliemer et al., 2008).

Where there is an absence of prior estimates, a prior assumption on the signs of the parameters can be used in an initial experiment design for the pilot survey (Bliemer et al., 2008). Prior assumptions were made here regarding the signs of the parameters and then to account for uncertainty about the size of the parameter values in the pilot survey design, Bayesian efficient designs were used utilising random priors, each with a uniform distribution. The experimental design used ©Ngene software to create a Bayesian efficient design for the pilot survey.

Results from the pilot survey provided an improved set of parameter estimates for the main survey design. Again a Bayesian efficient design was used utilising random priors described this time based on normal distributions centred around the prior estimates from the pilot survey.

4.3 Questionnaire Design

After defining the attributes and determining the levels, the structure of the questionnaire needs to be developed, to present the information in a meaningful way that is dependent on the survey mode. An internet-based survey was the mode chosen, because of its low cost and ability to cover all of the members of the Waikato Federated Farmers quickly, it is also the preferred method of communication with members of the federation and is a regularly used mode for contact (S.Millar, personal communication, 8 February, 2013).

The questionnaire follows the typical CM format; however, specific aspects have been adapted due to the survey being internet based. The survey consisted of three sections, which were presented in a specific order typical to a CM survey (Rolfe et al., 2004). Section one of the survey focuses on framing issues around biodiversity being present on the respondent's farm. This was seen as a possible influencing factor on the respondent choice. It was also critical to account for the framing effect on whether biodiversity being present on the respondent's farm or, whether the landowner has recently undertaken enhancement works, affects their choice. Section two of the survey contains the choice scenarios. Information and instructions on how to complete the eight choice tasks are provided before the eight choice tasks are presented. From each choice task, respondents are required to indicate their preferred option. Section three, contains questions about the socio-economic characteristics of the respondents and also characteristics of the farm property. Within this section, there are questions on gender, age, household structure, type of farming operation, value of the farm and others. The purpose of these questions is to establish the representativeness of the sample population and to assist in the modelling of the data. The complete survey is shown in Appendix 2.

4.3.1 An introduction

The respondent needs to be introduced to the issue under question. This was achieved by using an email that encouraged the respondent to participate, outlined the credentials of the researcher and provided an electronic link to the survey. Clearly outlined within this email were rights of the participant, how they were selected, a method to contact the researcher to address any queries they may have and the confidentiality of their responses. The email also contained the Massey University logo to identify the organisation involved in the survey.

4.3.2 Statement of a Potential Solution

The initial questions aimed to identify the respondent's interest in native biodiversity, whether native biodiversity is present on their farm and if they have undertaken biodiversity enhancement work on their farm over the past two years. This established their experience of the environmental issue (biodiversity management on rural land) and their general attitude towards this particular environmental issue (an approach used in CM questions that is supported by Bennett & Adamowicz (2001).

Participants need to find the hypothetical solution to the issue believable in the choice scenarios, presented despite its hypothetical nature. This was achieved in describing a hypothetical scenario where a contestable fund was available, to which the landowner could apply to undertake various biodiversity management options on their farm. The potential management options offered aimed to improve biodiversity (such as weed control, possum control, and fencing) which would be funded by a targeted rate. To ensure respondents are realistic when answering each choice set, it was stressed that when making their choice, they would need to consider their budget (Bennett & Adamowicz, 2001).

The proposed solution in the survey was communicated in a way that was clear and concise due to the online survey mode. This was achieved by using short sentences, simple words and bulleted statements which is an approach supported by Mathews, Freeman, & Desvousges (2007). To inform the respondent on how to answer each choice scenario, an example was provided with clear instructions on what is required because of the inability to verbalise the question, which would occur in other modes such as in-person surveys.

The payment vehicle presented in the choice sets is an important part of the solution offered, this should be viewed as being plausible, and provides an indication of their WTP (Bennett & Adamowicz, 2001). A targeted rate that would contribute to the contestable fund was viewed as the best payment vehicle available, to ensure a plausible solution is offered.

4.3.3 Framing

Framing occurs when the questionnaire unknowingly gives an unbalanced weighting towards the issue in question. This puts the situation or frame of the issue in the mind of the respondent, making it difficult to respond in unbiased manner Bennett & Adamowicz, (2001). Framing problems within CM are referred to as being when the situation changes and the frame has little influence or excessive influence on the value of the estimation (Rolfe, 2006a). For example, the 2012/2013 drought in New Zealand could influence the commitment a farmer has and their WTP for a biodiversity project on the farm. S. Millar (personal communication, February 8, 2013) viewed this as one potential influencing factor, as other farming matters would have greater priority. Values of a CM study need to be framed by the context in which they are offered.

Common areas viewed by Rolfe (2006a, p. 23) as being areas where framing is likely to occur are:

- "WTP versus WAP formats
- with the scope and scale of the issue presented
- the use of a particular policy mechanisms
- type of payment vehicle being used
- context of the survey, weather, wealth conditions, or political climate."

Values can be shown in stated preference surveys to be embedded with a wider range of issues, which is the case for biodiversity on private land. Farmers could view this survey as providing agencies with the opportunity to set a precedent, with the possibility of widening the set of goods to include more than what has been defined in this exercise. It is important to ensure that the context of the issue does not influence how respondents frame the issue, therefore resulting in variations in the value estimates (Rolfe, 2006a).

A key component of any stated preference questionnaire is to make participants aware of the environmental good under consideration. The CM questionnaire needs to enable the respondent to identify the status quo position and the improvements being considered. This was achieved by ensuring the questionnaire was balanced, so that respondents were not unknowingly lead to give unnecessary weight towards the issue (Bennett & Adamowicz, 2001).

4.3.4 Follow-up Questions

Directly after the choice set questions, a series of questions were presented to explore the motivations behind the respondent's choices, should they have chosen "Management option 1 - Do nothing (limited resources)" all of the time. This enables the explanation behind this decision to be investigated, identifying any framing effects and protest votes. Respondents were asked to indicate their main reason for making this choice from the possible four options:

- Limited financial resources
- Limited space for farming operations
- Limited time
- I object to paying the Council any money towards biodiversity enhancement.

4.3.5 Data Collection

Selecting a mode of data collection for a non-market valuation survey requires consideration as no one method is explicitly superior to others (Champ, 2003). An internet based survey mode was selected for this research. The individual was emailed an explanation of the survey with an invitation to the survey embedded in the message, that took the respondent directly to the survey. Champ & Welsh (2007), consider the web based approach used here, to have the greatest control over presentation and format of this collection method.

Windle & Rolfe (2009), state that there are several key advantages in utilising an internet survey as a collection method, these being the low collection costs, rapid collection times, increased flexibility of tailoring questionnaires to respondent groups, and increased automation of data recording and coding. An internet collection method is able to incorporate new and innovative design features and information provision. The most commonly referred to disadvantages of using internet surveys is the potential sample frame bias (non-random exclusion of individuals who do not use the internet) and response bias (responses of those who respond may be different from those who do not). In acknowledging these disadvantages, this mode appears to be one that is growing in popularity in stated choice studies (Champ & Welsh, 2007).

4.3.6 Labelled versus unlabelled

Labelled or unlabelled choice cards can be used to present the choice sets. The main benefit of using an unlabelled experiment is that there is no need for the identification and use of every alternative within the universal set of alternatives. One of the assumptions made in the CM process is that the alternatives are assumed to be independently and identically distributed (IID) which is more likely to be met if the alternatives are unlabelled (Hensher et al., 2005).

The decision was made to use unlabelled alternatives to maintain the IID and to remove any preconceived assumptions that may exist with a respondent if a labelled alternative was presented. Therefore, the alternatives in the choice cards were referred to as Management option (2,3,4,5,6,7,8 etc.) and the status quo constant was referred to as Management Option 1 “Do nothing”.

An example of a choice set is shown in Figure 4:

Figure 4 Choice set example

Scenario 1 of 8

Biodiversity components	Management Option 1	Management Option 2	Management Option 3
Protecting native habitat by:	Do nothing (limited resources)	Fencing stock	Fencing stock <u>and</u> weed control
Protecting locally important species, e.g. flora and fauna	Do nothing (limited resources)	Possum control <u>and</u> other pest control	Possum control
Protecting ecosystem services by:	Do nothing (limited resources)	<u>Increasing</u> actions to enhance ecosystem services	Maintaining <u>current</u> actions to protect ecosystem services
Cost to you	$0	$200	$150

4.3.7 Sample Design

The sample design refers to the population of interest, the sampling frame and the technique used in selecting a sample from the sampling frame. There is a recognised link between the survey mode and the sample design (Champ & Welsh, 2007).

The population used for this study was limited to the membership of the Federated Farmers in the Waikato Region excluding those in the South Waikato District.[5] A map illustrating the area where the survey was distributed to is shown in *Figure 5*. To ensure those that pay for biodiversity improvements described in the survey scenarios, will actually be paying via the payment vehicle offered, the survey was restricted to members who owned a farm and would likely pay council rates. Since the

[5]To remove any bias and to maintain anonymity between the researcher and those surveyed, members living in the South Waikato District were excluded since the researcher works for the South Waikato District Council and liaises with landowners on biodiversity matters.

survey was conducted online through Federated Farmers it could be sent out to all Federated Farmer members for the area in question. There were no cost constraints so no sampling of the members of the Federated Farmers was required.

By limiting the sample population of rural landowners to the Federated Farmers' Waikato membership, it is acknowledged that this may introduce a small element of bias into the results. This is primarily related to the Federation's strong directive in emphasising the economic importance of agriculture, while addressing the concerns raised by environmental groups concerning the impact agriculture has on the environment. As part of this, the group has shown a tendency to balance the environmental implications of farming practices with economic benefits while advocating to reduce the cost to farmers for environmental impact of agriculture on the environment (Reid, 2013). This, however, needs to be balanced with the understanding that Federated Farmers was one of three non-government land user organisations which successfully lobbied the Government for funding to support land care groups, which saw the establishment of the New Zealand Landcare Trust (NZLT) in 1996. NZLT is now an established non-government organisation within New Zealand in working alongside landowners to improve the sustainability of our landscapes and waterways, while maintaining economic and productive farming practices (Neely, Johnson, Poussard & Youl, 2009). The Federation is currently one of the seven non-government land user organisations trustees that govern the Trust (New Zealand Landcare Trust, 2014). This element of bias within this sample is accepted. The survey has addressed potential bias by including questions that capture whether or not the respondent is a member of an environmental group, whether native biodiversity is present on their farm and whether they have undertaken native biodiversity enhancement works on their farm in the past 2 years. This will enable these variables to be included in the model to account for these preferences.

4.3.8 Data validation

The project involves the collection of qualitative data; therefore, it is necessary to validate the data. Amaya-Amaya, Gerard & Ryan (2008) refer to data validation within CE as the degree a study can effectively measure the anticipated values while addressing possible biases and the overall hypothetical nature of the scenario presented in the valuation exercise. Typically, triangulation is used; however, CEs build in tests within the survey to determine if the standard assumption of utility theory holds. This establishes the rationality of responses and identifies any dominant choice sets that may exist within the survey. There are methods that can be used to address any violations. Amaya-Amaya et al. (2008) refer to these as the use of warm up questions and the use of clear instructions with a well explained example. Both of these methods have been used within the questionnaire.

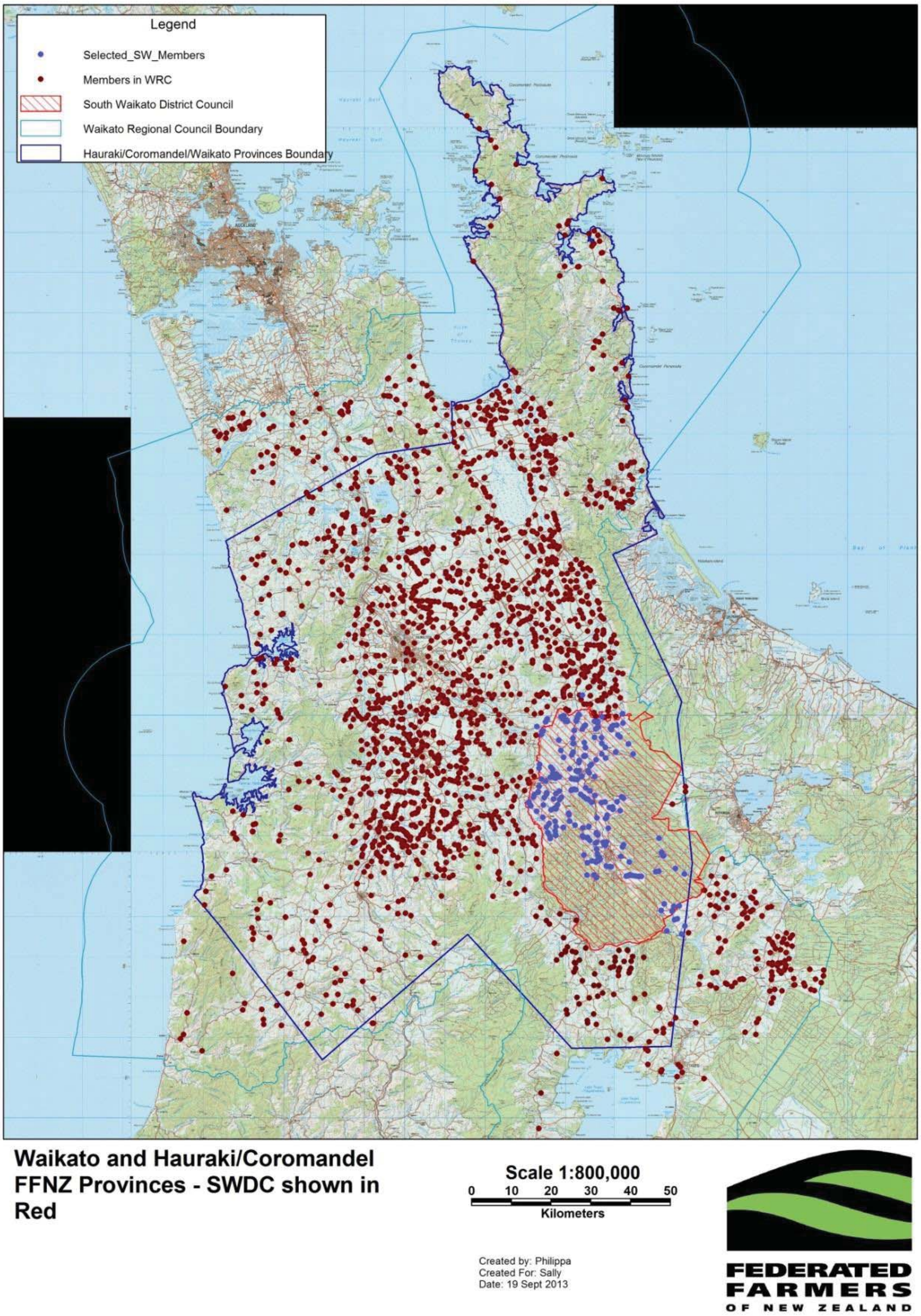

Figure 5 Waikato Regional Map showing the sample population.

4.3.9 Pilot testing and implementation

The final version of the online survey was distributed by a Member Advisory email to Federated Farmers members in the Waikato Region (excluding South Waikato District), who own and operate a farm or own a farm but do not manage it. The survey was sent out via email on 14 May 2013, with reminder emails sent out at regular intervals on 25 May, 6 June, 13 June and 20 June. The survey closed on 28 June 2013.

4.4 Summary

This chapter has provided a detailed outline of the methodology used for this research. There are several important elements of the design, which include the establishment of the decision problem, defining the attributes and levels using focus group discussions, generating an experiment design, question design, and pilot test for the survey. At each step, the relevant theory, that reinforces the CM process, were explored to assist in the development of the model and its application. This approach aims to ensure that the estimated non-market values are robust, and relevant to future management decisions concerning native biodiversity on farmland.

The next chapter will report and analyse the results of the choice model. This will comprise of an overview of the survey results and the presentation of welfare estimates.

Chapter 5

5 Data Analysis and Results

5.1 Survey results

A total 187 respondents began the survey, however, 41 (30%) did not complete questions beyond question 3 and were subsequently discarded, leaving 146 respondents. Eighteen respondents consistently selected the status quo (i.e. across all eight scenarios); these responses were retained as they were viewed as relevant choice, which would form an individual class in the Latent Class Model. Of the 146 respondents, 25 only partly completed the survey, not answering all eight choice scenarios or socioeconomic and demographic information; however, these were retained for the responses provided. Therefore, from the 146 respondents, there were 1088 useable results for the choice experiment (down from the 1168 had all the 146 responded to all 8 choice tasks).

Feedback was received from respondents during the survey period, seeking further clarification of the survey's purpose and the hypothetical scenario which was presented. This feedback suggested some confusion in how the payment vehicle would be applied, due to the differences in how existing agencies, local and regional, currently fund biodiversity projects. In hindsight, this needed to have been clarified in the survey.

The overall characteristics of the respondents are presented in Table 5.

Table 5 Respondents' characteristics

	Number of Respondents	Percentage of Respondents
Current situation		
Owner and operator of a farm	109	74.7%
Own a farm but do not operate	31	21.2%
Respondents who choose not to answer	6	4.1%
Native biodiversity present*		
None	46	31.5%
Remnant forest	63	43.2%
Wetland	59	40.4%
Various	50	34.2%
*some respondents have selected more than on type of biodiversity on their farm		
Undertaken enhancement works		
Yes	82	56.2%
No	64	43.8%
Respondents who choose not to answer	0	
Age		
Median	55	
Maximum age	89	
Minimum age	32	
Respondents who choose not to answer	15	
Gender		
Male	100	68.5%
Female	42	28.8%
Respondents who choose not to answer	4	4
Child status		
Children	130	89.0%
No Children	11	7.5%
Respondents who choose not to answer	6	
Environmental Organisation Membership		
Member	26	17.8%
Non-member	117	80.1%
Respondents who choose not to answer	3	2.1%
Current farm government valuation		
<$3,000,000	31	21.2%
$3,000,001 - $6,000,000	63	43.2%
$6,000,001 - $9,000,000	18	12.3%
$9,000,000>	26	17.8%
Respondents who choose not to answer	8	5.5%
Farm Type		
Dairy	86	66.4%
Dry stock	25	18.5%
Mixed	11	8.9%
Other	4	2.7%
Respondents who choose not to answer	2	3.4%

Table 5 shows that three-quarters of respondents own and operate the farm, which would indicate that they have a large amount of control of the decisions on the farm concerning the management of biodiversity. Respondents have a wide spread of ages from 32 to 89 (median age 55) indicating a spread of generations and possibly of views on farming, biodiversity and the environment. Almost two-thirds of respondents have native biodiversity present on their farm property, with the most common types of biodiversity being wetlands and remnant forest (40 to 43%). Just over half of respondents have undertaken biodiversity enhancement work on their farm within the past two years. Dairy farms were the most common farm type at 66.4%, which supports the high proportion of respondents who indicate their current farm value as being greater than three million dollars. Over two-thirds of respondents are male and most have children. Only 18% indicated they were a member of an environmental organisation such as Forest and Bird or a catchment care group.

The follow up questions (see the questionnaire in Appendix 2) provided suggested reasons why the respondents might have selected the status quo option 'Management Option 1- Do nothing (limited resources)' all of the time. These results are shown in Table 6.

Table 6 Follow up question response

Follow up question why option one was selected	Number of Respondents
Limited financial resources	3
Limited space	2
Limited time	1
Object to paying the Council any money towards biodiversity	9
Respondents who choose not to answer	3

Eighteen respondents chose option one in all eight scenarios. Of the 15 who responded to these, nine chose the status, stating that they objected to paying the Council any money towards biodiversity. A further three respondents indicated limited financial resources, and chose the status quo on that basis. This shows that financial reasons, either 'objecting to pay the Council any money towards biodiversity' or 'having limited financial resources' made up over two thirds of respondents' motivation for selecting the status quo.

5.2 Choice Modelling

Choices made by respondents in a CE are based on random utility theory, where alternatives based on attribute levels are chosen and the social characteristics of the individual chooser, are observed. Assuming individuals will maximise their utility, choice models characterise the observed decision rule, with the probability of selecting an alternative that offers the greatest utility. The MNL model assumes that respondents have similar preferences and that the unexplained error terms are independent and identically distributed (Bell, 2011).

The data was initially analysed using an MNL model. However, the MNL model provided large standard errors, several fixed parameters and a relatively flat log-likelihood, making it difficult to provide meaningful results. Kehlbacher et al. (2013) associate this with attribute non-attendance (ANA), where less variation in respondents' preferences occurs from ignoring attributes, therefore reducing the mean of the marginal utility coefficient. Kehlbacher et al. (2013) reference Scarpa et al. (2009) in describing ANA as likely being linked to a parameter that shrinks the marginal utility, which is associated with the variance being close to zero if an attribute is ignored, or otherwise, takes the value of one. Since ANA was observed in the data, the MNL model was rejected in favour of the Latent Class Model (LCM). The ability of the LCM to relax the independence of irrelevant alternatives (IIA) property, which is critical in the MNL model, supported this decision. The LCM divides the population into classes, where the preferences within each class are assumed to be homogeneous but can vary between classes.

Recognising that respondents ignored some attributes, does not infer that zero utility is derived from them, but instead that their behaviour is inconsistent with the underlying concept of random utility theory, and the resultant willingness to pay (Kehlbacher et al., 2013). This fundamental theory supports CM which is based on an individual's preference being complete, monotonic and continuous. Respondents were expected to make trade-offs between all attributes and their levels and choose the most preferred attribute (Scarpa et al., 2009). The absence of these trade-offs implied the respondents have exhibited non-compensatory behaviour. Regardless how much an attribute level improved, this improvement failed to compensate for decreases in levels of other attributes, and so is contrary to the MNL model (Alemu et al., 2011; Campbell et al., 2006; Scarpa et al., 2009). LCMs are recognised in the literature as a model that allows for ANA to be accommodated through separate classes where zero utility weight can be applied to selected attributes, depending on the attribute processing strategies adopted by the respondents (Alemu et al., 2011; Campbell et al., 2011; Campbell et al., 2006; Hensher, Rose, & Greene, 2011; Kragt, 2013; Scarpa et al., 2009).

5.2.1 Latent Class Models

The literature describes the latent class framework as a way of capturing a probabilistic decision process, where specific restrictions are imposed on the utility expressions for each class to represent the idea of pre-defined attribute processing strategies (Campbell et al., 2011; Hensher et al., 2011). In an Equality Constrained Latent Class Model (ECLCM), the attribute coefficients are constrained to zero and the class membership is estimated within the model, rather than utilising predetermined classes in a standard LCM (Campbell et al., 2011; Kragt, 2013; Scarpa et al., 2009). In analysing the results, some choice scenarios chosen showed a clear avoidance of particular attributes, which provided a starting point in establishing classes of non-attendance. The three suspected attribute levels avoided here are '*protecting habitat by fencing of stock*', '*protecting locally important species by possum control' and 'protecting ecosystem services by increasing actions to enhance ecosystem services*'. This view was formed when analysing how respondents answered the choice scenarios (particularly scenarios 4, 5, 7 and 8) and are presented in

Appendix 3. In addition, as mentioned earlier there is also a class consisting of those who consistently choose the status quo in every choice task presented. The social demographic variables, such as respondents, farm type and value, respondents' gender, age association with an environmental organisations etc. as shown in Table 5, were not significant in the models, therefore these are not included in the final model specifications.

5.2.2 Model Specifications

The standard random utility framework is used to estimate the discrete choice model, which is provided below along with the five latent classes that were used in the ECLCM. Firstly, Table 7 below provides a description of the variables used in the model and then is followed by the utility functions for the six latent classes.

Table 7 Variables used in the model

Variable	**Definition**
ASC	Alternative specific constant: Status Quo, do nothing
HAP	Fencing stock out of protected area
HAE	Fencing plus weed control
LIM	Active possum control
LII	Active control of possum and other pests
ECM	Maintaining current actions to protect ecosystem services
ECE	Increasing actions to enhance ecosystem services
CTR	Cost to you

1. Full attendance;

$$U(1) = \beta_1(HAP)+\beta_2(HAE)+\beta_3(LIM)+\beta_4(LII)+\beta_5(ECM)+\beta_6(ECE)+\beta_7(CTR)+ASC$$

The five classes of ANA used in the model are:

2. Ignore '*protecting locally important species by possum control*'

$$U(2) = \beta_1(HAP)+\beta_2(HAE)+\beta_4(LII)+\beta_5(ECM)+\beta_6(ECE)+\beta_7(CTR)+ASC$$

3. Ignore *'increasing actions to enhance ecosystem services'*;

$$U(3) = \beta_1(HAP)+\beta_2(HAE)+ \beta_3(LIM)+\beta_4(LII)+\beta_5(ECM)+\beta_7(CTR)+ASC$$

4. Ignore *'protecting locally important species by possum control', and 'cost to you'*;

$$U(4) = \beta_1(HAP)+\beta_2(HAE)+ \beta_4(LII)+ \beta_5(ECM) +\beta_6(ECE)+ASC$$

5. Ignore '*protecting locally important species by possum control*', 'increasing actions to enhance *ecosystem services', and 'cost to you'*

$$U(5) = \beta_1(HAP)+\beta_2(HAE)+\beta_4(LII)+\beta_5(ECM)+ASC$$

6. Ignore, all attributes except '*status quo'*

$$U(6) = ASC$$

5.2.3 Data coding

Several different methods are available for the coding of the dataset, with different techniques being required for quantitative and qualitative attributes. The majority of the attributes are expressed in qualitative terms (habitat protection, protection of locally important species, and maintaining or improving ecosystem services) which require the data to be effects coded. This method is an alternative format to dummy coding, and has been used in the choice experiment for this research. The effect coding structure is presented in Table 8.

Table 8 Effects coding structure

Attribute	**Levels**	**Effects Coding Structure**
Habitat	Do Nothing (limited resources), Fencing stock, (HAP) Fencing and weed control (HAE)	HAP =-1; HAE =-1 HAP = 1; HAE = 0 HAP = 0; HAE = 1
Locally important species (incl. flora and fauna)	Do Nothing (limited resources), Possum control (LIM) Possum control and other pest control (LII)	LIM =-1; LII = -1 LIM = 1; LII = 0 LIM = 0; LII = 1
Ecosystem services	Do Nothing (limited resources), Maintain current state (ECM) Increase activities to enhancement of ecosystem services (ECE)	ECM =-1; ECE = -1 ECM = 1; ECE = 0 ECM = 0; ECE = 1

The effects coded variable for each qualitative attribute level is equal to 1 when the qualitative level is present and equal to -1 if the status quo level is present, otherwise it is equal to 0 (Bech & Gyrd-Hansen, 2005). Effects coding enables the reference point to be defined as a negative sum of the estimated coefficients. This enables the constant term to only reflect the utility associated with the fixed comparator, preventing misinterpretation (Bech & Gyrd-Hansen, 2005).

5.2.4 Criteria for determining optimal number of classes

There is well established theory that supports the use of a combination of statistical information criteria such as Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC), to provide a guide to the appropriate number of classes in a LCM (Nylund, Asparouhov, & Muthen, 2007). The AIC statistic is a measure of an estimated statistical model, trading off the complexity of an estimated model against the model fit. CAIC is derived from AIC, and generally favours models with few parameters (Yang & Yang 2007). The AIC value sometimes overestimates the number of classes, therefore the "analyst must use their own judgement" (Scarpa & Thiene, 2005 p. 435) to account for the significance and meaningfulness of the parameter estimates. Yang & Yang (2007) concluded that while AIC and BIC can both be shown to satisfactorily predict the correct model, BIC is shown to "always select the correct model" (Yang & Yang, 2007 p. 191) and is considered a universal measure for fitting a LCM (Weich, McBride, Exeter, Brugha, & McManus, 2011). Lower values of BIC indicate a better model fit in terms of accounting for heterogeneity (van Putten, 2008), favouring models with large log likelihoods, few parameters and smaller sample size.

5.3 Model results

The LCM, and particularly the number of classes chosen, is based on the choice strategies the survey respondents have made. The strategies pertain to the non-attendance (or avoidance) of attributes made by respondents. The optimal number of classes in the LCM was identified by assessing the AIC, CAIC and BIC criteria from models with three, four, five and six classes as shown in Table 9.

Table 9 Latent Class Model comparisons with 3,4,5 and 6 classes

Number of classes	AIC	BIC	CAIC	Adjusted r^2	Class probabilities
3	1390.4	702.12	1217.47	0.4293	0.094, 0.775, 0.131
4	1363.7	686.77	1099.98	0.4421	0.094, 0.687,0.087, 0.131
5	1355.8	681.86	1010.04	0.4462	0.105, 0.230, 0.070, 0.462, 0.133
6	1320.3	663.11	879.06	0.4619	0.157, 0.166, 0.070, 0.320, 0.151, 0.136
AIC (Akaike Information Criteria) is -2(*LL*-P); BIC Bayesian Information Criterion is –*LL*+(p/2)**ln*(*N*), Consistent Akaike Information Criterion is -2*LL*-(*CK*-(*C*-1)*H*-1)(1n(2*N*)+1)					

In considering these criteria, the AIC, CAIC and BIC values altered significantly when applying different attribute processing strategies based on the survey data as shown in Appendix 3. Models with four, five and six classes tended to produce similar AIC, BIC and CAIC values indicating a better model fit, with the values decreasing as the number of classes increased. The six-class models performed better with lower AIC, CAIC and BIC values when compared to the three, four and five-class models. The six-class model had marginally better AIC and BIC values when compared to the four and five-class models.

Presented in Table 10 are the results for the six-class ECLM identifying each class (according to the attributes attended and not attended to) and providing the associated parameter values. The probability of membership to each class is also presented.

An evaluation of the different classes of LCMs is shown in Table 9. This offers a clear comparison of the statistical information criteria values used. The results of the ECLCM, showing the utility associated with different management options for biodiversity and the different class memberships, are outlined in Table 10.

Table 10 Results from the six-class ECLCM

	Latent Class Membership					
	(1) All attributes attended to	(2) LIM nat	(3) ECE nat	(4)LIM, CTR nat	(5) LIM, ECE, CTR, nat	(6) Status Quo attended to
Variable	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
HAP	-6.921	-8.201	-8.201	-8.201	-8.201	-30.5494
HAE	-7.518	-7.518	-7.518	-7.518	-7.518	
LIM	-0.727		-0.727			
LII	-1.336***	0.741**	-1.336**	0.741***	0.741***	
ECM	1.191***	1.191***	1.588**	1.191***	1.588**	
ECE	1.619***	1.619***		1.619***		
CTR	-0.027***	-0.027***	-0.027***			
ASC (= 1 for non-SQ)	-26.498	-26.498	-26.498	-26.498	-26.498	-26.498
Latent class membership probability	0.157**	0.166***	0.070**	0.320***	0.151	0.136***
Log-likelihood	-643.173					
AIC	1320.3					
BIC	663.11					
CAIC	879.06					
* Significant at 10% level ** Significant at 5% level *** Significant at 1% level						

Note: nat = 'not attended to'

The results presented in Table 10 show that membership of five of the six classes are significant. The probability of membership in a class where all attributes are attended to is 0.157, and nearly 40% (0.393) attended to either all attributes or all but one of the attributes. The six-class ECLCM further suggests that approximately 60% did not attend to the cost attribute and 14% attended to the status quo only, ignoring all other attributes.

As seen in

Table 10 the parameter estimates for both '*maintaining current actions to protect ecosystem services*' and '*increasing actions to enhance ecosystem services*' are positive and statistically significant across all classes where each of these attributes were attended to. Therefore, it can be concluded that all other factors remaining constant, there is strong support for both actions; however, this must be traded off against the expected annual cost which, when attended to has a statistically significant marginal disutility. This is further supported by the observation that there is a 0.643 probability of membership in these classes where both attributes are attended to.

In addition to this, the table shows that farmers in the survey region who either attended to all attributes or at least to both attributes, which describe actions to protect locally important species (22.7% of farmers) had a disutility towards the protection of locally important species using both possum control and other pest control. The low membership probability of 0.227, in these classes, suggests that respondents would be unlikely to consider both actions. In contrast, those who ignored the possum control (only) option did have significant utility toward the protection of locally important species using possum and other pest control. The probability of membership in a class where support is shown for this action is 0.637.

5.3.1 Welfare measures

Welfare measures can be estimated for each class of respondents, with the assumption being made that everyone within that class is identical. To determine whether respondents are willing to pay more for particular actions to improve biodiversity, the WTP can be calculated. The implicit price of an attribute is calculated, using the following equation.

$$IP = -\frac{\beta_k}{\beta_7} \qquad (11)$$

Where IP is the implicit price

β_k is the parameter of the non-marketed attribute of interest where k= 1,2,.....6

β_7 is the parameter of the monetary attribute (CTR)

The delta method was used to estimate the confidence intervals for the implicit price as shown in Table 11. This method is shown to be able to determine the variance of the ratio of parameter estimates and makes three assumptions (Bliemer & Rose 2013). These are, that the WTP is normally distributed around its mean, the estimated model has used an appropriate sample size, and the cost parameter coefficient is accurate (Hole, 2007).

Hensher et al. (2005) simplifies this expression as

$$s.e._{\left(\frac{\beta_k}{\beta_7}\right)} \cong \sqrt{\frac{1}{\beta_7^2}\left[Var(\beta_k) - \frac{2\beta_k}{\beta_7}.Cov\,(\beta_k, \beta_7) + \left(\frac{\beta_k}{\beta_7}\right)^2 Var\,(\beta_7)\right]} \qquad (12)$$

where:

β_k is the parameter for attribute $_k$

β_7 is the parameter for the cost attribute

The resulting values can be substituted into equation (13) shown below (Hole, 2007, p. 829)

$$CIs = -\left(\frac{\beta_k}{\beta_7}\right) \pm 1.96 \sqrt{var\frac{\beta_k}{\beta_7}} \tag{13}$$

The implicit prices and confidence intervals for the six-class LCM are presented for each class for which the cost parameter was attended to. This represents 0.393 of respondents. The 95% confidence intervals for these estimates are given in the parentheses directly under the estimates. These have been made on a 'ceteris paribus' basis, and should be viewed from the perspective of being an estimate of a respondent's willingness to pay for an increase in utility of that particular attribute, should everything else remain constant (Bennett & Adamowicz, 2001).

Table 11 Marginal willingness to pay for actions to maintain or improve biodiversity on agricultural land.

	Class membership	Class probability	LII	ECM	ECE
1	All attributes attended to	0.157	$-49.22 – $98.29 - $0.15	$43.90 $8.71 - $79.00	$59.65 $31.18 - $88.12
2	LIM nat	0.166	$27.31 $16.05- $38.57	$43.90 $8.71 - $79.09	$59.65 $31.18- $88.12
3	ECE nat	0.070	-$49.22 -$62.11- -$36.32	$58.52 $56.24- $60.81	
4	LIM, CTR nat	0.320			
5	LIM, ECE, CTR nat	0.151			
6	HAP,HAE,LIM, LII,ECM, ECE,CTR nat	0.136			

Note: nat = 'not attended to'

The results shown in Table 11 indicate that where all attributes are attended to in (class 1), Waikato farmers showed a $43.90 WTP for maintaining actions to protect ecosystem services and $59.65 for increasing actions to enhance ecosystem services annually for ten years. In addition to this class, members indicated they would be willing to accept (WTA) a payment of $49.22 annually for 10 years to '*control possums and other pests*' when undertaking actions to improve biodiversity.

For class 2, farmers in the region attending to all attributes except '*possum control*', were willing to pay $27.31 annually for 10 years for the protection of locally important species using '*control of possums and other pests'*. Within this class, farmers were willing to pay $43.90 annually for ten years towards '*maintaining of ecosystem services*' and $59.65 annually for 10 years to '*increase actions to maintain ecosystem services*'.

Where respondents ignored enhancement of ecosystem services (class 3), there was an increase in their WTP towards actions that maintain ecosystems services of $58.52 annually for 10 years. In contrast to this, where respondents attended to both attributes describing actions to protect locally important species within this class, respondents indicated they would be WTA a payment of $49.22 to do more to control possums and other pests.

5.3.2 Summary

This chapter has provided a detailed analysis of the choice data and presented the results of the choice model. Data obtained from the survey have been analysed and an overview of the survey results and the demographics of the sample population provided. The results of the model have illustrated that attribute processing strategies have taken place by respondents, in the form of attribute non-attendance.

This chapter presents the results, in terms of the model output and welfare estimates. The key findings indicated that farmers had a positive utility for management actions which maintain and enhance ecosystem services. However, farmers had a disutility towards the protecting of locally important species using both 'possum control' and '*possum and other pest control*'. In contrast, respondents that ignored the '*possum control*' action had a significant positive utility towards the protection of locally important species using '*possum and other pest control*'.

Farmers in the Waikato showed that they would be willing to pay annually for 10 years for some biodiversity preservation actions. Specifically, across 3 classes, farmers were willing to pay up to $58.52 annually for '*maintaining current actions to protect ecosystem services*'. In comparison, farmers attending to both attributes describing taking actions to protect locally important flora and fauna, would be willing to accept a payment of $49.22 to do more to protect locally important species by '*controlling possums and other pests*'.

Attribute non-attendance towards certain attributes was present amongst farmers. Notably only 16% of respondents considered all attributes but nearly 40% of respondents attended to either all attributes or all but one of the attributes. An example of the attribute processing strategies that were adopted by respondents are indicated by the low probability (0.227) of combined class membership where both management actions to protect locally important flora and flora are considered. Approximately 64% of respondents are likely to consider actions that '*maintain current actions to protect ecosystem services*' and 'increasing action to enhance ecosystem services'.

The next chapter will discuss the key findings of this research within the context of the literature on valuing biodiversity. The implications of these results, in terms of the management of biodiversity on Waikato farmland, will also be discussed.

Chapter 6

6 Discussion

The preceding chapter presented the results of this research, including the estimation of a non-market value for indigenous biodiversity on agricultural land identified by rural landowners. These were presented in the form of marginal WTP values from different membership classes. The purpose of this chapter is to discuss the key findings of this research. The first section will detail the importance of the economic value of biodiversity. The second section will discuss the importance of the results for the management of biodiversity in the Waikato region. This will be followed by investigating the specific aspects of the disutility shown in the results in terms of management actions involving pest control. Finally, comment will be made on the results in terms of the importance of ecosystem services to the agricultural system and the attendance to the status quo attribute.

6.1 Economic value of biodiversity

Despite the inability of markets to directly reward farmers for maintaining or enhancing biodiversity on private land, indigenous biodiversity is a source of economic value. While some farmers are inclined to state a preference towards continuing with the existing approach to biodiversity management on farmland, others indicated tangible value for management actions to improve biodiversity.

The basis of a farmer's land use decisions are generally around maximising an individual's gross returns, without accounting for environmental externalities, often placing barriers around additional investment into biodiversity management. The most important goal for farmers is for their farm to make a profit and therefore consider native biodiversity as having little direct economic value (Jay, 2005b; Trinh & Kaval, 2005). Jay (2005b) highlighted this concluding that up to 80% of farmers prioritise production and neglect the maintenance and enhancement of native biodiversity.

The heterogeneous preferences of farmers represented by each class towards biodiversity management on agricultural farm land make it difficult for agencies to gauge how resources should be allocated that would maximise the net benefits of biodiversity enhancement to all farmers. Farmers are willing to ignore particular management actions and have indicated that they would undertake biodiversity improvements on agricultural land when they consider it necessary. The 60% of respondents, who did not attend to the cost attribute here, would indicate that farmers are likely to commit little financial resource to biodiversity when given the choice. This supports Jay's (2005b) claim that where financial resources are scarce, regardless how sympathetic farmers are to environmental issues, they are unable to commit resources where other pressures exist with competing farm resources. Farmers would be more likely to commit financial resources when they align with the farm management goals and objectives. Overall, non-attendance of cost is relatively common in CM studies and can range from, 61% to 90% (Hess, Stathopoulos, Campbell, O'Neil Caussade, 2013).

Valuation studies of biodiversity enhancement programmes on private land (not limited to rural land) by Yao & Kaval (2008) indicated that landowners would be willing to participate in a biodiversity scheme, and would contribute an additional $42 in annual rates to support a hypothetical government programme to enhance biodiversity on public and private lands through planting native trees. Yao et al. (2014) indicated that habitat enhancement for threatened natives species is valued by the New Zealand public. Overseas CM studies valuing biodiversity such as Christie et al. (2006) indicated 85% of respondents on UK farmland would be willing to pay for biodiversity enhancement on farmland. MacDonald & Morrison's (2010) study in Australia showed improvements in quantity and quality of habitat and the diversity of species are supported by the public. However, 22.7% of farmers surveyed here showed a disutility towards taking actions to protect locally important flora and fauna and 14% of respondents within the model expressed a desire to remain with the status quo.

Although the WTP findings shown in this research are comparable to the Yao & Kaval (2008) study when all attributes are attended to, for actions involving '*maintaining current actions to protect ecosystem services*' and for '*increasing actions to enhance ecosystem services',* other outcomes shown in this research tend to differ in some respects from these studies. This could possibly be due to the economic characteristics of the biodiversity good on private land, in exhibiting non-excludable and non-rivalry traits, whereby farmers individually make their own decision according to their resources available.

6.2 Biodiversity management in the Waikato Region

Two of the objectives of this choice experiment was to identify what components of biodiversity are important when valuing biodiversity on private agricultural land and to establish non-market values of indigenous biodiversity on agricultural land for rural land owners. The outcomes of these objectives would assist agencies in the development of strategies and policies for biodiversity management on private land in the Waikato Region. This information can be used to establish funding programmes that are consistent with the preferences and values farmers have towards biodiversity. The results of this research indicate that there is stated preference by farmers towards actions associated with '*maintain current actions*' and '*increasing actions to enhance ecosystem services*' and the protection of locally important species by '*controlling possums and other pests*'.

There was however, a conflict in the results where farmers showed a disutility towards both actions related to the protection of locally important species when both actions were considered. When '*possum control*' was ignored, farmers showed a positive utility towards '*controlling possums and other pests*', therefore making it difficult to interpret a preference for these actions. In addition to this, 31.5% of respondents indicated they had no biodiversity present on their farm; indicating that some farmers hold some degree of non-use value towards biodiversity, deriving value from knowing that farmers are undertaking actions to preserve this resource.

6.2.1 Protecting locally important flora and fauna

The implications for biodiversity investment into a possum and other pest control management regime to protect locally important species were seen as having a positive effect on farmers' welfare. This is indicated by the positive WTP figure for this attribute when '*possum control*' on its own was ignored. The high level of attribute non-attendance (ANA) associated with this action is reflected in the attribute processing strategies adopted by farmers, with 77% ignoring the management action of '*possum control*' for protecting locally important flora and fauna.

When this action was attended to with '*possums and other pest control',* there was a disutility associated with this action. This high level of non-attendance and disutility shown here, is concerning as it does not align with the ecologist's perspective on animal pests, as pests are viewed as having multiple impacts on the structural and functional components of biodiversity which will affect the conditional balance of the forest fragment (Dodd et al., 2011).

There are several reasons that can explain ANA, and why it is has occurred here. The most relevant from those described by Alemu et al. (2012), is that the association respondents have with this attribute '*possum control*' does not affect their utility. The high level of ANA shown here indicates that farmers consider protecting locally important species using possum control is more of a cost, that has less direct benefits to the individual farmer, when compared benefits of undertaking actions that involve '*possum and other pest control*'. In addition to this, the ANA identified here, can be attributed to the existing possum and other pest control programmes that exist within the region and are paid for in two ways. Firstly, the annual biosecurity targeted rated paid to the Waikato Regional Council (WRC[6]) and secondly, the payment of levies by farmers to existing agricultural industry bodies for bovine tuberculosis control[7]. Alternatively, farmers may consider possum control as not an issue, and would be willing to undertake the work as and when required at their own expense. While these explanations are credible, the actual areas where these possum control programmes take place in the Waikato region would only account for small areas of the survey population. Areas that are identified as priority possum control areas are detailed in the map in Appendix 4.

The principle objective of the Regional Pest Management Strategy is for the effective management of pest plants and pest animals in the region. This strategy supports the maintenance and enhancement of biodiversity, and is of economic benefit to the landowner through maintaining the economic productive capacity of the land. Farmers are already paying the WRC for the control and management of pests, for additional economic and environmental benefit at a catchment scale (Waikato Regional Council,

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[6]The WRC has in place an operative Regional Pest Management Strategy (RPMS), which is a requirement under section 100B of the Biosecurity Act 1993. The RPMS provides funding for a number of pest control initiatives, undertaken by pest control contractors throughout the region of which some involve possum control, which are funded through a targeted regional rate "Biosecurity rate".

[7]Bovine tuberculosis (TB) (Mycobacterium bovis) is an infectious disease and is known to be present in some parts of the Waikato region. Possum populations are the main method that transmits bovine TB to domestic livestock such as deer and cattle. The eradication of Bovine TB is seen as being vital to maintain the production and reputation of dairy, beef and deer exports worth around $14 billion a year. Parts of the Waikato are subject to an eradication programme where possum numbers are controlled approved pest control contractors and therefore no additional possums control is required by landowners as part of biodiversity enhancement works. This programme is funded through levies paid by farmers to various agricultural industries bodies, such as Dairy NZ, Beef and Lamb New Zealand and Federated Farmers to list a few.

2008). These results show there to be minimal increase in individual welfare for these management actions on an individual property scale.

Past studies have indicated there is a willingness by the public to pay more for the avoidance of pests than for the preservation of localised indigenous biodiversity. This is associated with the high likelihood of pests spreading from their initial establishment within a particular habitat (Bell, 2011). The outcomes here are consistent with the Bell study (the demographics of the survey population were a mixture of urban and rural) when '*possum control*' as a management action was not attended to. However, when both management actions involving pest control are considered the results indicate a degree of disutility associated with this management action. Farmers require a form of compensation payment in order to undertake additional actions '*involving possum and other pest control'*. The level of disutility shown in the results associated with this management action when all management options were considered, indicates that this is the least preferred management option.

6.2.2 Protecting ecosystem services

The high level of utility shown by respondents towards undertaking actions to maintain and enhance ecosystem services, supports Sandhu et al. (2007) argument that farmers place a strong value on ecosystem services within the agricultural system. Management actions, involving '*maintaining current actions to protect ecosystem services*' and '*increasing actions to enhance ecosystem services*', are of the greatest value to Waikato farmers. The relatively high probability of class membership shown within this model of 0.643 '*maintaining current actions to protect ecosystem services*' or '*increasing actions to enhance ecosystem services*' indicated they are considered a preferred part of actions to improve biodiversity management.

The agricultural sector indirectly depends on healthy functional ecosystems and degradation of ecosystem services would have consequences in terms of biodiversity and economic loss (Sandhu et al., 2012). The value of ecosystem services to society has already been referred to in chapter 3 as 'a hidden economy in the Waikato region'. The results of this study show that actions farmers may choose to undertake to manage biodiversity on agricultural land by protecting or enhancing ecosystem services, to firstly directly improve the native biodiversity present on the farm and secondly, to enhance the existing ecosystem services that support the farm operation.

From an economic perspective, ecosystem services are contributions that the natural world provides which are used to generate goods that people value (Bateman et al., 2011). The ecosystem services were described by Hart et al. (2013) of Landcare research in chapter 2 as being most important in terms of New Zealand society. This recognition of importance is supported by the results here, where Waikato farmers showed a positive utility across all classes where each of these actions were attended to, for both '*maintaining current actions to protect ecosystem services*' and '*increasing actions to enhance ecosystem services*' on a farm. Waikato farmers view these services as having a direct impact on the value they can extract for their agricultural business.

Agriculture is known as being a consumer and producer of ecosystem services, which is a credible explanation as to why farmers showed such a high level of utility towards this attribute and these management actions. These services per say are integral to a high value agriculture system. Examples of the values derived from these services were described in chapter 3. The farmer essentially receives these services at no cost, however, it is the role of the farmer as part of the operation to utilise these services in a sustainable way. The WTP shown in the results indicated that 40% (0.393) of farmers in the Waikato were willing to pay up to $58.52, to '*maintain current actions to protect ecosystem services*' annually for 10 years on agricultural land.

Reference was made within chapter 2, in describing the value ecosystem services provide to agriculture in the Waikato region. The results here support Baskaran et al. (2009) & Sandhu et al. (2012) view, that payments would assist in sustaining the services ecosystems provide. The importance of management actions to protect ecosystem services is well evident in the Proposed Waikato Regional Policy Statement (2010). The results shown here provide economic justification for the development of policy directed at preserving ecosystem services.

6.3 Status quo

A notable outcome of this choice experiment is the desire to maintain the status quo approach (14% of respondents). This could be explained by problems face when using stated preference methods for valuing biodiversity when compared to other environmental goods. (Thiene et al., 2012). Respondents, unfamiliarity with the good, such as the concept of biodiversity, therefore they may lack the information about the consequences of biodiversity loss or the need for preservation. This point was highlighted in section 2.1 of chapter 2.

The status quo effect is described by Meyerhoff & Liebe (2009) as a phenomenon in the decision making process where respondents tend to choose the existing situation or SQ when faced with the choice of new alternatives. In addition to this, respondents may choose the status quo for a number of different reasons. Thiene et al. (2012) described these as; their choice may infer that they do not place any value on environmental change in the scenarios proposed; their choice may hide some protest attitude; it could be a result of an extreme choice complexity within the choice scenarios presented; or disinterest in the change in question. The main reasons indicated by respondents for choosing the status quo in this research, were related to objecting to pay the council any money towards biodiversity and having limited financial resources.

Chapter 7

7 Conclusions

The aim of this research was to use the CM approach to determine the non-market value rural landowners place on biodiversity on private agricultural land. In this final chapter, conclusions are drawn and recommendations for future research are made.

7.1 Research Conclusions

The rural landowners surveyed for this research were members of Federated Farmers in the Waikato study area and three-quarters of these owned and operated their farm. Two-thirds were dairy farms and just over two-thirds had some indigenous biodiversity present on their farm.

The research has demonstrated that the CM approach is a suitable means of establishing non-market value for indigenous biodiversity on agricultural land and identifying what components of biodiversity are important when valuing this biodiversity. The components that were selected for this research have shown that they can be used to establish different non-market values, in terms of whether or not they are considered by the landowner as part of biodiversity management. There is some indication that biodiversity has an element of non-use value held by rural landowners, where they derive value in the existence of biodiversity present on agricultural land and demonstrate some level of willingness to preserve this resource.

The results provide some evidence of the importance to farmers of the ecosystem services provided by indigenous biodiversity on agricultural land.

From this survey almost 40% of farmers were willing to pay $58.52 annually over 10 years for maintaining current actions to protect ecosystem services. In addition to this, 32% of farmers were willing to pay $59.65 annually over 10 years to increase actions to enhance ecosystem services.

It is difficult, however, to provide definite conclusions from which clear recommendations can be made, for a number of reasons. These include, feedback during the survey process which indicated some confusion regarding how the payment vehicle would be applied. From this it appeared that it was not completely clear that rural landowners were being asked to contribute into a designated fund for 10 years, from which those who had indigenous biodiversity on their farm could apply for funding to assist them with actions to protect or enhance that biodiversity. Thirty percent of the original survey respondents began the questionnaire but completed very little of it so these had to be removed from the survey process, and 12% of the final number chose the status quo – 'do nothing' option for all choice tasks, and half of these stated that they objected to 'paying their Council any money towards biodiversity'. In addition, to this, 60% of farmers were willing to ignore some of the attributes presented in the choice tasks for funding biodiversity improvements on farmland, therefore, exhibiting non-compensatory behaviour. For example, 60% of farmers ignored the cost attribute.

There are conflicting results regarding the utility gained for actions to protect locally important species. For example, 22.7% of farmers (those who attended to all attributes or, all except '*increasing actions to enhance ecosystem services*'), were willing to accept a payment of $49.22 annually for 10 years for the protection of locally important species by '*controlling possum and other pest control*' when both actions ('possum control' and '*controlling possum and other pest control*') were considered. However, when 'possum control' only, was ignored, 17% of farmers indicated a WTP of $27.37 annually for 10 years for the protection of locally important species by '*possums and other pest control*'. It is difficult to reconcile these two results. Finally, results regarding habitat protection by '*fencing stock out of the protected area*' or by '*fencing plus weed control*' were not significant. However, there appears to be a conflict in the results where respondents place a monetary value on both protecting and enhancing ecosystem services, yet they do not value habitat protection or enhancement. This is evident because in undertaking actions to protect or enhance ecosystem services, then the protection and enhancement of habitat would be a necessary step as part of this process.

For all of these reasons it is difficult to make clear recommendations from this research. Perhaps it can be suggested that if there is a desire by society to protect and enhance the indigenous biodiversity that is currently present on agricultural land, society may need to consider whether it is willing to financially support this.

7.2 Further Research

Based on the outcomes of this research, several suggestions can be made in regards to future research. These relate to attributes used in this research and the framing of the scenario in the establishment of hypothetical fund. The outcome of the findings show that further research should be done in exploring the types of ecosystem services (such as, soil stability, pollination, nutrient cycling) that farmers value and the associated welfare estimates. This could be based around the actions (such as planting of trees for soil stability and increases in pollination or retiring of land for maintaining hydrological protection and increased nutrient cycling) providing they may be willing to take to maintain and enhance these services and how much they would be willing to pay to undertake such actions.

As suggested at the close of the previous section, further research could focus on the value to society, as a whole, of protecting and enhancing indigenous biodiversity on agricultural land. The scenario could be framed around habitat loss or preservation on farmland, to obtain welfare estimates for preservation of specific habitats on agricultural land. As a corollary to this, an estimate could be made of the willingness by rural landowners to accept compensation for the protection and enhancement of this biodiversity on their land.

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Appendix 1: Definition and Examples of Ecosystem Services

Main service	Definition	Examples
Provision services		
Food production	That portion of gross primary production extractable as food	Production of animal, fish, fruit and vegetables for human consumption
Water regulation	Regulation of hydrological flows	Provision of water for agricultural, industrial processes or transportation
Water supply	Storage and retention of water	Provision of water by watersheds, reservoirs, and aquifers
Raw materials	That portion of gross primary production extractable as raw materials	The production of timber, fibres
Genetic resources	Sources of unique biological materials and products	Medicine, genes for resistance to plant pathogens and crop pests
Regulating services		
Climate regulation	Regulation of global temperature, participation, and other biologically mediated climatic processes at a global or local level	Greenhouse gas regulation, DMS production affecting cloud formation
Gas regulation	Regulation of atmospheric chemical composition	CO_2/O_2 balance, 03 for UV protection and SO_x levels
Disturbance regulation	Capacitance, damping and integrity of ecosystem response to environmental fluctuations	Storm protection, flood control drought recovery, an other aspects of habitat response to environmental variability mainly controlled by vegetation structure
Erosion control	Retention of soil within an ecosystem	Prevention of loss of soil by natural weathering from rainfall and wind and the storage of silt in lakes and wetlands.

Soil formation	Soil formation processes	Weathering of rocks and the accumulation of organic material
Waste treatment	Recovery of mobile nutrients and removal or breakdown of excess or xenic nutrients and compounds	Waste treatment, pollution control, detoxification
Pollination	Movement of floral gametes	Provision of pollinators for the reproduction of plant populations
Nutrient cycling	Storage, internal cycling, processing and acquisition of nutrients	N, P and other elemental or nutrient cycles
Biological control	Trophic dynamic regulations of populations	Keystone predator control of prey species reduction of herbivore by top predator
Habitat services		
Refugia	Habitat for resident and transient populations	Nurseries, habitat for migratory species regional habitat for local species.
Genetic resources	Sources of unique biological materials and products	Medicine, genes for resistance to plant pathogens and crop pests
Cultural and Amenity services		
Cultural	Providing opportunities for non-commercial uses	Aesthetic, educational, spiritual and scientific values of ecosystems
Spiritual experience	Natural features provide an element of religious meaning or are considered sacred	Nature association with traditional knowledge, and customs, that creates a sense of belonging.
Opportunities for recreation and tourism	Providing opportunities for both passive and active recreational and tourism uses	Bushwalking, boating, fishing and sight seeing

Source: adapted from Groot et al. (2010, p. 26) and Patterson and Cole (1999, p. 13)

Appendix 2: Survey Questionnaire

MEMBER ADVISORY

FREEPHONE0800327646 **WEBSITE** WWW.FEDFARM.ORG.NZ

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA

24 June 2013

Last chance - Biodiversity survey: Waikato region

To all Waikato members

James Piddock is a Massey University student doing his Master's degree in Environmental Management and has chosen the Waikato region as a case study for this independent research project.

This project is looking at management options that could assist in improving outcomes for native biodiversity on farmland. We hope you will take the time to complete this survey and provide your thoughts on native biodiversity enhancement on farmland.

This survey is completely anonymous. All identifying data, names and addresses, will be removed, before being passed onto the researcher.

Once you have completed the survey, you will be no longer be able to access this link.

James knows you are busy at work on the farm and at home, but would really appreciate the 10 minutes of your time to complete the survey.

The survey closes 28 June 2013

For more information, please contact,

James Piddock

Researcher

College of Sciences

Massey University

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Supervisor

College of Business

Massey University

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This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics

Committees. The researcher(s) named above are responsible for the ethical conduct of this research. If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s) please contact Professor John O'Neil, Director (research Ethics), telephone 06 350 5249, email humanethics@massey.ac.nz.

You are subscribed to the Federated Farmers member advisory list, to unsubscribe, email: federatedfarmers@fedfarm.org.nz

Biodiversity Management on Farmland

Section 1

1. Which of the following fits your current situation?

   ☐ I am an owner and operator of the farm

   ☐ I own the farm but do not operate the farm

*2. Indicate the type of native biodiversity on the farm:

   ☐ None

   ☐ Remnant forest

   ☐ Wetland

   ☐ Wildlife

*3. Have you undertaken native biodiversity enhancement work on your farmland within the past 2 years?

   ☐ yes

   ☐ no

Section 2 Choice Scenarios

PLEASE READ FIRST BEFORE PROCEEDING

Next, you will be presented with eight scenarios of how you may choose to manage biodiversity on your farm, similar to the example below.

In this example, we found Management Option 2 to be the most suitable, and Management Option 1 and 3 to be unsuitable.

You will be shown eight scenarios similar to this one. Each scenario will show you three different potential management options. In all scenarios, Management Option 1 is do nothing.

Scenario 1

Biodiversity components	Management Option 1	Management Option 2	Management Option 3
Protecting native habitat by:	Do nothing (limited resources)	Fencing stock <u>and</u> weed control	Fencing stock
Protecting locally important species e.g. flora and fauna	Do nothing (limited resources)	Possum control	Possum control <u>and</u> other pest control
Protecting ecosystem services by:	Do nothing (limited resources)	Maintaining <u>current</u> actions to protect ecosystem services	<u>Increasing</u> actions to enhance ecosystem services
Cost to you	$0	$200	$50

***4. Bearing in mind your budget, choose the management option (column) you prefer. You must choose one only.**

- ☐ Management Option 1
- ☑ Management Option 2
- ☐ Management Option 3

They are not linked, so please do not try to remember how you have answered any previous scenarios.

When making your decision, you need to consider:

- You will pay for each option annually for 10 years through a Council targeted rate
- A contestable fund for native biodiversity enhancement will be established from this targeted rate, which you could apply for annually.

This fund will assist in funding possible management options, which enhance native biodiversity on farmland such as:

- Weed control
- Fencing
- Possum control
- Planting
- Improvements to ecosystem services.

Each scenario should be considered separately.

You must choose one option from each scenario.

Please make sure that you understand the task before proceeding. Once you go to the next screen you will not be able to go back.

Scenario 1 of 8

Biodiversity components	Management Option 1	Management Option 2	Management Option 3
Protecting native habitat by:	Do nothing (limited resources)	Fencing stock	Fencing stock <u>and</u> weed control
Protecting locally important species e.g. flora and fauna	Do nothing (limited resources)	Possum control <u>and</u> other pest control	Possum control
Protecting ecosystem services by:	Do nothing (limited resources)	<u>Increasing</u> actions to enhance ecosystem services	Maintaining <u>current</u> actions to protect ecosystem services
Cost to you	$0	$200	$150

***4. Bearing in mind your budget, choose the management option (column) you prefer. You must choose one only.**

☐ Management Option 1

☐ Management Option 2

☐ Management Option 3

Scenario 2 of 8

Biodiversity components	**Management Option 1**	**Management Option 4**	**Management Option 5**
Protecting native habitat by:	Do nothing (limited resources)	Fencing stock	Fencing stock and weed control
Protecting locally important species e.g. flora and fauna	Do nothing (limited resources)	Possum control	Possum control and other pest control
Protecting ecosystem services by:	Do nothing (limited resources)	Maintaining current actions to protect ecosystem services	Increasing actions to enhance ecosystem services
Cost to you	$0	$100	$50

***5. Bearing in mind your budget, choose the management option (column) you prefer. You must choose one only.**

☐ Management Option 1

☐ Management Option 4

☐ Management Option 5

Scenario 3 of 8

Biodiversity components	Management Option 1	Management Option 6	Management Option 7
Protecting native habitat by:	Do nothing (limited resources)	Fencing stock	Fencing stock and weed control
Protecting locally important species e.g. flora and fauna	Do nothing (limited resources)	Possum control	Possum control and other pest control
Protecting ecosystem services by:	Do nothing (limited resources)	Increasing actions to enhance ecosystem services	Maintaining current actions to protect ecosystem services
Cost to you	$0	$100	$200

***6. Bearing in mind your budget, choose the management option (column) you prefer. You must choose one only.**

☐ Management Option 1

☐ Management Option 6

☐ Management Option 7

Scenario 4 of 8

Biodiversity components	**Management Option 1**	**Management Option 8**	**Management Option 9**
Protecting native habitat by:	Do nothing (limited resources)	Fencing stock <u>and</u> weed control	Fencing
Protecting locally important species e.g. flora and fauna	Do nothing (limited resources)	Possum control	Possum control <u>and</u> other pest control
Protecting ecosystem services by:	Do nothing (limited resources)	<u>Increasing</u> actions to enhance ecosystem services	Maintaining <u>current</u> actions to protect ecosystem services
Cost to you	$0	$200	$100

***7. Bearing in mind your budget, choose the management option (column) you prefer. You must choose one only.**

☐ Management Option 1

☐ Management Option 8

☐ Management Option 9

Scenario 5 of 8

Biodiversity components	Management Option 1	Management Option 10	Management Option 11
Protecting native habitat by:	Do nothing (limited resources)	Fencing stock and weed control	Fencing
Protecting locally important species e.g. flora and fauna	Do nothing (limited resources)	Possum control and other pest control	Possum control
Protecting ecosystem services by:	Do nothing (limited resources)	Maintaining current actions to protect ecosystem services	Increasing actions to enhance ecosystem services
Cost to you	$0	$50	$150

***8. Bearing in mind your budget, choose the management option (column) you prefer. You must choose one only.**

☐ Management Option 1

☐ Management Option 10

☐ Management Option 11

Scenario 6 of 8

Biodiversity components	Management Option 1	Management Option 12	Management Option 13
Protecting native habitat by:	Do nothing (limited resources)	Fencing stock and weed control	Fencing
Protecting locally important species e.g. flora and fauna	Do nothing (limited resources)	Possum control	Possum control and other pest control
Protecting ecosystem services by:	Do nothing (limited resources)	Maintaining current actions to protect ecosystem services	Increasing actions to enhance ecosystem services
Cost to you	$0	$50	$100

***9. Bearing in mind your budget, choose the management option (column) you prefer. You must choose one only.**

- ☐ Management Option 1
- ☐ Management Option 12
- ☐ Management Option 13

Scenario 7 of 8

Biodiversity components	Management Option 1	Management Option 14	Management Option 15
Protecting native habitat by:	Do nothing (limited resources)	Fencing stock <u>and</u> weed control	Fencing
Protecting locally important species e.g. flora and fauna	Do nothing (limited resources)	Possum control <u>and</u> other pest control	Possum control
Protecting ecosystem services by:	Do nothing (limited resources)	<u>Increasing</u> actions to enhance ecosystem services	Maintaining <u>current</u> actions to protect ecosystem services
Cost to you	$0	$150	$200

***10. Bearing in mind your budget, choose the management option (column) you prefer. You must choose one only.**

☐ Management Option 1

☐ Management Option 14

☐ Management Option 15

Scenario 8 of 8

Biodiversity components	Management Option 1	Management Option 16	Management Option 17
Protecting native habitat by:	Do nothing (limited resources)	Fencing stock	Fencing stock and weed control
Protecting locally important species e.g. flora and fauna	Do nothing (limited resources)	Possum control and other pest control	Possum control
Protecting ecosystem services by:	Do nothing (limited resources)	Maintaining current actions to protect ecosystem services	Increasing actions to enhance ecosystem services
Cost to you	$0	$150	$50

***11. Bearing in mind your budget, choose the management option (column) you prefer. You must choose one only.**

- ☐ Management Option 1
- ☐ Management Option 16
- ☐ Management Option 17

12. If you choose "Management Option 1 - Do nothing (limited resources)" option all of the time, please indicate the main reason for doing so (choose one)

- ☐ Limited financial resources
- ☐ Limited space for farming operations
- ☐ Limited time
- ☐ I object to paying the Council any money towards native biodiversity management

Section 3 Background Questions

The purpose of these background questions is to assist in understanding why respondents' opinions may differ. Your answers will remain confidential and in no way identify you.

13. What is your age?

[ ]

14. Gender?

- ☐ Male
- ☐ Female

15. Do you have children?

- ☐ Yes
- ☐ No

16. Are you a current member of an environmental group/organisation eg Forest and Bird, Catchment Care etc?

- ☐ Yes
- ☐ No

17. What is the current Government Valuation of your farm?

- ☐ <$3,000,000
- ☐ $3,000,001 - $6,000,000
- ☐ $6,000,001 - $9,000,000
- ☐ >$9,000,001

18. What type of farm do you own?

- ☐ Dairy
- ☐ Dry stock (sheep, Beef)
- ☐ Mixed
- ☐ Other

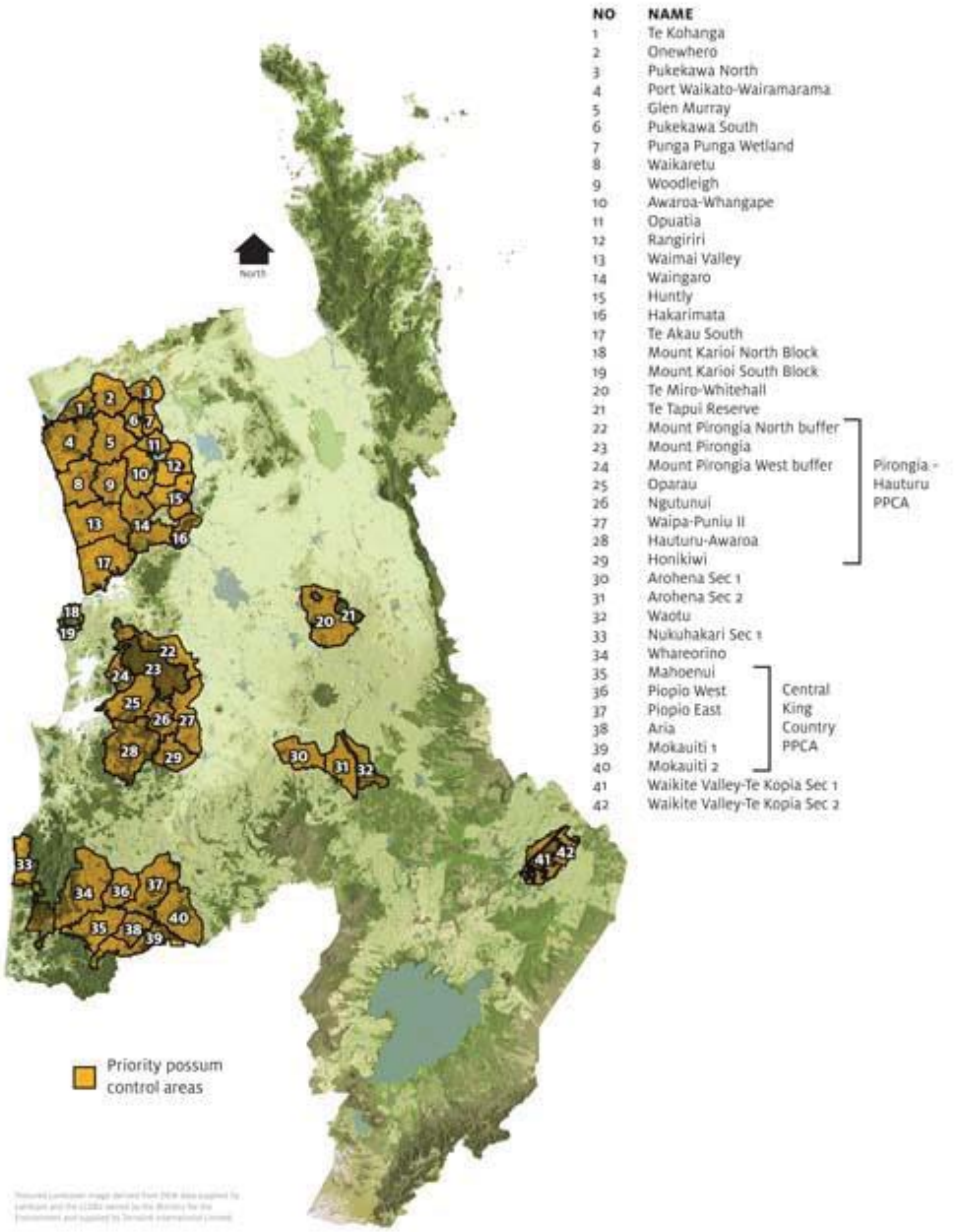
Thank you for taking time out of your day to complete this survey.

Appendix 3: How respondents answered the choice scenarios

Scenario 1	Response %	Response count	Excluding protests
Management Option 1 $0	17.8%	22	
Management Option 2 $200 (HAP,LII,ECE)	36.3%	53	44%
Management Option 3 $150 (HAE,LIM,ECM)	45.9%	67	55%
	answered question	146	
	skipped question	41	
Scenario 2			
Management Option 1 $0	14.3%	20	
Management Option 4 $100 (HAP,LIM,ECM)	28.6%	40	33%
Management Option 5 $50 (HAE,LII,ECE)	57.1%	80	66%
	answered question	140	
	skipped question	47	
Scenario 3			
Management Option 1 $0	21.3%	29	
Management Option 6 $100 (HAP,LIM,ECE)	38.2%	52	48%
Management Option 7 $200 (HAE,LII,ECM)	40.4%	55	52%
	answered question	136	
	skipped question	51	
Scenario 4			
Management Option 1 $0	20.7%	28	
Management option 8 $200 (HAE,LIM,ECE)	20.7%	28	26%
Management option 9 $100 (HAP,LII,ECM)	58.5%	79	74%
	answered question	135	
	skipped question	52	
Scenario 5			
Management option 1 $0	15.7%	21	
Management option 10 $50 (HAE,LII,ECM)	71.6%	96	84%
Management option 11 $$150 (HAP,LIM,ECE)	12.7%	17	16%
	answered question	134	
	skipped question	53	

Scenario 6			
Management option 1 $0	15.3%	20	
Management option 12 $50 (HAE,LIM,ECM)	57.3%	75	67%
Management option 13 $ 100 (HAP,LII,ECE)	27.5%	36	33%
	answered question	131	
	skipped question	56	
Scenario 7			
Management option 1 $0	22.9%	30	
Management option 14 $150 (HAE,LII,ECE)	62.6%	82	81%
Management option 15 $200 (HAP,LIM,ECM)	14.5%	19	19%
	answered question	131	
	skipped question	56	
Scenario 8			
Management option 1 $0	16.2%	21	
Management option 16 $150 (HAP,LII,ECM)	23.1%	30	27%
Management option 17 $50 (HAE,LIM,ECE)	60.8%	79	73%
	answered question	130	
	skipped question	57	

Appendix 4: Priority Possum Control Areas in the Waikato Region



Source :Waikato Regional Council (2014c)