Tasmanian landowner preferences for conservation incentive programs: A latent class approach

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January 2008

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Abstract

Incentive programs aimed at encouraging private landowners to set aside areas of forest for their conservation value have existed in Australia for more than two decades. Many programs restrict the use of the land by legal agreements or other means and some programs offer the landowner financial compensation. Most programs are based on voluntary entry by landowners.

Programs available in Tasmania have added significantly to the total forest area conserved on private land. Nevertheless, in some regions more than 80 percent of land with conservation value remains unprotected and programs routinely fail to meet enrolment targets. This has resulted in considerable debate about the design of programs and has resulted in an increase in the amount of compensation offered and the introduction of more flexible conservation management options. In a limited number of situations, the option of forcing landowner entry into conservation incentive programs has also been considered.

The objective of this study is to provide information for policy makers that hasn't existed before and that can be used in designing conservation programs. An improved understanding of landowners' decision framework, their motivation and the strength of their behavioral response will facilitate better forecasting of landowner participation decisions which may lead to an increase in landowner enrolment in programs.

In this dissertation a conceptual model of landholders' participation choice is developed that combines a traditional utility maximisation framework with information about landowner attitudes. An empirical model of landowners' conservation incentive program choice is then developed. The model is estimated using stated preference data from a Best-Worst and a Choice survey. The responses to the Best-Worst survey, which was carried out first, were used to determine the choice set for the subsequent Choice survey. The Best-Worst survey was also used to explore differences between the perceived importance of program attributes by program designers and administrators, and landowners.

The Choice survey gathered information on landowner preferences for incentive program attributes, the socio-economic characteristics of the landowner and their attitudes, and property characteristics.

Landowners were presented with two experiments mimicking program choice in a voluntary and forced choice scenario. Landowner heterogeneity was accounted for using a latent class approach to estimating preference parameters. These were compared to preferences estimated using a two step logit approach.

Three latent classes of landowners with different attitudes to the role and outcome of establishing conservation reserves on private land were identified: *multi-objective owners*; *environment owners*; and *production owners*.

Preferences for program attributes and estimated welfare impacts when forced to enter a 'restrictive' program are found to differ significantly between the landowner classes. Estimated welfare losses were lowest for *environment owners* and highest for *production owners*. Results suggest that compensation is not a main driver of program choice for any of the groups when entry is forced.

Only a small proportion of landowners were willing to voluntarily join a conservation program. Preferences for program attributes were not significantly different between landowner classes, even though groups differed in their attitude. The welfare implications of voluntarily joining a 'restrictive' program were small and compensation funding was, again, only of secondary importance in determining program choice. The research also showed little difference in the perceived relative importance of different program attributes between landowners and program designers and administrators.

The results of this study will be of use to policy makers in the design of better targeted incentive programs. For instance, results suggest that when designing forced entry programs for *environment owners* special attention should be paid to the provision of logistical assistance, which is relatively important to this group. Furthermore, programs that do not permit any productive use of reserved areas do not deter entry by *production owners*.

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1 Introduction

Conservation incentive programs that encourage landowners to set aside areas of privately owned forest have existed in Australia for more than two decades (Figgis 2004). Nevertheless, a comprehensive analysis of the way in which landowners make decisions about whether to join such programs has not previously been undertaken. This dissertation provides such an analysis by combining information about landowners' socio-economic and property characteristics and their attitudes, with incentive program choice data gathered by means of a Choice survey, within an econometric model of landowner behaviour. Incentive programs are modelled as 'bundles of attributes', allowing a comprehensive representation of incentive program choice. Landowner heterogeneity is accounted for by using a latent class approach to estimation. The results reported in this dissertation provide information that may be useful to policy makers wanting to forecast landowner participation decisions and to design programs that target particular groups of landowners.

1.1 Motivation

Australia possesses flora and fauna that is both highly endemic and has great species richness compared to many other parts of the world (Department of the Environment, Sport and Territories n.d.). However, much of Australia's rich biodiversity[1] is threatened with extinction due to habitat loss or the degradation of habitat quality. The Australian Government has, on many occasions, indicated its commitment to avoiding further loss of biodiversity by increasing the area of reserves, while at the same time preventing further land clearing (Luzar and Diagne 1999).

Over 60 percent of land in Australia is managed by private landholders (Productivity Commission 2001). Consequently, many threatened ecosystems[2] in Australia occur

[1] "Biological diversity or biodiversity refers to the variety of life forms: the different plants, animals and microorganisms, the genes they contain, and the ecosystems they form" (Department of the Environment, Sport and Territories n.d.).

2 An ecosystem is "... the dynamic and interrelating complex of plant and animal communities and their associated non-living environment" (www.biology-online.org/dictionary/ecosystem viewed on 5 October 2005). For instance a forest ecosystem is characterised by the predominance of trees, and the fauna, flora and ecological cycles (energy, water, carbon and nutrients) with which they are closely associated.

on private land. It is important, therefore, to consider the role of private landholders in conserving high value biodiversity areas.

Standard presentations of the economics of biodiversity argue that undefined or inadequately defined property rights for this environmental resource may lead to reduced incentives for landowners to protect biodiversity on their own land. The market for biodiversity conservation on private land does not deliver an efficient or Pareto optimal outcome (e.g. Kahn 1995). This result underpins the suggestion that implementing policies to protect biodiversity on private land is a legitimate role of government (e.g. Callan and Thomas 2000). All levels of governments can provide incentives to motivate landowners to undertake conservation action and protect additional areas of private land with high nature conservation value. Motivation can be through financial incentives such as grants obtained by participation in incentive programs and tax breaks, but also through, for instance, education. Governments can also use other policy instruments such as direct legislation or the development of regional strategies.

Landowners make decisions about the implementation of conservation management actions and participation in conservation oriented programs in a complex environment. Landowner decisions in general have been shown to involve many factors including culture, social setting, property structure, finances, and perception (Vanclay and Lawrence 1995). The framework within which the decision to enrol land in legally-binding conservation incentive programs is made, is expected to be equally complex. Crase and Maybery (2004) find that by revealing the intricacies of the individual's decision framework and understanding their behavioural responses, incentive programs with high success rates can be designed.

By 2002 Tasmanian private landholder participation in incentive programs resulted in the protection of more than 32 000 hectares of land for the purpose of biodiversity conservation (Resource Planning and Development Commission 2003). Nevertheless, landowner enrolment in conservation incentive programs in Tasmania has fallen short of achieving the total area targeted to be set aside for conservation. In some regions of Tasmania, more than 80 percent of the total targeted areas remained unprotected in 2003 (Resource Planning and Development Commission 2003). A significant proportion of this area occurs on private land. The Tasmanian Government has a stated commitment to protect additional areas on private land through funding incentive programs for private landholders (Department of the Environment and Water Resources 2004).

Research and anecdotal evidence both suggest that landholder participation in incentive programs will vary with the expected private costs and benefits of conserving land of conservation significance, as well as with various landowner, property and business characteristics such as productive income (e.g. Wilson 1996; Drake, Bergström *et al.* 1999; Greiner, Herr *et al.* 2003). Non-financial motives and environmental attitudes are also likely to play a role in the decision to enrol land in a conservation incentive program (e.g. Wynn, Crabtree *et al.* 2001). Lastly, the attributes of the incentive program itself are expected to play an important role in the participation decision (e.g. Purvis, Hoehn *et al.* 1989; Cooper and Keim 1996).

The attributes of conservation incentive programs, such as the legal implications and the restrictions placed on the use of land, are generally determined by the government officials who design and implement these programs.[3] Since landowner participation rates are affected by program attributes, a better understanding of the importance ascribed by landowners to various attributes can potentially lead to the more effective design of programs.

Conservation incentive programs in Australia are currently based largely on voluntary entry into the program by landowners (CSIRO Wildlife and Ecology 2001) and there are only a few examples where government has compulsorily acquired land of conservation significance (e.g. *Western Australian Public Works Act* 1902 quoted in Stoneham, Crow *et al.* 2000). Continuing low private land enrolment rates may mean that governments are called upon to consider forcing landowner participation in order to achieve stated policy objectives. This possibility makes an understanding of landowners' preferences for program attributes in the context of forced program entry both relevant and important.

Overall, an improved understanding of landowners' decision framework, their motivation, and the strength of their behavioural responses in the context of both forced and voluntary entry could lead to better tailoring of programs to suit particular landowners or groups of landowners. At the same time it would increase the

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[3] Although the development of government programs frequently occurs in consultation with the target audience (e.g. Department of the Environment and Water Resources 2004).

likelihood of achieving program goals and could result in more efficient financing of conservation targets.

1.2 Objectives

The overall aim of this dissertation is to contribute to an improved understanding of the way in which landowners make decisions about participating in incentive programs aimed at conserving biodiversity on private land in Tasmania as a basis for improving program design.

The following policy related research objectives are central to achieving this:

- To investigate landowner preferences for incentive program attributes in the context of both forced and voluntary choice. This involves identifying and quantifying the tradeoffs that landowners make between incentive program attributes, and exploring how such tradeoffs are affected by the socio-economic characteristics of landowners, landowner attitudes and property characteristics.
- To compare the welfare implications of program 'restrictiveness' when choice is forced and voluntary.
- To compare landowners to program designers and administrators with respect to the perceived importance of incentive program attributes in the landowner decision framework.

1.3 Methodological overview

Achieving the above objectives involves the development of a theoretical model that describes landowner decisions to conserve biodiversity through participation in conservation incentive programs. A conceptual model of landholders' participation choice is developed that combines the traditional utility maximisation framework with information about landowner attitudes. The development of this model follows a review of the literature related to the economic modelling of the decision to participate in incentive schemes and the literature related to environmental attitudes and their measurement.

The empirical study of choice and participation in incentive programs may be undertaken using information about landowner preferences as revealed by their actual participation in available programs or by eliciting stated preferences for incentive programs using survey methods. In this research an empirical model of landowner participation in conservation incentive programs is developed using data gathered by means of two separate, but related, stated preference surveys: a Best-Worst (BW) and a Choice survey. A review of existing programs and policies informs thc design of both surveys.

The responses to the Best-Worst survey, which was carried out first, are used to determine the choice set for the subsequent Choice survey. The Best-Worst survey was also used to explore differences between the perceived importance of program attributes by program designers and administrators, and landowners.

The Choice survey gathered information on landowner preferences for incentive program attributes, the socio-economic characteristics of the landowner and their attitudes, and property characteristics.

Landowners were presented with two choice experiments mimicking program choice in a forced choice and voluntary scenario. Landowner heterogeneity was accounted for using a latent class approach to estimating preference parameters.

1.4 Contribution of this research

The approaches taken in this research are innovative for several reasons. Firstly, the Choice survey gathered information on landowner preferences for incentive program attributes. Although choice studies are frequently carried out to explore issues in environmental economics, a review of the literature has not shown any previous studies that applied this approach to the design of policy instruments in Australia. Investigating incentive program choice using choice modelling is a state of the art application of this approach for the design of new policy.

Secondly, the choice question in the survey was phrased in such a way that made it possible to consider landowner preferences for program attributes both in a situation where entry into a program is voluntary and where entry is compulsory or forced. The simulation and comparison of a forced and voluntary entry choice situation has not been carried out in Australia or elsewhere, in the context of conservation incentive programs. The comparison is important as different policy options for Australian Government incentive programs may need to be considered in the future if voluntary programs do not achieve their stated conservation aims.

Thirdly, to my knowledge, no other study has carried out an economic analysis of landowners' decision framework surrounding participation in incentive programs in which four classes of independent variables have been combined: socio-economic characteristics of landowners; landowner attitudes; property and business characteristics; and incentive program attributes. This study advances the understanding of attributes that are important in influencing incentive program choice which can therefore be targeted in future government initiatives aiming to increase landowner participation.

Moreover, the assessment of landowner attitudes is based on 'outcome evaluation' which varies from the more traditional classification of attitudes on the basis of a general environmental characterisation of the landowner. To my knowledge, this type of attitude variable has not previously been included in a model of incentive program choice and greatly adds to the comprehensiveness of the economic analysis.

Fourthly, the trade-offs between incentive program attributes are modelled using a latent class technique, rather than the more traditional two-stage cluster / logit approach. The latent class technique accounts for heterogeneity among landowners. Key variables that explain landowner participation can be identified using this method. The application of a latent class regression model to conservation program choice data, in which the difference in landowner choice behaviour is explained by landowner heterogeneity in terms of observable and unobservable characteristics, is novel. The results of the latent class estimation technique are compared to the more traditional two-stage cluster / logit regression approach.

Lastly, although Best-Worst and Choice surveys have been combined in other studies (e.g. Sawtooth Software 2002), a Best-Worst survey has not previously been used to set attributes for a subsequent Choice survey. This type of Best-Worst survey application is an innovative and comprehensive survey approach which can lead to better Choice survey design. The Best-Worst survey was also used to explore differences between program designers and administrators, and landowners in relation to the perceived importance of different program attributes. This innovative use of the Best-Worst survey allows an appraisal of program designers' understanding of the importance of program attributes to stakeholder. A Best Worst survey has not previously been applied in this manner.

1.5 Outline of the dissertation

This dissertation is organised as follows:

Chapter 2 describes the current status and historical development of biodiversity conservation in Australia. The traditional economic treatment of biodiversity conservation as a public good and the occurrence of market failure is established. An outline of current incentive programs aimed at nature conservation in Australia in general, and Tasmania in particular, and participation in these programs is presented.

The empirically based literature related to modelling private landowner land use choice and the decision framework surrounding the participation in incentive programs is reviewed in **Chapter 3**. Previous application of the stated preference techniques used to gather data in this research is also reviewed.

The description of landowner choice in a utility maximising framework is presented in **Chapter 4** followed by the behavioural theories which form the foundation of stated preference techniques. A brief introduction to decision making models in psychology as they relate to the development of a comprehensive model of landholder utility is presented.

The estimation technique and statistical methods applied in this dissertation are the subject of **Chapter 5**. In this chapter the use of the latent class estimation approach to account for heterogeneity in data is presented. The statistical indicators for the latent class, the Best-Worst, and the attitude data are also discussed.

The development of the Best-Worst and Choice survey instruments and the survey application methods are presented in **Chapter 6**. Survey design considerations are also discussed.

The empirical results for the Best-Worst and Choice models are reported in **Chapter 7** and **Chapter 8**. In each chapter a descriptive analysis of the socio-economic and property characteristics data is followed by the statistical analysis of the data.

The results are discussed in **Chapter 9** and implications of the findings are presented. The tradeoffs that landowners make between incentive program attributes, and how these are affected by various socio-economic characteristics of landowners, landowner attitudes, and property characteristics are discussed. This is followed by a discussion of the effect of forced entry into conservation programs on landowner preferences for program attributes. Welfare estimates of changes in program restrictions under the two choice scenarios are also compared. Latent class estimates are then compared to the results obtained from a two-stage cluster analysis / logit regression. This is followed by a brief conclusion and recommendations for further research.

2 Biodiversity conservation

In this dissertation conservation incentive programs are modelled as a bundle of attributes. In this context it is important to understand the makeup of existing programs, how they work, and where they fit into the current policy environment. This chapter begins with an outline of the current status of biodiversity conservation in Australia followed by a discussion of the traditional treatment of biodiversity conservation in economics. A discussion of policy tools available to government is followed by an outline of current incentive programs and participation in these programs.

2.1 Conservation in Australia

It is well established that there is a great species richness of plants and animals in Australia. Over 80 percent of Australian flowering plants, mammals, and inshore, temperate-zone fish are endemic (Department of the Environment, Sport and Territories n.d.). However, habitat loss or the degradation of habitat quality threatens much of Australia's rich biodiversity with extinction.

A natural rate of species extinction has occurred throughout the ages with the occasional massive and rapid extinction, such as that of the dinosaur (e.g. IUCN World Conservation Union 1999). Scientists have acknowledged that the relatively rapid rate of recent species extinctions cannot be attributed to naturally occurring environmental change but rather is the result of anthropogenic or human based factors (Kahn 1995). Maintaining current biodiversity levels, or at least slowing further species extinction, requires maintenance of habitat (e.g. Soule 1991).

Traditionally, the responsibility for the conservation of biodiversity in Australia has rested in the public domain. Recognising that habitat degradation needs to be halted, governments are spending funds in all sectors of the economy to protect biodiversity. The latest available Australian Bureau of Statistics (1997) information suggests that annual household expenditure on the protection of biodiversity and landscape in Australia was approximately $169 million in 1996-97 and the amount spent by industry was approximately $173 million in that same year. Some of the money spent on biodiversity conservation includes setting aside areas as reserves specifically aimed at preserving biodiversity.

The protection of biodiversity has to date been achieved largely through the creation of public parks and reserves. The conservation of biodiversity in these parks was often incidental because the parks were mainly created for their natural beauty and recreational values and less frequently for the protection of threatened species (Thackway and Olsson 1999). Governments have now determined, on behalf of society, that biodiversity conservation should be increased above current levels (Productivity Commission 2001) by creating more conservation reserves (Aretino, Holland *et al.* 2001).

2.1.1 Meeting biodiversity targets

The Australian national and state governments' recognition of their role in setting targets for biodiversity conservation reached a new level in 1992 through their commitment to conserve a " ... comprehensive, adequate, and representative sample of Australia's ecosystem types" (Thackway and Olsson 1999, p.89). The Interim Biogeographic Regionalisation for Australia (IBRA) provided a framework for setting protection priorities at a regional and national level (Thackway and Cresswell 1995; Thackway and Olsson 1999) for both private and public land.

Both the 1992 National Strategy for Ecologically Sustainable Development and the subsequent 1996 National Strategy for the Conservation of Australia's Biological Diversity (Department of Environment and Water Resources 1992) recognised the need for partnerships among all levels of government, industry and the community (Thackway and Olsson 1999). To ensure adequate representation of ecosystems in the process of conservation of biodiversity in Australia, protection needed to be on land of various tenure, and by both the public and private sectors (Productivity Commission 2001). To facilitate the process of biodiversity conservation, biodiversity resource reservation targets were determined by an external scientific process for each of the States and Territories in Australia.

As over 60 percent of land in Australia is managed by private landholders, many of the threatened and under-represented ecosystems in Australia occur on private land. It is therefore important to consider the role of private landholders in conserving important areas for biodiversity conservation. The question arises why, in a country such as Australia that is so reliant on markets, the market does not deliver the desired level in relation to biodiversity conservation? In other words, why do markets fail when it concerns the conservation of biodiversity?

2.2 A case for government intervention

Most resource and environmental economics textbooks classify biodiversity as an environmental resource that is a public good, that is, what Samuelson (1954) referred to as non-excludable and non-rival. Biodiversity is non-excludable because it is not possible to stop anyone from "consuming or enjoying" the good. It is non-rival as the enjoyment of biodiversity by someone does not reduce the amount of biodiversity available to others. For example, it is not possible for a landowner who protects an area of land on their property, thereby conserving biodiversity, to stop the neighbour enjoying the increasing number of native animals. At the same time, the neighbour's enhanced enjoyment will not reduce the farmer's own ability to enjoy the presence of these animals.

The non-rival and non-excludable nature of public goods may cause problems for their supply. These goods are one of several categories of goods where market failure may apply (Kahn 1995). Because no private individual or organisation can reap all the benefits of a public good which they have produced or made available, there will be insufficient incentive to produce it voluntarily. Consumers can take advantage of public goods without contributing sufficiently to their creation. This is called the 'free rider' problem (e.g. Samuelson 1954).

Specific to the production or protection of biodiversity, landowners may not have an incentive to protect biodiversity if they are unable to encourage others to contribute to the benefit they enjoy. Similarly, there may not be an incentive if the landowners are able to enjoy the benefits regardless of their own contribution. The landowner is able to free ride and will not incur the cost of producing the good (Söderqvist 2003). It may therefore be argued that an allocatively efficient outcome of biodiversity provision is not established with natural market incentives (Callan and Thomas 2000).

A characteristic of biodiversity is that property rights[4] are inadequately defined or are unprotected. Undefined or inadequately defined property rights mean that there are no valid claims to exclusive use of the resource and the resource cannot be sold. Property rights are generally limited by law and through social customs (Callan and Thomas 2000). The attribute of biodiversity as a public good in combination with insufficiently specified property rights makes it different from "an *ordinary* resource and leads to deficient market valuation" (Lerch 1998, p.286). Further, until recently biodiversity was perceived to be available in abundance. Property rights are generally not an issue where resources are not perceived as scarce (Anderson and Hill 2004).

In relation to deficient market valuation the Coase theorem suggests that "proper assignment of property rights to any good ... will allow bargaining between the affected parties such that an efficient solution can be obtained, regardless of which party is assigned those rights" (Callan and Thomas 2000, p.87). Some major obstacles in relation to the assignment of property rights to biodiversity exist, such as the development of equitable allocation methods. Additionally, potentially prohibitive transaction costs in trading may apply once property rights are allocated (e.g. Whitten and van Bueren *et al.* n.d).

Thus, the above discussion indicates that the public good nature of biodiversity is recognised and that government has a potential role to encourage the provision of biodiversity which will otherwise not be achieved through markets. The next section provides an overview of the instruments available to government to encourage biodiversity conservation, particularly on private land.

2.2.1 Government instruments

Governments may use regulations, suasion, and incentive programs to encourage biodiversity conservation actions on private land by landowners. Figure 1 summarises a variety of policy tools available to government for managing environmental outcomes, as broadly defined in the relevant literature.

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[4] "Property rights include the right to acquire property, the right to dispose of property; the right to exclude others, the right against trespass, the right to quiet enjoyment and, importantly, the right of active use - with the general proviso, of course, that one may do so only as long as these rights do not hinder the rights of others to enjoy or use their property" (Nahan 1999).

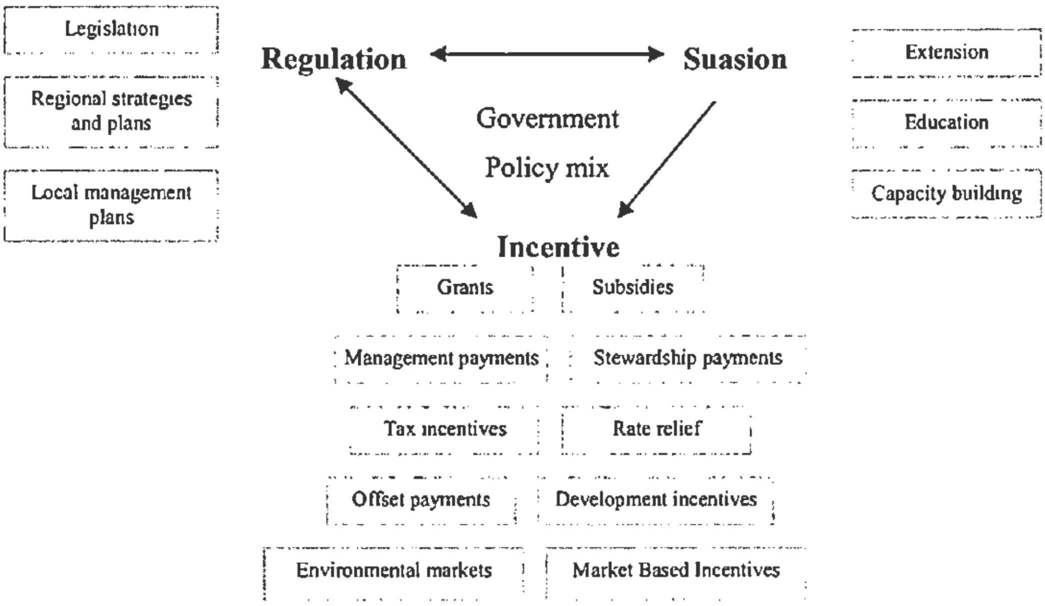

Figure 1: Policy tools available for managing environmental outcomes (based on Young and Gunningham 1996).

As is shown in Figure 1 above, conservation incentives provided to private landholders by different levels of government currently comprise grants (including management and stewardship payments[5]), subsidies, tax relief, rate relief, offset payments, development incentives, the creation of environmental markets, and market based incentives (MBIs). These incentives are aimed at encouraging management change and thereby improving environmental outcomes, such as water quality and the protection of biodiversity (e.g. James 1997).

Governments often use a combination of (overlapping) policy instruments, in particular incentives and legislation, to realise the full value of the biodiversity resource (e.g. Young and Gunningham 1997; Binning and Young 1999; Mountford and Keppler 1999). The focus of the next section is on the source of the funding the government uses to encourage conservation.

[5] Stewardship payments are to assist landowners to carry out tasks they have an obligation to do in any case. This implies some sort of duty of care on the landowner's behalf. A management payment is for a specific action and finishes when the action is carried out. Management and stewardship payments are often provided with the direct aim of protecting biodiversity and areas of conservation significance through specific management actions or reservation of land (Kabii 2004).

2.2.2 Who should pay?

The public good nature of biodiversity suggests insufficient private incentive to conserve biodiversity and to use it in a sustainable way. The provision of incentives may encourage private landholders to set aside areas for conservation. However, there remains an argument as to who should bear the cost of conserving biodiversity on private land (Bates 2001).

Article 11 of the Convention on Biological Diversity raises the issue that individuals are likely to personally bear the costs associated with their conservation effort, however, "... most, if not all, of the associated benefits would accrue to society-at-large" (United Nations Environment Program n.d.).

Numerous elements contribute to resolving this issue (Commonwealth of Australia 2001), but two central themes can be identified. These are referred to as equity[6] and duty of care, which can be translated into a number of questions:

- Should the public pay landowners for conserving biodiversity?
- Which management actions should they be compensated for?
- Which landowners who undertake these actions should be paid? and
- How much should they be paid?

According to Coase (1960), the compensation obligation depends on who has the property rights. The property rights of private landowners are well defined in the Australian constitution, but the biodiversity values that occur on that private land are not (Wiebe, Tegene *et al.* 1997).

Where government compulsorily acquires property – for instance to protect biodiversity values – the compensation issue seems to be relatively straightforward. Legally, Part V – Powers of the Parliament, Section 51 (xxxi) of the Australian constitution states that if the government acquires property from any State or person "full and adequate compensation" has to be paid (Nahan 1999).[7] However, where biodiversity conservation is achieved by changing management practices, but retaining private ownership, the government may be reluctant to pay compensation.

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[6] Equity is interpreted here as the need to share the costs and benefits necessary to achieve biodiversity conservation (Kabii 2004).

[7] The 'just compensation' clause does not appear in the State's own constitutions.

In this situation, the government may be perceived to compulsorily acquire part of the 'bundle' of property rights, while leaving the title with the landowner.

Binning and Young (1997) argue that conservation of biodiversity is a normal part of the production process for any landowner. After all, the landowner also captures some of the benefits of conservation. This means that the landowner has a "duty of care" and governments should not provide financial assistance to landowners to protect this biodiversity. Only those activities that go beyond the normal duty of care should be considered for cost sharing arrangements as the landowner is providing a community service by maintaining environmental quality beyond what is expected (Binning and Young 1997).

Nevertheless, the argument remains as to what constitutes more than the norm. Some studies seem to indicate that there is a relatively high level of community support for compensation payments to landholders independently of defining what is expected. For example, Whitten and Bennett (2001) undertook a Choice survey in the upper southeast of South Australia and the Murrumbidgee to investigate views on options for managing land in the region. In both regions, 68 percent of survey respondents felt that compensation should be paid to farmers if they were made worse-off by changes in land management practices to improve the environment. Only 9 percent of respondents felt that farmers should not be compensated, while the remainder were unsure. A Finnish study by Horne (2004) suggested that a "clear majority of citizens are in favour of full compensation to the forest owners for lost revenues and possible costs of nature conservation action" (Horne 2004, p.2). These Finnish citizens indicated that they supported forest owners' sovereignty in forest management decisions.

Even though in Australia there seems to be strong support from community members for compensation payments to landowners, many landowners themselves remain unconvinced of the benefits that they are capturing by, for instance, retaining remnant vegetation areas on their farms. They indicate concern as to the effect on profitability. Not only are these landowners unsure about the benefits, they feel inadequately compensated for any costs arising from changing management actions aimed at conservation. Accordingly in the absence of attractive financial incentives or change in attitudes, the majority of farmers are likely to remain disinterested in the protection and management of conservation areas (Denys-Slee & Associates 1998).

A discussion of the programs and financial incentive available in Australia and Tasmania follows. Prior to this discussion however, a review of the relevant national and state regulation and suasion programs is presented. This review is not intended to be comprehensive, but rather to illustrate the range and extent of government involvement.

2.3 Regulation and suasion

The Commonwealth Government and through it, the states, is party to a number of conventions that pertain to conserving biodiversity. The International Convention on Biological Diversity is most relevant in this context (Nature Conservation Branch 2000).

A number of inter-governmental agreements exist between Tasmania and the Commonwealth which outline the respective responsibilities of the jurisdictions for various conservation related matters, such as the National Strategy for the Conservation of Australia's Biological Diversity (1996).

The Australian Government legislative mechanism for national environment protection and biodiversity conservation is by means of the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). The Act provides for the protection of critical habitat, the preparation of protection plans, and the preparation of conservation agreements, among other things. When the EPBC Act was introduced, a national list of threatened species, ecological communities, and threatened processes that were endangered, vulnerable or extinct, was carried forward from the preceding *Endangered Species Protection Act* 1992. The list was expanded to include categories of threatened species that were critically endangered, conservation dependant, or extinct in the wild.

In Tasmania, the *Threatened Species Protection Act* 1995 provides for the conservation of threatened species and management of threatening processes.[8] Schedules of the Act list more than 600 species of threatened plants and animals in

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[8] A threatened process is defined in the *Environment Protection and Biodiversity Conservation Act* 1999 as such if it " ... threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community".

Tasmania (Department of Primary Industries and Water - Threatened Species Section 2007).

The protection of biodiversity through the creation of conservation covenants is enabled under the *Nature Conservation Act* 2002. The Act sets out broad guidelines regarding the appropriate private reserve types (Protected Areas on Private Land Program 2003). Covenants and management agreements are enabled under the *Land Use Planning and Approvals Act* 1993. Section 71 of this Act allows a planning authority to enter into an agreement with a landowner and grant approval to register a covenant on the title which prohibits the clearing of vegetation (Binning and Young 1999). As well as legislation that underpins the conservation of biodiversity nationally and at a state level, the Australian Government supports many programs that can collectively be categorised as suasion (Figure 1).

Extension is achieved through, for example, the provision of funding to each State for a Threatened Species Network Coordinator. The coordinators provide advice and facilitate community involvement in the conservation of nationally listed species. A National Threatened Species Day is held every year to encourage biodiversity conservation. There are many more programs aimed at increasing the knowledge base with the ultimate aim of increasing conservation efforts. These programs include resource kits (e.g. *Hands-on for habitat*) and music kits (e.g. *Logs have life inside*), threatened species publications, threatened species networks, national poster competitions, and flora and fauna networks.

Idea and information exchange is also achieved by means of, for example, funding facilitators for the Land for Wildlife program in each State. The Federal Government funds Aboriginal education programs such as the Aboriginal Landcare Education Program in the Northern Territory (delivered through Greening Australia).

Aside from legislation and suasion, the government provides incentive programs aimed at biodiversity conservation. These are discussed in the next section.

2.4 Australian incentive programs

Much has been written about the different Federal, State and Municipal incentive programs aimed at achieving environmental outcomes that presently exist (e.g. James 1997; Bateson 2001; Comerford and Binney 2004). The programs that are on offer vary in their focus, and they are aimed at achieving different environmental outcomes: e.g. salinity reduction, soil degradation reduction, water quality improvement, and biodiversity conservation. A multitude of programs provide funding to undertaking management actions that are of benefit to conservation such as fencing and planting trees (e.g. Department of Environment and Water Resources 2006). In this study the focus is on programs that are aimed at biodiversity conservation through reservation.

The incentive programs aimed at biodiversity conservation have traditionally been delivered primarily by the three levels of government. Increasingly, however, the trend is to deliver the programs through Natural Resource Management (NRM)[9] for instance Catchment Management Authorities (CMAs), stakeholder organisations such as farmers' federations, dedicated conservation organisations, and Non Government Organisations (NGOs). A summary of the delivery routes is shown in Figure 2.[10]

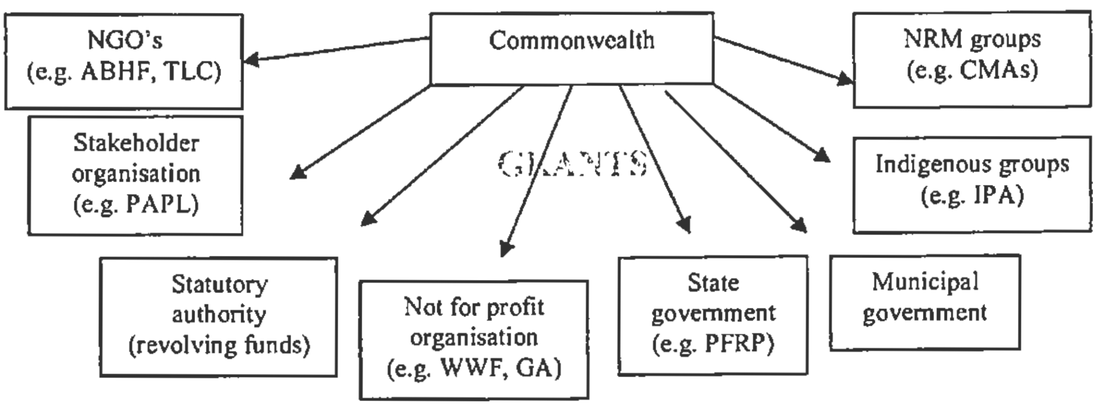

Figure 2: Delivery routes of Commonwealth funding.

One increasingly important method of achieving biodiversity conservation is through NGOs (see Bennett 1995). Funds donated to these NGOs to conserve biodiversity are, in most cases, fully tax deductible. Organisations such as the Australian Wildlife Conservancy (AWC), the Australian Bush Heritage Fund (ABHF), the former Earth

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[9] The delivery of NRM relies on the cooperation of Commonwealth, state and local governments, as well as that of regional NRM bodies specifically established to ensure delivery of at the regional level. Joint Australian and State/Territory Government steering committees are responsible for managing the delivery of the NAP and NHT across the states and territories. NRM is delivered via the integrated implementation of the National Action Plan for Salinity and Water Quality (NAP) and the Natural Heritage Trust (Australian Government 2007).

[10] In this figure only Commonwealth funding is shown, obviously the States also collect and allocate taxes while NGOs also receive funding through private donations.

Sanctuaries, and local organisations such as the Tasmanian Land Conservancy (TLC), buy land of conservation significance and turn private property into nature reserves.[11] The Australian Government indirectly provides these NGOs with means through which individual citizens can commit to protecting habitat (Kahn 1995).

The Commonwealth National Reserve System funding program (NRS) provides funding to local government, community groups, industry, and non-government conservation agencies to protect areas of land they purchase. The program provides two-thirds of the purchase price if the area is legally protected by means of a covenant and the proponents take responsibility for the management. This funding is not available to individual landowners (Department of Environment and Water Resources 2007).

Biodiversity is also protected by means of so-called revolving funds, which are a financially and legally effective method of ensuring conservation outcomes on private land (Mortimer 2003). The Commonwealth Department, Environment Australia (EA), developed a "Bush for Wildlife Revolving Fund" which is administered by statutory authorities or NGOs. The authorities that run these revolving funds purchase properties that contain an area of conservation significance. The authority subsequently protects the property by legal means (e.g. covenant on title) after which it is re-sold. After the re-sale of the land, the funds are returned for new acquisitions.

Revolving funds have been established in New South Wales (Nature Conservation Trust of NSW), South Australia (Nature Foundation SA), Victoria (Trust for Nature), Queensland (Queensland Trust for Nature) and Western Australia (National Trust of Australia - Western Australia). These organisations are partly funded by Federal Government grants aimed at scheme establishment, covering administration costs, or creating employment opportunities. The Bush Brokers program in Western Australia was established in 1999 and also administers a revolving fund. The Brisbane City Council has a bushland acquisition program that is funded by an environmental levy,

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[11] The growth in the private land conservation sector has been significant. For instance, incoming funds for the AWC increased from $2.5 million to $5.5 million in just one year. The " ... AWC now owns and manages 10 properties across Australia covering more than 575,000 hectares (1.3 million acres) in the Kimberley, north Queensland, western NSW, the Flinders Ranges and the forests of southwestern Australia" (Australian Wildlife Conservancy 2002).

which revolves properties after protecting their nature conservation values through re-zoning or covenants.

Federal government "devolved grants" have been issued to Greening Australia (GA) to establish the Remnant Vegetation Fencing Incentive Scheme which grants conservation works for areas not necessarily under permanent protection. Funds are available through this scheme in New South Wales, Tasmania, Victoria, Queensland, and the Australian Capital Territory. Grants for on-ground conservation works for priority grassland are available through the Grassy Ecosystems Grants managed by the World Wildlife Fund (WWF).

Federal funds are provided to assist Indigenous landholders to manage protected areas on their land through the Indigenous Protected Areas (IPA) program. As well as the above direct grants programs, funds are delivered using different methods, for example Market Based Incentives (MBIs).

The majority of MBI schemes to date address land and water degradation problems. Transferable water entitlements in the irrigation regions of the Murray Darling in the early 1980s and the performance bonds scheme implemented by the Great Barrier Reef Marine Park Authority in 1987 (van Bueren 2001) were some of the earliest quantity based MBIs in Australia other than fisheries quota systems[12].

Property rights are an underpinning requirement for market creation and all tradeable right systems for different resources are based on this premise[13]. MBIs rely on enabling legislation and need a 'cap', or total load, to be set for a particular area (whether it be catchment or local government area) within which trading takes place.

Although the idea of biodiversity trading systems is widely debated at various forums (e.g. Key Issues in Australia's Biodiversity September 2000 Seminar Series, Discovery Centre, CSIRO, Black Mountain, Canberra) there is currently no such system that operates in Australia. However, recently an agreement for a biodiversity trading scheme was signed between the Environment Minister and the South Australian Farmers Federation (SAFF). Although no trading between farmers will

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[12] The most well known MBI is the tradeable quotas that have been used in the fisheries industry for decades (for instance the Southern Bluefin Tuna Fisheries quota system commenced in 1984).

[13] The Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) produced guidelines in relation to the creation of property right for water in 1995.

take place, this agreement will allow farmers in the upper south-east of region South Australian to trade off their salt water drainage levy payments by protecting native vegetation and undertaking management activities on their property (Upper South East 2003). In a successful biodiversity trading market, landholders would protect an endangered ecological community or species, if the option is financially attractive when compared to other use options.

There are many concerns related to the feasibility and desirability of a system of biodiversity credits some of which centre around the intractable difficulties of creating markets in biodiversity due to the difficulties in allocating property rights (Doremus 2003). Some other issues that have been raised are the definition of trading units, the potential thinness of the market, the long production timeframe, and the geographical boundaries of the trading market.

The Department of Sustainability and Environment (2007) has been testing a system of auctioning government funds ("Bush Tender Trial") that may be used to undertake environmental management actions on private properties.[14] This funds dispersal system is frequently categorised as a market-like approach. Prior to the auction, field officers visit the interested landholders in an area and agree on a management plan best suited to their property and which achieves optimal environmental outcomes. The landowner then submits a sealed bid nominating the amount of money required to undertake the management on their property. Assessing the nature conservation priority on the property and value for money, the auctioning body determines who will receive funding. Those who are elected to receive funding then sign at least a three-year agreement.[15]

An advantage of the process of auctioning the money available for environmental management is that it reveals market information about the minimum cost of various environmental management options. Because the auctioning process pays landowners at the price level they are willing to accept, the flexibility may result in a higher number of landowners being successful in obtaining these funds.

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[14] Sometimes referred to as "price based MBIs" (Action Salinity and Water Australia 2002).

[15] As at February 2002, there had been 126 expressions of interest, 98 bid submissions and 73 accepted bids, accounting for $400,000 in payments (Stoneham, Chaudhri *et al.* 2002 quoted in Chan, Laplagne *et al.* 2003).

In Tasmania no auctioning of government funds has taken place to date. However, several programs disperse funding to landowners for conservation purposes. These are the subject of Section 2.5.

2.5 Tasmanian incentive programs

In Tasmania a number of incentive programs are available to landowners to protect biodiversity. The Private Forest Reserves Program (PFRP) offers landowners funding for areas of high conservation significance if conservation covenants are placed on the land, or management agreements are entered into. The program was established through a $30 million grant from the Commonwealth to the PFRP delivered through the State Government (Department of the Environment and Heritage n.d.). The program has been finalised and was replaced by the Forest Conservation Fund (FCF) Commonwealth program in mid 2006.[16]

The PFRP offered two types of legally-binding conservation management agreements.[17] The first was referred to as "a covenant", which is an agreement that is binding upon the title of the land. The second, referred to as "management agreements" involved personal contracts. Both these types of conservation agreements are " ... contracts between a government authority, or NGO,[18] and landholder, and they prescribe terms and conditions under which the landholder agrees to manage their land" (Public Land Use Commission 1996, p.37). The size and shape of the area of land to which the contract applies is determined in the agreement. In both types of conservation agreements, ownership of the land remains with the landowner.

The duration of conservation agreements can be fixed-term or permanent. A fixed-term, legally-binding management agreement is established through negotiation between the landowner and an NGO or government agency. The terms of the

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[16] At the time this dissertation was commenced the PFRP was still in operation. Reference will thus be made to this program rather than the one that replaced it in 2006.

[17] Non-legally-binding management agreements also exist where the landowner is not required to enter into contractual arrangements to receive funding. Land for Wildlife is an example of a non-binding program which encourages and supports landholders to provide habitat for native plants and animals on their property (e.g. Department of Sustainability and Environment 2005).

[18] The agreement can also be between all three: landowner, government authority and a NGO.

agreement can only be altered with the agreement of all parties. The Private Forest Reserve Program in Tasmania offered temporary management agreements for periods up to 20 years.[19]

Covenants in perpetuity, also called permanent covenants, are developed in negotiation between the landowner and a government agency (or a government funded organisation). The document containing the covenant outlines the restrictions on the land and the management obligations and entitlements of the landowner (Binning and Young 1997). A management plan that sets out practical vegetation management actions is typically prepared in conjunction with a covenant. After the establishment of a covenant on title, the landowner may be able to access funds and/or assistance to achieve the vegetation management actions outlined in the management plan, such as technical assistance. The amount of technical advice and assistance available to landowners varies between covenanting scheme providers.

By 2005, protective conservation measures, including covenants, management agreements and operation plans, had been placed on 26,468 hectares comprising 180 properties under the PFRP. The program has paid an average of $536 per hectare to secure these covenants, which was then approximately one third of the estimated market price. In exceptional cases, where no other options exist to protect a forest type, properties were purchased at an average cost of $1,022 per hectare (Smith 2001). A total of 21 properties (5,453 hectares) had been purchased by the program at that time (Department of Primary Industries and Water n.d.).

Assistance and a range of incentives are provided by the Tasmanian Protected Areas on Private Land Program (PAPL) to place covenants or fixed-term management agreements on land. "PAPL is a joint initiative between the Natural Heritage Trust's National Reserve System, the Department of Primary Industries, Water and Environment, the Conservation of Freshwater Ecosystem Values Project, the Tasmanian Farmers and Graziers Association, and the Tasmanian Land Conservancy" (Department of Primary Industries and Water 2007). PAPL does not provide direct financial incentives in return for fixed-term conservation agreements, but does offer

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[19] A 30 year agreement of the Remnant Vegetation Protection Scheme is offered in Western Australia (Kabii 2004); a 20 year property agreement is offered under the *Native Vegetation Conservation Act* 1997 in New South Wales. The Queensland Vegetation Incentives Program, the Heritage Agreement Scheme in South Australia offer temporary management agreements for periods up to 20 years.

free technical advice, free drafting and registration of agreements. PAPL also assists in obtaining exemptions from State land tax for covenanted titles; and, in 15 of the State's 29 municipal areas, rate rebates for covenanted titles. Currently in Tasmania over 100 properties now have covenants established under PAPL (Jim Mulcahy, 2006, pers. comm.).

The development of management plans for Tasmanian properties is enabled through Private Forests Tasmania (PFT) as part of the property management planning process. PFT is a "government funded authority established to specifically promote, foster and assist the private forest sector to sustainably manage native forests and encourage the expansion of plantations" (Private Forests Tasmania 2006). The main focus of the program is forestry and plantation management but it has a limited provision for assistance in conservation matters. The program does not provide funds directly, but refers landowners to available programs in Tasmania.

Currently, no schemes provide funding to establish covenants and fixed-term management agreements on private land directly by municipal authorities in Tasmania. Fifteen out of 29 municipalities in Tasmania[20] offer rate rebates for land that is protected by means of a covenant or management agreement. In some municipalities, a developer may negotiate to set aside some area for nature conservation in exchange for rezoning or other concessions. Rezoning is often referred to as a bonus development right where the developer foregoes the ability to develop a portion of a site.

Another tool for local councils is the so-called Green Offset. This is a market-based tool underpinned by the premise that the negative impact of a development can be offset by a positive environmental action on, or nearby, the development site. The organisation or person who wants to undertake the development will have to pay for the offset to take place or pay someone else to undertake the environmental action (Environment Protection Authority 2002).

The placement of a management agreement or covenant over a parcel of land is sometimes a prerequisite for gaining access to other monetary benefits, rebates, or

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[20] These include: Burnie, Clarence, Devonport, George Town, Glamorgan/Spring Bay, Hobart, Huon Valley, Kentish, Kingborough, Latrobe, Launceston, Meander Valley, Sorell, Waratah/Wynyard, and West Tamar. Break O'Day had a scheme and cancelled it in April of 2005.

concessions. For instance, tax relief is provided to landowners on the proviso that land is protected by means of a covenant or management agreement.[21] Further, the landowner has access to subsidies and stewardship payments provided by all levels of government for the purpose of assisting the undertaking of further management actions on reserved land. For instance, PAPL monetary grants are available in some circumstances to assist with conservation works associated with conservation agreements (e.g. fencing). In some circumstances, entry into an agreement through PAPL may also attract priority assistance from other programs (Jim Mulcahy, 2006, pers. comm.).

The preceding discussion focussed on biodiversity conservation on private land through participation in a wide range of incentive schemes with different funding avenues. In the next chapter the literature concerned with the uptake of incentive programs and related conservation choice is reviewed.

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[21] The Federal Minister for the Environment and Heritage approved several covenanting programs for the purposes of the *Income Tax Assessment Act* 1997. In Tasmania the PFRP and PAPL were approved (Department of Environment and Water Resources 2006).

3 Literature review

The previous chapter reviewed the incentive programs available to Australian landowners to conserve biodiversity on private land. Landowners are encouraged to participate in various incentive programs to formally protect areas of conservation significance on their land. By making such schemes available, governments in Australia are aiming to increase landowner participation in conservation, thereby adding to currently existing areas of land set aside for biodiversity conservation. A better understanding of the decision framework surrounding the participation in incentive programs may help increase the total area of land set aside for biodiversity conservation in Australia.

An understanding of landowner participation can be gained through descriptive studies that look at, for instance, participation rates and areas managed sustainably (for instance in the annual reports of the former Private Forest Reserve Program in Tasmania; Vercoe 2003). Case studies can also provide an understanding of landowner behaviour. For instance, conservation auctions have provided information on the relationship between landowner participation and the level of compensation payment (Connor, Ward *et al.* 2007). Further, experimental economics can be used to understand landowner behaviour. This method was used to, for instance, test the efficacy of policy approaches and also to guide the " ... design of an on-ground trial of a recharge cap and trade scheme" (Connor Ward *et al.* n.d., p.1). In addition, more complex studies based on behavioural models, having their origins in different disciplines, can also be undertaken to develop a complete picture of the decision to participate.

In this chapter the literature related to incentive program uptake and conservation-related choice is reviewed. The focus of this review is on empirical studies carried out in the USA, Canada, Europe and Australia from the mid 1980s onwards and includes literature drawn from various disciplines. The review begins with an overview of biodiversity conservation by voluntary activity without receipt of financial assistance. This is followed by a review of the behavioural models used in economics to study participation in incentive programs: profit maximisation and utility maximisation. These sections give an overview of the empirical literature as it relates to the behavioural models. Four groups of variables that are commonly found to affect participation are described. The last section of this chapter reviews different econometric approaches used to analyse the decision to participate in incentive programs, focussing particularly on the latent class method used in this dissertation.

3.1 Voluntary conservation without participation in an incentive program

Biodiversity values on private land can be protected by means of participating in an incentive program. However, biodiversity values can also be protected by voluntary activity without receipt of any financial or other assistance from any government or privately funded programs. The motivation for voluntarism may be the so-called "warm-glow effect" it generates (Becker 1992), but may also be explained by, for instance, tradition, reputation, or the desire for recognition by a community (Economic Focus 1998). Additionally, the landowner's short-term as well as long-term self-interest may be to protect biodiversity (Gunningham and Young 2001).

Voluntarism is not necessarily inconsistent with economic theory, which traditionally assumes that *homo economicus* operates in the pursuit of rational self-interest. From the perspective of behavioural economics[22] it may be argued that self-interested individuals behave altruistically because they get some utility from doing so (e.g. Andreoni 1988, 1990).

Defining the characteristics of landowners who are likely to display voluntary behaviour is complex. Some studies have focussed on landowner experience as an important driver of voluntary behaviour. These studies have found that control and knowledge of the outcome of an action increases voluntarism (Slovic 1987; Kamppinen and Walls 1999). The more complex a system is believed to be, or the lower the level of knowledge about a system, the more cautious people are likely to be about change (Kamppinen 1997).

This finding is consistent with the success of education and awareness campaigns aimed at increasing the landowner's knowledge base which successfully increases

[22] "A branch of economics that concentrates on explaining the economic decisions people make in practice. Behavioural economists " ... seeks to use psychology to inform economics" (Camerer 1999, p.10575).

voluntary protection of biodiversity by landowners (e.g. Kaplan 1984; Scherer 1990; Schrader 1995; Gilfedder and Kirkpatrick 1997). Gunningham and Young (2001, p.4) emphasise that motivational instruments and mechanisms that develop a "custodial ethic" and "community norm" are fundamental to successful biodiversity conservation.

The literature concludes that if there is a gap between public interest in biodiversity conservation and the private interests of the landowner it will make it more difficult to rely on voluntarism alone to meet conservation targets (Gunningham and Young 2001). Biodiversity values may be lost in the future if the reliance to conserve was solely on voluntary implementation of conservation practices, making a case for a range of policy instruments to be used (Chapter 2).

3.2 Economic approach to studying landowner choice

The importance of understanding the decision making process with regard to participation in policy programs was recognised, for instance, by Brotherton (1989). This recognition led to a focus on the development of theoretical behavioural models in economics (e.g. Lynne, Shonkwiler *et al.* 1988; Beedell and Rehman 2000), psychology, and the other social sciences (e.g. Sinden and King 1990).

In economics, the development of models explaining the decision of whether or not to participate in incentive programs have been based on two different behavioural assumptions: profit maximisation and utility maximisation. While the theoretical basis of these two behavioural approaches is discussed in Chapter 4, the empirically based literature that applies these models is reviewed in this section.

In a profit maximising framework, the decision of a landowner to participate in a conservation incentive program is guided by maximising profit in a single period or over time. Parks and Schorr (1997) define the landowner's problem as maximising profit by choosing the optimum area of land to enrol in a program. This maximisation problem includes the option of selling the land.

Studies based on the profit maximisation framework clearly establish the link between participation rates and program funding amounts and the financial and resource constraints of landowners (Greiner, Herr *et al.* 2003). Plantinga, Alig *et al.* (2001)

also find that policy instruments that offset higher opportunity costs are more attractive and encourage participation.

In a utility maximising framework other objectives the landowner may have for their land, including non-economic motivations can be incorporated (Chapter 4). These non-economic motivations have traditionally mainly been the focus of other disciplines (e.g. Vanclay and Lawrence 1995; Schaberg, Holmes *et al.* 1999; Vanclay 2004). More recently, however, many economic studies have found that both land ownership and management are strongly related to these non-economic variables (e.g. Erickson, Ryan *et al.* 2002; Jennings and van Putten 2003). These variables, which are now recognised as potentially having a significant impact on management decisions and participation rates, cannot be easily encompassed in a strict profit maximising framework. In this context a utility maximisation framework is a less restrictive framework and will accommodate these non-economic variables (Lynne, Shonkwiler *et al.* 1988).

A sizable empirical literature in economics has been developed, particularly agricultural economics, that examines the impact of a range of landowner characteristics, property characteristics, and the business aspects of the farm operation, on participation in incentive schemes within the utility maximising framework. For instance, several models were developed to describe landowner participation in programs aimed at changing management practices, in particular soil management (e.g. Ervin and Ervin 1982; Esseks and Kraft 1986; Drost, Long *et al.* 1996).

Where the utility maximising approach has been applied to the incentive scheme participation decision four main groups of variables form the landowners' decision framework: program characteristics; landowner characteristics; property and business characteristics; and landowner attitude (e.g. Purvis, Hoehn *et al.* 1989; Cooper and Keim 1996).

The next sections review the literature that has investigated participation in incentive schemes from the perspective of one or more of these four groups of variables. Not all studies reviewed apply the utility maximising approach and some studies are from other disciplines, such as, psychology. The headings of the sections below reflect the variable group on which that section focuses.

3.3 Program characteristics

An incentive program may be characterised by a number of attributes, such as, funding amount, length of the commitment, and legal implications. A small number of studies has focused on the link between program attributes and landowner utility maximisation and the impact of the program attributes on the decision framework (e.g. Purvis, Hoehn *et al.* 1989; Cooper and Keim 1996).

Much of the literature linking the likelihood of participating in a scheme to the monetary rewards offered is based on findings from the soil conservation and management programs in the USA. These empirical studies confirm the relationship between the size of an inducement payment and the likelihood of participation. Farmers are found to be more likely to participate in a soil conservation program with higher payments for the implementation of a series of management actions (Purvis, Hoehn *et al.* 1989). This finding is confirmed by Cooper and Keim (1996) and Greiner, Herr *et al.* (2003) who found that the likelihood of implementing soil conservation practices increased with higher inducement payments. Lynch, Hardie *et al.* (2002) also found that installation of riparian buffer zones in Maryland in the USA increased with higher incentive payments.

Higher payments also increased participation in conservation reserve programs for highly erodable cropland in the USA (Esseks and Kraft 1986). Stevens, White *et al.* (2002) found that US landowners were guided by monetary motives and required 'realistic' levels of compensation in order for them to agree to participate in programs where they lose private rights such as access and timber rights (see also Chisholm and Dumsday 1988 in Australia).[23]

The positive relationship between higher payments and increased participation seems to be straightforward. However, there is little information on the shape of the curve describing this relationship. It is also unclear from the above studies whether there are any 'groups' for whom the response to higher payments varies, that is, who would not, under any circumstance, participate.

Several other program characteristics have also been found to impact on participation rates. Wynn, Crabtree *et al.* (2001), who studied the effect of participation in

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[23] The study finds that US landowners are very reluctant to loose these rights.

environmental schemes on farm income in Scotland, found that high compliance cost, which effectively reduces total farm income and effort required after joining the program, would both decrease the likelihood of participation.

Many studies also suggest that longer periods of commitment to a scheme had a significant negative impact on the uptake of a program (Esseks and Kraft 1986; Gasson and Hill 1990; Stevens, White *et al.* 2002; Horne 2004). The relationship between scheme duration and the likelihood of scheme participation was not found to be significant in a study in the UK by Wilson (1997).

Program flexibility, in particular allowing for easy succession planning for families, was also found to affect participation (Wilson 1997). Johnston, Swallow *et al.* (1999) found in a valuation study, which estimated citizens' willingness to pay (WTP) for a watershed management plan in the USA, that confidence in the payment mechanism as an efficient and guaranteed funding source had a significant positive impact on program uptake. Dedrick, Hall *et al.* (2000) found that landowner attitude towards the agency responsible for delivering the program also determined participation.

Horne (2004) examined the factors that affect the acceptability of biodiversity conservation and the amount of compensation needed in private forests in Finland. In this study it was found that the legal implications of joining a conservation incentive program had an impact on the acceptability of entering into a contract to protect biodiversity.

3.4 Landowner characteristics

Although only a small number of studies included program characteristics in their economic analysis (reviewed above), many studies have included the influence of socio-economic factors on landholder decision making and participation in incentive schemes. Wilson (1996), Drake, Bergström *et al.* (1999) and Greiner, Herr *et al.* (2003) all reported that socio-economic characteristics, such as age, education, and residency, were important in explaining farmer conservation behaviour and participation.

Younger people who were preoccupied with pursuing other activities were found less likely to participate in incentive schemes than older people by Steel (1996) and Lynch, Hardie *et al.* (2002) in the USA and Dupraz, Vanslembrouck *et al.* (2003) in

Europe. Higher education had a positive effect on likely participation in Europe (Wilson 1997; Dupraz, Vanslembrouck *et al.* 2003) and longer residency increased the willingness to enter an incentive program in Wales in the UK (Wilson 1997).

Landowner tenure has also been found to have an impact on the willingness to participate in incentive programs in a number of studies. For instance, landowners were associated with faster entry into programs in Scotland than those who rented their land (Wynn, Crabtree *et al.* 2001). Further, non-farmers were more likely to participate in erosion control programs than full-time farmers (e.g. Force and Bills 1989; Kraft, Lant *et al.* 1996), possibly because non-farmers were in a more favourable financial situation.

Mixed results were found in studies that included the effect of succession plans on participation in incentive programs. The intention to transfer a farm to a successor, thereby extended the planning period length to include the successor, may discourage a landowner from addressing an environmental issue by means of participating in a scheme. Long term planning horizons may tend to discourage landowners from incurring costs to address environmental issues in the short run. In contrast, Ervin and Ervin (1982) found that longer planning periods were associated with lower discount rates which are associated with making participation more attractive. However, Wynn, Crabtree *et al.* (2001) report that in Scotland, the presence of a successor to take over the farm did not have an impact on the likelihood of farmer participation in conservation schemes.

Landowner awareness of an environmental problem also has a significant impact on likely participation in incentive programs. Esseks and Kraft (1986) in the USA, and Sinden and King (1990) in Australia found that landowners who know of an environmental problem on their farm, were more likely to implement measures to control these problems on their property.

Landowner awareness of available incentive programs and the options provided by the programs, also impacted on participation. Landowners who did not participate in conservation incentive schemes were generally less aware of, and less informed about, available incentive schemes than those who participated. A history of prior participation in incentive schemes in Europe also significantly increased the likelihood of entry into another scheme (Drake, Bergström *et al.* 1999; Wynn, Crabtree *et al.* 2001).

Awareness of incentive schemes is frequently gained through neighbourhood networking. Networking increases the probability of participation in a program (Skerratt 1994 quoted in Wynn, Crabtree *et al.* 2001). Drake, Bergström *et al.* (1999) also found that participating neighbours and relatives had a positive influence on the likely participation of a landowner.

3.5 Property and business characteristics

Business and property characteristics that have been found to play a role in the decision framework include property size, agricultural use, income, and household debt. Landowners with larger farms in Europe were more likely to participate in environmental programs (Drake, Bergström *et al.* 1999; Dupraz, Vanslembrouck *et al.* 2003). Increased participation is likely to be due to economies of scale for larger farms in producing conservation benefits because fencing, for instance, can be carried out using existing infrastructure. Higher participation of larger farms may also be attributable to lower marginal utility of lost income.

An evaluation of the Environmentally Sensitive Area scheme (ESA) in the United Kingdom found that one of the main factors determining participation was the changes required to the land (Wynn, Crabtree *et al.* 2001). Where the scheme prescription fitted the farm situation better[24], the probability of participation in a scheme increased. If there were many changes required to the way the farm was being managed, it was likely to impact negatively on the decision to participate in an incentive program (Vanclay and Lawrence 1995; Drost, Long *et al.* 1996) as it was more costly to enter.

Similarly, Esseks and Kraft (1986) found that participation in a conservation reserve program in the USA was more likely when some grazing was allowed, suggesting that this would allow landowners to continue their current practices relatively unaltered, thus making it less costly. A report prepared by Gilfedder and Kirkpatrick (1995)

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[24] This can also be interpreted as the attribute of a scheme (section 3.3). However it is presented in this section as the focus is on changes to existing property characteristics.

indicated that higher participation rates in Tasmania were likely when the landowner was paid for changing management practices while maintaining some productive capacity of the land.

The role of off-farm income has been found to have two potential effects on participation in incentive schemes: it may reflect the availability of additional funds (Loftus and Kraft 2003); and, on the other hand, it may reflect the need of the family to have additional income to cover living expenses (e.g. Tisdell and Harrison 1999). Farmers in the USA who were less reliant on farm income were found to be more likely to participate in a conservation reserve program (Loftus and Kraft 2003). Farmers, whose primary income source was from farming, who anticipated production losses, and hence lower farm income, from conserving biodiversity by setting aside forested areas were less likely to participate in incentive programs in Australia (Tisdell and Harrison 1999).

Landowners with larger farm debt, and who depended on farming for their income, were less likely to participate in incentive schemes or to implement conservation actions (Loftus and Kraft 2003). The authors speculated that these landowners may not have been financially able to incur what was perceived to be the high opportunity cost of setting aside productive areas of their property. Farmers with high debt levels may be forced to place greater weight on financial returns, which may not include conservation.

Force and Bills (1989) indicate that opportunity costs explained much of the participation in the soil conservation scheme in New York State. Landowners who were reliant on the income obtained from farming only, were less likely to participate in incentive programs. Landowners with fewer financial constraints were also more likely to join an incentive program (Gasson and Potter 1988).

The studies reviewed thus far found that a range of program characteristics, landowner characteristics, and property and business characteristics impacted on the decision to participate in an incentive program. The utility maximisation approach (discussed in detail in Chapter 4) also accommodates a range of non-economic motivations, including attitudes to environmental issues and conservation. The behavioural foundation for the role of attitudes in decision making originates in psychology (discussed in detail in Chapter 4). The ability to 'measure' attitudes allows them to be incorporated into an economic model. The effect of attitudes on participation is the subject of the next section.

3.6 Landowner attitudes

Attitudes[25] have been found to play a significant role in decision making processes. In this context, a number of studies have related environmental attitudes to the choice of participation in incentive programs aimed at conservation. Other studies that have incorporated a variable for attitude in landowner decision models have generally based this variable on the measurement of an individual's pro-environmental or anti-environmental attitude or belief (e.g. Aldrich *et al.* 2005). The measurement of environmental attitude was operationalised by Dunlap and van Liere (1978). Studies that incorporate environmental attitudes frequently measured these attitudes using Likert (1932) scale rating systems applied to questions that weigh the value of nature versus economic growth (Corbett 2002).

Klosowski, Stevens *et al.* (2001) established that those landholders who participated in incentive programs had a more favourable attitude towards the environment. Luzar and Diagne (1999) and Drake, Bergström *et al.* (1999) also found that their results supported the hypothesis that landowners with a positive environmental attitude were more likely to participate in reserve programs. In Europe Dupraz, Vanslembrouck *et al.* (2003) found that attitudinal characteristics towards the environment strongly affected participation in different agri-environmental schemes. Gasson and Potter (1988) in the UK found that farmers' responses to incentives were dependent on their attitude to conservation.

A variety of papers have examined the influence of attitude on conservation behaviour. For example, Söderqvist (2003) found that a landowner with a positive environmental attitude was guided by the feeling of 'doing some good for the larger community' and concluded that the relevance of the "public environmental benefits were a rather important motive for farmer participation" in incentive programs (Söderqvist 2003, p. 117). Lynne, Shonkwiler *et al.* (1988) also found that stronger conservation attitudes raised voluntary conservation effort in the USA and concluded

[25] Attitudes are learned stable psychological tendencies to evaluate particular entities with favour or disfavour.

that this may reduce the need for net incoming-enhancing programs. Wynn, Crabtree *et al.* (2001) found that landowner attitude to conservation explained early entry into conservation schemes (timing) but did not impact on the probability of entry. The link between attitude and entry into a program is also questioned by Vanclay and Lawrence (1995) who indicated that landowner behaviour may change due to intervening factors, such as financial opportunity, even if the attitude remained the same.

As the literature discussed so far suggests, the participation decision is expected to depend on a number of variables that can be loosely classified as program characteristics, landowner characteristics, property and business characteristics, and landowner attitude.

As mentioned in Section 3.3, the attributes of an incentive program are expected to play a role in a landowner's decision to participate in a program. The Choice survey approach gathers data in a way that allows the measurement of the contribution of different attributes of a good or service, or in this case incentive program, to the choice. A brief review of the choice modelling literature, in particular environmental choice modelling, is given below.

3.7 Choice survey

The choice modelling approach investigates "... people's willingness to give up some amount of an attribute[26] in order to achieve more of another" (Bennett 1999, p.3). Variation in the level of the environmental alternatives and an associated cost with at least one of the attributes means that the marginal rate of substitution of the attributes can be found or can be used to derive implicit prices or to develop welfare measures (Bennett 1999).

Choice modelling was first used in a marketing context (e.g. Wittink and Cattin 1989; Farber and Griner 2000) to elicit responses to goods and services with various potential combinations of attributes (e.g. Earnhart 2002 in the context of housing decisions). The choice technique was later used to assess the dollar value of goods,

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[26] An attribute is the description of the environment/product/service (for example the colour *red* is the attribute of a *car* which is the product).

such as environmental goods, that are often not traded in a market. More recently choice modelling has been used to investigate equity preferences in benefit cost analyses (Scarborough, Bennett *et al.* 2004), to value recreation, transport, health, and in the context of cultural valuation. The question of allocating funds to policy programs so that welfare is maximised can be addressed by measuring the effect of different policies and estimating the change in utility between different groups in society.

Rolfe, Bennett *et al.* (2000, p.i) used a choice experiment to " ... estimate the values held by Brisbane residents for both environmental and social factors associated with tree clearing in the Desert Uplands region of central-western Queensland". Mallawaarchchi, Blamey *et al.* (2001) examined placing a value on the protection of natural vegetation in areas suitable for cane production. Whitten and Bennett (2001) identified the non-market value of wetlands in the southeast and eastern region of Australia. The value of watershed quality improvements was investigated by Farber and Griner (2000) in the USA. A paper by Kerr and Sharp (2004) used choice modelling to estimate the types and scale of mitigation that were acceptable to local communities in New Zealand to compensate for adverse environmental effects in streams from development projects. Choice modelling was also used to assess the value of amenities and quality improvement of recreation locations by Schroeder and Louviere (1999) and Hearne and Salinas (2002) in Costa Rica. The latter study demonstrated that in general tourists preferred improving infrastructure, information, and low entrance fees. Tourists from outside the country preferred restrictions in the access to some trails and had a higher marginal willingness-to-pay for information.

Choice modelling has been used to estimate cultural values and trade-offs. Rolfe and Windle (2003) estimated the non-use value of protecting cultural heritage sites in relation to further water allocations to irrigation. Cultural values for large increases in protected areas, as estimated by non-indigenous groups, were lower than for aboriginal people. However, non-indigenous groups held positive values for small increases of protected cultural heritage site. A similar study was carried out by Windle and Rolfe (2002) that looked at the values held by aboriginal people and other groups in society on floodplain development. Again, differences between the way non-indigenous people and indigenous people value water were evident. The general community was more concerned about environmental issues than additional protection of cultural heritage sites.

Choice modelling has been used in the medical and health care sectors eliciting non-use value for several health related issues. For instance, Scott, Watson *et al.* (2003) used choice modelling to determine patient preferences for 'out of hours' care. Farrara, Ryana *et al.* (2000) showed that choice modelling was useful within the area of health care priority setting to estimate cost per unit of benefit ratios for competing clinical service developments.

Very few studies have applied choice modelling to study preferences for the attributes of policy instruments. Conjoint analysis[27] was used in a policy context to " ... examine landholder attitude toward specific management program attributes and requirements" by Stevens, White *et al.* (2002, p.169). The study found that US landowners were reluctant to lose private rights such as access and timber rights and would not participate in incentive programs without realistic levels of compensation of between US$ 53 and US$ 185 per hectare per year.

A study by Horne (2004) carried out in Finland was the only study at the time of writing that used choice modelling for a decision problem similar to that of this research. Horne (2004, p.3) examined factors that affect the "acceptability of voluntary contracts of biodiversity in non-industrial private forests and the amount of compensation needed". If the forest owner is the initiator of the contract, an average compensation of 224 euro per hectare would be needed to protect small areas of forest for 10 years.

An overview of the econometric modelling methods that were used in the literature is presented in the next section. The econometric methods include logit, probit, multinomial logit models, tobit models, and latent class analysis. The latent class analysis is used in this current research.

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[27] Conjoint analysis is a statistical technique used to determine how people value different attributes of a product. Utilities of different levels of an attribute can be calculated on the basis of listing the combinations of product attributes in order of decreasing preference (Lilien and Kotler 1983).

3.8 Econometric modelling approaches

The decision to participate in an incentive program is a binary choice (yes/no or 1/0) and as such the dependent variable is a discrete outcome. In the logit and probit approaches the dependent variable is discrete. These models are collectively also known as qualitative response models (Green 2003). The goal of the models is to quantify the relationship between the independent variables (such as socio-economic and business characteristics) and the probability of joining a program. Logit models are most often used to analyse participation in incentive programs aimed at changing management that benefits environmental and conservation outcomes.

A logit model was used by Wynn, Crabtree *et al.* (2001) to predict the probability of entry into a scheme aimed at changing land management practices. The dependent variables in their model were related to landowner and property characteristics. Drake, Bergström *et al.* (1999) used the logit model to explain participation in an agri-environment scheme. They also used socio-economic variables as the independent variables. In Australia, a logit model was applied to investigate the adoption of soil conservation measures in New South Wales by Sinden and King (1990). The independent variables in their study included the adoption process, land factors, personal factors, economic factors, and institutional factors.

Söderqvist (2003) applied a logit analysis to investigate the determinants of Swedish landowners' willingness to participate in a wetland creation program, including observable and non-observable landowner characteristics and attitudes. Stevens, White *et al.* (2002) applied a logit model including socio-economic and program characteristics (including funding amount), and attitude variables to predict participation in a forest management program. A logit model was applied by Force and Bills (1989) to examine participation rates in a conservation reserve program in New York. They included socio-economic as well as attitudinal variables in their model.

A study by Klosowski, Stevens *et al.* (2001) applied a logit model to estimate the effects of the economic incentives offered by a hypothetical scheme on the likelihood of participation.[28] This study particularly focussed on the probability of coordinated

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[28] The results were compared to those obtained using OLS regression.

management between landowners and included attitudinal variables. Esseks and Kraft (1986) used a logit regression to determine whether changes to incentive scheme characteristics in southern Illinois would change likely participation.

In addition, Soule, Tegene *et al.* (2000) used a probit model to analyse the influence of land tenure on the adoption of conservation practices. Cooper and Keim (1996) used a probit model to predict farmer adoption of environmentally sound practice as a function of the payment offer. The predictive powers of the logit and probit specifications are generally comparable, but the higher computational demands of the probit model and the generally weak theoretical justification for employing a probit specification limits practical use of this model. This means that the logit model is more widely used in empirical work (Greene 2003).

The logit and probit models are used in the context of binary choice models. If these models are generalised to more than two alternatives they are referred to as multinomial logit models. Multinomial logit models are frequently used in studies that gather decision data using a choice modelling approach. A study by Horne (2004) in Finland applied a multinomial logit model to predict participation in a conservation incentive program. Horne's (2004) study incorporated independent variables related to landowner, property, and incentive program characteristics.

An early study by Purvis Hoehn *et al.* (1989) applied a tobit model to estimate the participation in a filter strip program. In tobit models the dependent variable is continuous instead of discrete, which allowed participation rates to be estimated. The independent variables included payment level, transaction cost, and future expectations and preferences as independent variables. Tobit models are a direct extension of the logit/probit models. Tobit models relate to both quantity and probability, frequently referred to as joint decisions models (Green 2003).

Another approach to analysing choice data that characterises heterogeneity in preferences for program attributes on the basis of attitude and socio-economic characteristics is the latent class approach. In this approach classes of individuals are assumed to be homogenous with respect to their preferences for alternatives as well as their sensitivity to changes in the levels of the attributes of the alternatives (Lee, Fujiwara *et al.* 2003).

No previous study has used the latent class approach to incentive program choice as is applied in this dissertation. The development of latent class models and their application to date is reviewed below. The latent class model is specified in Section 5.1.

3.8.1 Latent class models

The development of latent class models using empirical data is common in many disciplines including the health sciences (e.g. Bucholz *et al.* 1996; Sullivan, Kessler *et al.* 1998; Thatcher, Morey *et al.* 2003), social sciences (e.g. McCutcheon 1987; Yamaguchi 2000), marketing (e.g. Swait 1994), and in travel behaviour research (e.g. Lee, Fujiwara *et al.* 2003). The latent class approach has also been applied in a study by Bijmolt, Paas *et al.* (2003) to analyse country and consumer segmentation in Europe with respect to financial product ownership.

A limited number of studies has developed latent class models of environmental economic preferences (e.g. Boxall and Adamowicz 2002, Morey, Thatcher *et al.* 2006, Scarpa and Thiene 2004). The models in these studies are estimated with the intention of identifying and characterising heterogeneity in environmental preference data. Boxall and Adamowicz (2002) applied the latent class approach to wilderness park choice data. They developed a model of wilderness recreation demand for five wilderness parks in Canada incorporating attitudinal measures and stated preferences over wilderness park attributes. The results showed that four classes of recreationists exist. Morey, Thatcher *et al.* (2006) developed a latent class model characterising angler heterogeneity with respect to fishing characteristics of Green Bay in Wisconsin, USA. The results of this study suggest that "Green Bay anglers separate into a small number of distinct classes with varying preferences and willingness to pay for a PCB-free Green Bay" (Morey, Thatcher *et al.* 2006, p. 91). Scarpa and Thiene (2004) used the latent class approach to model the destination choice of rock climbers in the northeast Alps of Italy. Their study revealed four 'well defined classes' on the basis of climber preference for alpine climbing destination attributes. Unlike the previous two latent class studies, this study did not incorporate an attitude or motivation variable in the model.

In the current research the latent class modelling approach is applied to landowners' choice of conservation incentive programs incorporating landowner attitude and socio economic characteristics. The rationale for using the latent class approach is that it is expected that landowner heterogeneity is reflected in their preferences for incentive programs attributes. Understanding landowner heterogeneity is particularly important from a policy perspective. Understanding landowner heterogeneity would enable better targeting of incentive programs and can potentially help prepare managers for unintended consequences of some programs. It would also enable a better understanding of the distributional consequences of landuse policy and programs.

Some economic models account for heterogeneity by including socio-economic variables in the utility function or by stratifying individuals into segments on the basis of socio-economic variables. While these models 'account' for preference heterogeneity they do not adequately 'explain' the source of it, where heterogeneity may reflect other characteristics of individuals such as the motivation, attitude, and past experiences (Boxall and Adamowicz 2002).

To adequately explain heterogeneity in demand analysis " ... there must be *a priori* knowledge of the element of heterogeneity" (Boxall and Adamowicz 2002, p.422). The latent class approach has advantages in explaining heterogeneity by constructing classes on the basis of observed measures such as attitude scales. Latent class models enhance the explanation of heterogeneity by incorporating unobserved heterogeneity and by adding structure to the distribution of unobserved heterogeneity.

The latent class approach has not previously been applied in the type of study central to this research. The latent class choice modelling approach is discussed in detail in Chapter 5. Prior to this, Chapter 4 presents the theoretical foundations of the economic and psychological models used in this research. The use of choice modelling in the context of the theoretical approach is also discussed.

4 Theoretical framework

Chapter 2 described the ways in which the market for biodiversity on private land in Australia fails to provide a socially optimal outcome. One of the ways in which government addresses this market failure is through the provision of incentive programs that make available funding for the protection of biodiversity. Convincing landowners to set areas aside for conservation is paramount if adequate protection is to be achieved through voluntary measures. Understanding the decision framework of landowners who own and manage land of conservation values is important to ensure adequate numbers enrol in the available schemes (Chapter 3). Moreover, it is important to understand landowner preferences in a scenario where entry is forced if voluntary measures do not adequately achieve conservation targets.

In Section 4.1 the economic theory and behavioural foundation of land use decisions by landowners is explored. The data used to build an empirical model describing landowner preferences for incentive program attributes are gathered in this research using a Stated Preference (SP) method called choice modelling. In Section 4.1.1, the behavioural foundation, based in the field of psychology, which underpins the use of the SP technique, is briefly explored. The SP choice modelling approach also has its roots in two distinct areas of economic theory: Random Utility Theory (RUT); and Lancaster consumer theory. In Sections 4.2 and 4.3 the latter two theories are discussed. Choice modelling is also founded in decision making theory developed in psychology discussed in Section 4.4. Chapter 5 presents the model estimation method and the statistical analysis used in this current research.

4.1 Economic theory and behavioural foundation

In economics the two most common approaches to studying landowner decision making are profit maximisation and utility maximisation (Chapter 3). Utility maximisation forms the basis of neoclassical theory of consumption. Standard consumer choice theory develops models that analyse a range of choice problems. In these models consumers are assumed to optimise their utility subject to budget constraints and other factors. Consumers are assumed to be rational decision makers who assign preferences to different bundles of goods and will choose the preferred alternative. If a consumer has stable preferences then a consistent pattern of choice emerges. Utility can explain economic behaviour in terms of individuals aiming to increase, or maximise their utility.

In this current research the landowner's decision to set aside a parcel of land for conservation is considered in the utility maximising framework. A landowner will conserve biodiversity values if the overall utility obtained from setting the land aside is greater than the utility of the status quo. From micro economic theory it follows that each individual chooses alternatives that maximise utility subject to budget constraints and other factors.

In the literature reviewed in Chapter 3 the variables that contribute to the decision to protect land for conservation purposes were explored. Schematically this decision framework is described in Figure 3.

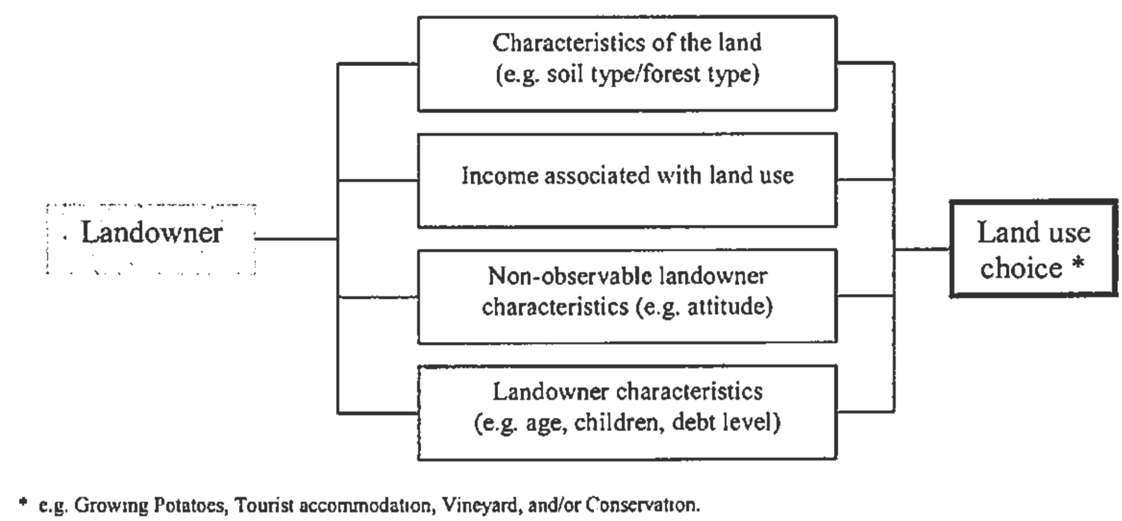

Figure 3: Groups of variables included in a landholder's land use decision framework.

As shown in Figure 3 above the landowners' land use decision framework is made up of four groups of variables which are income, property characteristics, socio economic characteristics of the landowner, and landowner attitudes.[29] The variables that make up the groups are likely to have varying impact on the land use choice. Some interaction between variables may also be expected. For example, property

[29] Although there is no general agreement in the psychology literature upon what the term attitude denotes, most psychological definitions includes statements about an underlying state of mind or a feeling or disposition to behave in a certain way (e.g. Strauss 1945).

characteristics are expected to impact on income because soil types partly determine and limit production options. Landowner characteristics such as age or life stage may also impact on the land use choice, and thus on, for instance, conservation management activities. The land use choice for a parcel of land change to conservation only if the overall utility obtained from conserving the land is greater than the status quo, assuming the land is not already conserved.

In the literature reviewed in Chapter 3 the attributes of an incentive program were reported to have an affect on landowner participation in conservation incentive programs and thus, ultimately, on the landowner's land use decision. Program attributes included not only the subsidies received (hereafter referred to as compensation funding) but also, for instance, the legal implications and land use restrictions imposed by the incentive program.

The choice modelling approach is used in this current research to analyse choice behavior with respect to joining incentive programs. The data used to estimate landowner preferences for attributes of incentive programs are gathered using a Choice Survey. Choice modelling is one of a number of SP techniques used in the valuation of environmental goods. Others are, for instance, Contingent Valuation (CV), contingent rating, contingent ranking, and paired comparison (Morrison, Blamey *et al.* 1996). The behavioural assumptions that underlie SP techniques have their origins in psychology.

4.1.1 Behavioural foundation of the Stated Preference technique

Adamowicz, Louviere *et al.* (1998) note that SP techniques were developed as a natural analogue to the "... already well established Revealed Preference (RP) method" (p.7). RP techniques, which includes the travel cost method, hedonic pricing, and the averting behaviour methods, are also commonly used to assess environmental use and non-use values (Morrison, Blamey *et al.* 1996). The RP technique was not used in this research as this type of information was not available from previously defined programs.

The SP approach gathers data by asking subjects to make choices between hypothetical situations. The SP technique generates behavioural data from subject choices, but is in itself not a theory of behaviour (Adamowicz, Louviere *et al.* 1998).

Consumer choice theory and econometric modelling techniques are applied to data gathered by means of SP techniques.

As mentioned previously, choice modelling is a SP technique. In choice modelling, respondents choose the most appealing/best/most important of two or more goods or services described by a number of attributes (sometimes also referred to as characteristics in the literature). The choice modelling approach elicits choices between different combinations and varying levels of the attributes describing a good. The marginal rate of substitution between pairs of attributes can be found using choice modelling (Bennett 1999) and implicit prices or welfare measures can be estimated.

The behavioral assumptions that underlie SP techniques, which are as such relevant to choice modelling, were developed by Thurstone (1927, 1959) and originate in psychology. The behavioral model that underlies the *paired comparisons* format posits that people are able to compare two states of being and determine what is, for example, 'best – worst', 'less preferred – more preferred', or 'most - least important' (Thurstone 1927). Later, Thurstone (1959) developed the behavioral assumption that supports the premise that people are able to make *comparative judgments*. Thurstone's models posit that people are able to choose between two extremes out of sets of three or more (Louviere 1994; Buckley, Devinney *et al.* 2004).

4.2 Random Utility Theory

The behavioural theory at the foundation of SP is consistent with random utility theory (RUT). It is consistent with utility maximisation as a conceptual economic framework (Adamowicz, Louviere *et al.* 1998). The behaviour of respondents can be forecast from an estimated utility function, which, in microeconomic theory is assumed to be coherent and invariant (Fujii and Gärling 2003).

RUT is used to estimate the probability of choice. To estimate these probabilities the utility (*U*) that individual (*n*) receives from choosing alternative (*i*) can be represented by equation 1. Variations in consumer choice can be explained by including a random element in the utility function (following the presentation of Adamowicz, Louviere *et al.* (1998), Boxall and Adamowicz (2002) and Walker and Ben-Akiva (2002)).

$$U_{ni} = V_{ni} + \varepsilon_{ni} \qquad (1)$$

U_{ni} = Unobserved utility of consumer *n* from alternative *i*

V_{ni} = Observable component of utility of consumer *n* from alternative *i*

ε_{ni} = Random unobserved component of utility of consumer *n* from alternative *i*

The observable component of utility is a vector of factors that affect consumer *n*'s utility, including choice-specific or individual-specific factors. The systematic component of utility that specifies the relationship between the explanatory variables (*X*) and choice behaviour can be written as follows:

$$V_{ni} = \alpha_{ni} + \beta X_{ni} \tag{2}$$

Where β is a vector of utility coefficients and α is the Alternative Specific Constant (ASC). The systematic component of utility can be identified, and the parameters estimated, by determining how choice varies with different levels of attributes and differences in individual decision makers (Adamowicz, Louviere *et al.* 1998). Due to the presence of a random component in the utility function, probabilistic statements about consumer behaviour can be made.

In the decision to join a conservation incentive program a landowner (*n*) chooses from a finite set of incentive programs (*C*). Following Boxall and Adamowicz (2002) the probability (π) that program *i* will be chosen (equation 4) is equal to the probability that the utility gained from program *i* is greater or equal to the utilities of choosing another program, *k* in *C*.

$$\pi_n(i) = \Pr ob\{V_{ni} + \varepsilon_{ni} \geq V_{nk} + \varepsilon_{nk}; i \neq k, \forall k \in C\} \tag{3}$$

Different assumptions about the random term give rise to different probabilistic models. If errors are assumed to be distributed according to a bivariate normal distribution, a binary choice model can be specified (Thurstone 1927), which can be generalised to a multivariate case with a multivariate probit model. Type I extreme value (Gumbell) distributions[30] yield the conditional or multinomial logit model (McFadden 1974). A generalised extreme value distribution gives rise to the nested

[30] The 'three types theorem' by Fisher and Tippet asserts that there are only three types of distribution which can arise as limiting distributions of extreme values in random samples. In probability theory and statistics the Gumbel distribution is used to find the minimum (or the maximum) of a number of samples of various distributions. These distributions could be of the normal or exponential type

multinomial model (McFadden 1981). The standard assumption in RUT has been that the error terms are Independently and Identically Distributed (IID) following the type I extreme value distributions.

Many economic models assume homogenous preferences. A conditional logit model, with a Gumbel distribution of the error term, can be used to estimate the probabilities where preferences are homogenous (McFadden 1981). When the attributes associated with each choice are substituted into V the choice probability is given by equation 4.

$$\pi_n(i) = \frac{\exp(\mu\beta X_i)}{\sum_{k\in C}\exp(\mu\beta X_k)} \tag{4}$$

Where β is a vector of estimated parameters, not specific to n, and μ is a scale parameter assumed equal to 1 when the model is not segment specific (Boxall and Adamowicz 2002).

Lancaster consumer theory (discussed in the next section) gives rise to the idea that utility is obtained from the attributes of a good, in this case, the attributes of incentive programs.

4.3 Lancaster consumer theory

In the neoclassical tradition, utility models can be developed that analyse a range of choice problems. For each of these choice problems there are trade-offs between a range of alternatives. One branch of economic literature indicates that the attributes of a good determine the utility obtained from that good (Praag 1968). Lancaster's approach to consumer behavior gives rise to the idea that a good as such is not the ultimate object desired by consumers but rather that consumers demand the attributes which the good possesses (Lancaster 1971). Any good possesses an enormous number of these attributes, for instance, size, shape, colour, smell, and so on.

Lancaster's consumer theory poses that the utility of a good or service can be decomposed into separate utilities for the attributes of that good. The overall utility contributes to the choice of that good or service (Lancaster 1971).

Central to Lancaster's theory are the following observations (Lancaster 1991, p.13):

1. "The good *per se*, does not give utility to the consumer, it possesses characteristics, and those characteristics give rise to utility;

2. In general, a good will possess more than one characteristic, and many characteristics will be shared by more than one good; and

3. Goods in combination may possess characteristics different from those pertaining to the goods separately".

Lancaster theory helps understand how the utility of a conservation incentive program can in fact be broken down into separate utilities for attributes of the program. The attributes of an incentive program are expected to have an effect on landowner choice of program. One such attribute is, for instance, the size of the compensation payment. In the tradition of Lancaster in the current research, a landowner maximises utility by their choice of incentive program characterised by a *bundle* of program attributes.

The actual theory that underpins the ability of an individual to make choices between bundles of attributes was based in psychology (Section 4.1.1). Theory on information processing and judgement in decision-making, which is also based in psychology, helps to understand how choices are made. Of particular interest in this context is the role of attitudes, which is the subject of the next section.

4.4 Theory of planned behavior

Both economic theory and psychology are concerned with behaviour and decision making. Findings that originate in psychology can help to understand how and why people make choices. One field of psychology which developed in parallel to economics focuses on the relationship between the environment and behaviour. Psychological theory states that the decision making process that underlies choice behaviour is "informed by perceptions[31] and beliefs based on available information, and influenced by affect[32], attitudes, motives[33], and preferences[34]" (Ben-Akiva, McFadden *et al.* 1999, p.188).

The Theory of Planned Behaviour (TPB) (Ajzen 2001) is the psychological model most often used by economists to link attitudes to the prediction of behaviour. The

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[31] Perception is the cognition of sensation.

[32] Affect is the emotional state of the decision maker and its impact on cognition of the decision task.

[33] Motives are drives directed towards perceived goals.

[34] Preferences are comparative judgements between entities.

TPB "attempts to predict and understand behaviour by measuring the underlying determinants of that behaviour" (Beedell and Rehman 1999, p.174).

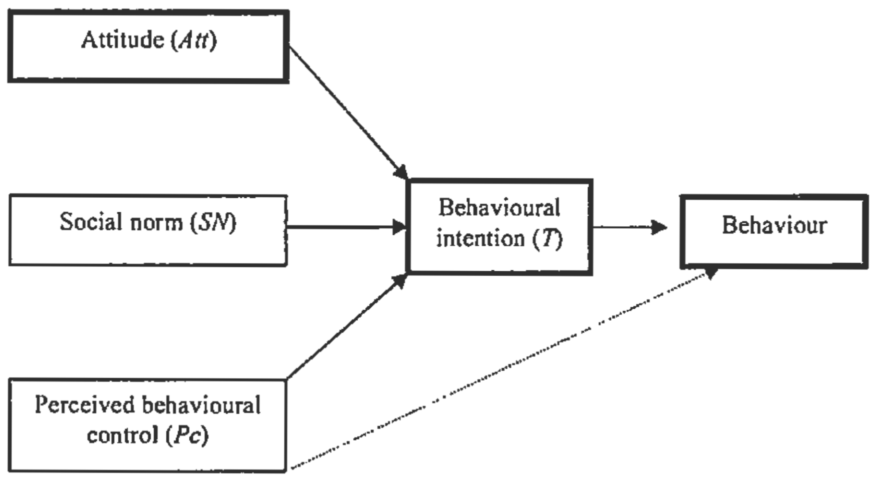

Figure 4: The theory of planned behaviour (adapted from Beedell and Rehman 1999)

An individual's attitude (*Att*) toward an issue and the perception of what others in society want, the Social Norm (*SN*), as well as other socio-economic characteristics will lead to behavioural intention. The behavioural intention is also affected by the landowner's perception of how easy or difficult it is to carry out the behaviour (*Pc*).

More formally the relationship between behavioural intention, attitude and social norm can be specified as (adapted from Luzar and Diagne 1999):

$$T = w_{Att} Att + w_{SN} SN + w_{Pc} Pc \qquad (5)$$

Where (*T*) is the intention to perform a behaviour, which is related to the attitude toward performing the behaviour and the social norm for performing the behaviour. The weights (*w*) are empirically determined. The strength of the intention is closely associated with the cause of the behaviour. Attitudes are empirically measurable, in an indirect way. To say that an individual has a strong attitude towards an activity is another way of stating that they gain a large amount of utility from an action (Lynne, Shonkwiler *et al.* 1988).

There is some debate regarding the relative strength of intention and attitude on behaviour. Gärling, Gillholm *et al.* (1998) reported that the correlation between intention and behaviour was greater than between attitude and behaviour and measuring relative intention improved the prediction of behaviour. Despite the lack of consensus on the relative importance of attitudes in the process of decision making, it is acknowledged they play a role in behaviour.

The field of environmental psychology explores the relationship between environmental attitude and behaviour. Kaiser, Wölfing *et al.* (1999) report that in 1999, more than 1,400 publications in the field of psychology dealt with environmental problems. Of these, more than one third dealt with ecological behaviour of which more than one third (153 papers) related environmental attitude to ecological behaviour.

Environmental attitudes are commonly divided into three main groups: egoistic (egocentric), social-altruistic (or anthropocentric), and biocentric (or ecocentric[35]) (Stern and Dietz 1994; Merchant 1992 quoted in Schultz and Zelezny 1999; Ruijgrok, Vellinga *et al.* 1999). Studies have found that individuals who held more ecocentric attitudes tended to be more supportive of protection-oriented management. Anthropocentric individuals were more likely to support resource extraction strategies (McFarlane and Boxall 2003).

There may be some interaction between environmental attitudes and socio-economic variables which impacts on behaviour. For instance, women are perceived to have more strongly held views towards environmental protection than males. Environmental attitudes are also positively related to higher income and the attainment of higher education levels (Stern and Dietz 1994; Steel 1996). The potential interaction between environmental attitudes and other variables leads both Kaiser, Wölfing *et al.* (1999) and Steel (1996) to the conclusion that the direct relationship between environmental attitude and behaviour is tenuous. However, in a robust analysis these interactions would be identified.

Some of the literature reviewed in Chapter 3 which looked at participation in incentive programs (e.g. Drake, Bergström *et al.* 1999; Stevens, White *et al.* 2002; Söderqvist 2003) and setting aside land for conservation (e.g. Force and Bills 1989;

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[35] Dunlap and van Liere (1978) and Fransson and Garling (1999) argue that the New Environmental Paradigm (NEP) constitutes another environmental attitude in which humans perceive themselves as an integral part of nature. The NEP incorporates the relatively new the concepts of 'limits to growth' and 'spaceship earth'. Although some may argue that these concepts are also inherent to the bio- or ecocentric attitude.

Klosowski, Stevens *et al.* 2001), included environmental attitude variables in a utility maximisation framework. The role of environmental attitudes in predicting participation in incentive schemes was significant in all the above studies.

In the current research attitudes were also evaluated and included as a variable in the decision model. The description of attitude used here is different to that defined in the above cited studies. In this current research it is assumed that a landowner's belief about the impact and outcome of establishing reserves on their land reflects their attitude. This approach was taken because extension programs tend to focus on changing 'attitudes' by providing information that affects people's evaluation of outcomes of reserve establishment. Thus, outcome evaluation of reserve establishment influences behaviour and reflects landowner attitudes.

As discussed in the preceding sections, the RUT approach can be used to investigate a landowner's decision to set aside land for conservation. The utility maximisation framework allows the incorporation of socio-economic and attitude variables to explain the decision. The TPB underpins the inclusion of attitudes as a separate explanatory variable in the utility maximisation model.

The next chapter presents the econometric approach (Section 5.1 and 5.1.1) used to model choice data gathered in this research and the statistical method (Section 5.1.2) used to analyse the data. The statistical methods used to analyse attitude data gathered as part of the same survey is presented in Section 5.2. The statistical method used to analyse the Best-Worst survey data, which was gathered prior to the Choice survey, is also presented (Section 5.3).

5 Estimation methods and statistical analysis

As mentioned in Section 4.2, many economic models assumc homogenous preferences. The probabilities for models with homogeneous preferences are estimated using, for instance, the conditional logit model (equation 4). However, the assumption of preference homogeneity is often not appropriate. For instance, landowner heterogeneity as reflected in preferences for incentive program attributes is to be expected. Some economic models have accounted for heterogeneity by including socio-economic variables in the utility function or by stratifying individuals into segments on the basis of socio-economic variables. Other studies have accounted for heterogeneity by following a two-step modelling procedure (e.g. Söderqvist 2003; Horne 2004). In a two-step model cluster analysis is used to divide individuals into groups on the basis of their stated attitudes. The second step is then to apply a logit or multinomial logit approach to each of the groups.

These models 'account' for preference heterogeneity but do not adequately 'explain' its source, where heterogeneity may reflect other characteristics of individuals such as their motivations, attitudes, and past experiences (Boxall and Adamowicz 2002). The latent class approach (also referred to as the finite mixture approach) discussed in the section below, can account for heterogeneity. [36]

5.1 Latent class model

To account for heterogeneity in choice analysis " ... there must be *a priori* knowledge of the element of heterogeneity" (Boxall and Adamowicz 2002, p.422). The latent class approach accounts for heterogeneity by constructing classes on the basis of observed measures such as attitude scales. In constructing these classes socio-economic characteristics can also be included as covariates.

The inclusion of attitudes in the preference function has generated some discussion in the literature (e.g. Provencher & Moore 2006). The discussion centres around two criticisms. The first criticism relates to the value of including attitudes in terms of explaining a choice situation. Provencer & Moore (2006) argued that some 'common

[36] The latent class approach will be compared to the two-step method in section 8.4.4.

sense' interpretation of latent classes would make attitudinal scales redundant for purposes of resource management. However, it is acknowledged that latent class analysis does provide a relatively easy and cheap source of class identification (Provencher & Moore 2006).

The second criticism relates to the likelihood of attitudes being endogenous variables in the explanation of choices. This would arise in this current research if a landowner choice of program were to influence his/her attitude. It is however argued that the attitude variable in this current research, that is, a landowner's attitude toward the role and impact of private conservation reserves, reveals a 'deeper' attitude that drives the utility derived from joining an incentive program. The attitude variable thus expresses a fundamental attitude that precedes joining an incentive program. The research therefore proceeds on the assumption that a landowners' attitude toward the role and impact of private conservation reserves is not an expression of incentive program related preferences.

In the latent class approach respondents make up several distinct segments (*S*) each with a different set of preferences (Provencher, Baerenklau *et al.* 2002). Assuming that individual *n* belongs to segment *s* (s=1, ... ,S) the utility function can be written as:

$$U_{ni|s} = \beta_s X_{ni} + \varepsilon_{ni|s} \qquad (6)$$

The latent class approach assigns individuals to " ... classes with identical preferences and estimates the probability of membership to each class along with their respective preference weights" (Scarpa and Thiene 2004, p.2).

Equation 4 can now be written as:

$$\pi_{n|s}(i) = \frac{\exp(\mu_s \beta_s X_i)}{\sum_{k \in C} \exp(\mu_s \beta_s X_k)} \qquad (7)$$

where β and μ are now utility and scale parameters specific to a segment (Boxall and Adamowicz 2002). Individuals can be allocated to one of the segments on the basis of their characteristics and their latent attitudes. To achieve this, a latent membership likelihood function is used. The membership likelihood function (M^*_{ns}) of individual *n* and segment *s* is given by equation 8.

$$M^*_{ns} = \tau_{ps} P^*_n + \tau_s S_n + \zeta_{ns} \qquad (8)$$

P^*_n is a vector of latent attitudes held by individual n. S_n is a vector of observed socio-demographic characteristics of individual n. Where τ_{ps} and τ_s are parameter vectors.

P^*_n can be defined by a vector of observed indicators of latent attitudes (P_n)

$$P^*_n = \varpi_p P_n + \zeta_{np} \qquad (9)$$

where ϖ_p are parameter vectors of the latent attitudes to be estimated. ζ_{ns} and ζ_{np} represent the error terms in equation 8 and 9 respectively.

If equation 9 holds, M^* can be expressed at an individual level by equation 10.

$$M^*_{ns} = \lambda_s Z_n + \zeta_{ns} \qquad (10)$$

Z_n is a vector of both the psychometric constructs (P_n) and the socio-economic characteristics (S_n) and λ_s is a vector of parameters. In equation 11 the assumptions are incorporated into the probability of membership in segment s.

$$\pi_{ns} = \frac{\exp(\alpha\lambda_s Z_n)}{\sum_{s=1}^{S} \exp(\alpha\lambda_s Z_n)} \qquad (11)$$

If the joint probability of an individual belonging to segment s and choosing alternative i is given by equation 12,

$$\pi_n(i) = \pi_{ns}\pi_{n|s}(i) \qquad (12)$$

then the probability that a randomly chosen individual n chooses alternative i is given by equation 13.

$$\pi_n(i) = \sum_{s=1}^{S} \pi_{ns}\pi_{n|s}(i) \qquad (13)$$

The data used for estimating segment membership can be combined with preference data related to choice of product or service, thus allowing "... joint estimation of the explanators of heterogeneity and the explanators associated with attributes of cboice" (Boxall and Adamowicz 2002, p.422).

$$\pi_n(i)=\sum_{s=1}^{S}\left[\frac{\exp(\alpha\lambda_s Z_n)}{\sum_{s=1}^{S}\exp(\alpha\lambda_s Z_n)}\right]\left[\frac{\exp(\mu_s\beta_s X_i}{\sum_{k\in C}\exp(\mu_s\beta_s X_k)}\right] \tag{14}$$

Welfare can be estimated for latent class choice models to understand the distributional impact of change in the attributes. This topic is discussed in the next section.

5.1.1 Welfare estimation

The ultimate aim of many choice studies is to estimate the welfare implications of changes in one or more of the attributes of a product. The welfare impact associated with the increase or decrease of an attribute reflects the amount of compensation needed to maintain utility at a certain level. For instance a change in environmental quality, waiting time in a hospital que, or in this case, land use restrictions or legal implications of an incentive program, is associated with a welfare estimate reflecting a change in utility.

Estimation of the welfare impact in latent choice models is based on Hanemann's (1982) theory of welfare estimation in conditional logit models (quoted in Boxall and Adamowicz 2002). Boxall and Adamowicz (2002) estimate the compensation variation on a segment by segment basis for latent choice models. As this current research involves estimating a WTA, the equivalent variation (*EV*) rather than the compensation variation is estimated. Following Boxall and Adamowicz (2002) the segment specific equivalent variation for individual *n* is given by:

$$EV_{n|s}=\frac{1}{\gamma_s}\left[\ln(\sum_{k\in C}\exp(\beta_s X_k^0)-\ln(\sum_{k\in C}\exp\beta_s X_k^1)\right] \tag{15}$$

Where γ_s is the segment specific marginal utility of income, $\beta_s X_k$ is the segment specific indirect utility over *k* choice, 0 is the initial state and 1 is the new state following a change in an attribute level in *X* in at least one of the choices in *k*. Accounting for segment membership in generating the welfare measure can be done by multiplying equation 15 by the probability of membership of segment *s*, namely $\sum_{s=1}^{S}\pi_s$.

5.1.2 Statistical indicators for latent class analysis

In this dissertation the latent class approach was used to model landowner preferences for incentive program attributes. The data used to estimate the model was obtained by means of a Choice survey. Landowner characteristics and attitudes, as well as property characteristics, collected in the same survey, were used as variables in the latent class analysis. The computer program used for estimating the latent class model was LatentGOLD Choice 4.0.

As discussed in Section 5.1.1. latent class models classify individuals into classes. In addition to the standard goodness of fit, classification and prediction statistics, practitioners of the latent class approach use information criteria to determine the number of classes.

The chi-squared (χ^2) statistic with the corresponding degrees of freedom yields the asymptotic *p*-values, which can be used to determine whether the specified model fits the data. The Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC), based on the L^2, are used to "weigh and fit the parsimony of a model" (Vermunt and Magidson 2005, p.46).

The number of classes in a latent class model cannot be predefined and the optimal number of classes must be selected on the basis of statistical criteria. Moreover, Boxall and Adamowicz (2002, p.433) suggest that " ... conventional rules for this purpose do not exist and judgement and simplicity play a role in the final selection of the size of *S*".

The BIC, the AIC, the explanatory power of the model (R^2), and the inherent intuitive correctness of the model, e.g. the signs of estimated parameters, serve as the main guides to determining the number of classes (see also Boxall and Adamowicz 2002; Scarpa and Thiene 2004; Morey, Thatcher *et al.* 2006).

The BIC (sometime referred to as the Schwarz criterion) is a statistical information criterion. Following Morey, Thatcher *et al.* (2006), the BIC is given in equation 16, where (d) is the number of free parameters to be estimated, (n) is the number of observations and (B) is the maximised value of the likelihood function of the estimated model.

$$BIC = -2\ln B + d\ln(n) \qquad (16)$$

Equation 16 becomes equation 17 under the assumption that the model error is normally distributed.

$$BIC = n\ln\left(\frac{RSS}{n}\right) + d\ln(n) \tag{17}$$

The BIC is a decreasing function of the Residual Sum of Squares (RSS) from the estimated model and an increasing function of the number of free parameters to be estimated. Lower values of the BIC for multiple class regression models, in comparison to a single class regression model, suggest heterogeneity in the data. Lower values of the BIC indicate a better model in terms accounting for heterogeneity.

The AIC is a measure of the goodness of fit of an estimated statistical model (equation 18). The AIC trades off the complexity of an estimated model against how well the model fits, assuming that the model errors are normally distributed. Similar to the BIC, smaller values of the AIC indicate better solutions.

$$AIC = -2\ln(B) + 2d \tag{18}$$

The AIC sometimes over estimates the number of classes (Scarpa and Thiene 2004). It is therefore important that the number of chosen classes also account for the significance and the meaningfulness of the parameter estimates according to the " .... analyst's own judgement" (Scarpa and Thiene 2004, p.9).

Another statistic is the Dissimilarity Index (DI), a descriptive measure which indicates how much " ... observed and estimated cell frequencies differ from each other" (Vermunt and Magidson 2005, p.46). The DI is defined as follows:

$$DI = \frac{\{(\sum_{i^*=1}^{I^*}(|n_{i^*} - \hat{q}_{i^*}|) + (N - \sum_{i^*=1}^{I^*}\hat{q}_{i^*})\}}{2N} \tag{19}$$

where q is a particular alternative and is distributed as χ^2. The classification statistic provides information on how well observed values predict latent classes, or how well the classes are separated. Classification is based on class membership probabilities. Observed and predicted values can be presented in a classification table where each cell reports the number of observations correctly or incorrectly classified.

In the preceding section the statistical methods used to analyse data obtained from the Choice survey was presented. The latent class approach used in this research to estimate the decision model allows the inclusion of several variables, including attitudes. Attitude data was obtained from a question included in the survey which asked landowners to rate how much they agreed with a number of statements regarding the role and outcome of establishing conservation reserves on private land. The section that follows shows how the attitude variable included in the latent class analysis was derived. The statistical method used in the analysis of the attitude data is also discussed.

5.2 Statistical analysis of attitude data

Attitude data were collected as part of both the BW and the Choice survey. In the survey respondents were asked to indicate their level of (dis)agreement with statements related to the role and outcome of conservation reserves on private land on a Likert scale. For instance the first 3 statements in this part of the survey were as follows:

Conservation reserves on private land:

	Please tick ☑ **only 1** of the 5 options				
	++ Strongly Agree	+ Agree	+/- Neutral	- Disagree	-- Strongly Disagree
Are an effective way to ensure wildlife survival	☐	☐	☐	☐	☐
Are expensive to manage	☐	☐	☐	☐	☐
Create a good image for landowners	☐	☐	☐	☐	☐

The attitude data were analysed using a Principal Component Analysis (PCA). PCA is a multivariate technique that reduces a large body of data so that a maximum of the variance is extracted (Harman 1967). PCA involves a mathematical procedure that transforms a number of (possibly) correlated variables into a (smaller) number of uncorrelated variables called *principal components*. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible.

More formally, the object of component analysis is to represent a variable in terms of several underlying factors, or hypothetical constructs. The model for component analysis is:

$$Z_j = a_{j1}F_1 + a_{j2}F_2 + ... + a_{jn}F_n \qquad (j = 1,2, \ldots,n) \qquad (20)$$

Each of n observed variables is described linearly in terms of n new uncorrelated components, F_1, F_2, ..., F_n. An important property of this method, insofar as the summarisation of data is concerned, is that each component in turn makes a maximum contribution to the sum of the variances of the n variables. The sum of the variances of all n principal components is equal to the sum of the variances of the original variances when $n \rightarrow \infty$ (Harman 1967).

A component analysis can be conducted with any method of factor extraction as long as the matrix to be operated on by these methods is initially the unreduced correlation matrix with ones in its principal diagonal.

A brief mathematical summary of PCA (adapted from Mulaik 1972) is as follows:

$$Z = FX \qquad (21)$$

where Z is the n x 1 random vector whose coordinates are n variables and X is a n x 1 random vector whose coordinates are the n principal components for the n variables. F is the n x n square matrix of principal-axes factor loadings of the n variables on the n principal components. The matrix F is given as:

$$F = AD^{½} \qquad (22)$$

where A is the n x n eigenvector matrix and D is the n x n diagonal eigenvalue matrix for the matrix R. R contains the correlations between the n variables such that:

$$R = E(ZZ') \text{ and } A'RA = D \qquad (23 \text{ and } 24)$$

The coordinates of X, representing the principal components, are mutually orthogonal so that:

$$E(XX') = I \qquad (25)$$

PCA yields a matrix of correlations between variables and factors. The advantage of PCA is the mathematical convenience of working with the eigenvalues and eigenvectors to determine the number of factors that are to be retained and to compute factor scores (Mulaik 1972).

5.3 Statistical analysis of Best-Worst data

In Sections 5.1 and 5.2 the statistical methods for analysis of the choice and attitude data were reported. Prior to carrying out the Choice survey, a Best Worst survey was administered. In the BW survey respondents were asked to to indicate the most and least important incentive program attribute, out of a different combination of five of 10 attributes. They were asked to repeat this a total of 18 times.[37]

The main aim of the BW survey was to the rank the program attributes in order of importance and thus limit the number of attributes used in the subsequent Choice survey to only the most important ones. Limiting the number of attributes was thought to minimise Choice survey complexity. An additional aim of administering the BW survey was to test for any differences between landowners and professionals who administer and manage incentive schemes in the ranking of the relative importance of the incentive program attributes. The degree of importance of incentive program attributes was measured on an underlying continuum of importance.

In the BW survey, the respondent was asked to choose the most and least important program attributes from a different set of five attributes several times. For example, the first and second question of the survey were as follows:

Which program attribute do you think is most important and which do you think is least important to a landowner who is thinking about joining an incentive program to protect native vegetation?

Part 1

Most important	Tick only one Program attribute	Least important
☐	Funding amount	☐
☐	Funding agency	☐
☐	Program duration	☐
☐	Application procedure	☐
☐	Technical support availability	☐

Part 2

Most important	Tick only one Program attribute	Least important
☐	Payment method	☐
☐	Application procedure	☐
☐	Monitoring & survey requirements	☐
☐	Funding allocation process	☐
☐	Funding agency	☐

[37] The data BW were collated in Excel and statistical analysis was carried out in SPSS 13.0.0 and StataSE 8.

The joint probability of choosing the most important attribute (i) and the least important attribute (j) across all blocks of 5 attributes can be estimated independently of the marginal probabilities using the appropriate block design and its complement (Appendix 1) (Auger, Devinney *et al.* 2004; Buckley, Devinney *et al.* 2004).

Following the presentation of Louviere (1994) and Buckley, Devinney *et al.* (2004) the choice process associated with each attribute pair i and j can be represented as follows:

$$D_{ij} = \delta_{ij} + \varepsilon_{ij} \qquad (26)$$

D_{ij} is the unobservable true difference between attributes i and j on the underlying continuum of importance; δ_{ij} is the observable (mean) difference revealed by the choices that a respondent makes; and ε_{ij} is a random error component of choice. The probability that a respondent chooses the ij pair of attributes in each subset is given by:

$$P\langle ij|B_n\rangle = P(\delta_{ij} - \varepsilon_{ij}) \qquad \text{all other } K-1(\delta_{ik} + \varepsilon_{ik})\text{ pairs} \qquad (27)$$

B_n is the block (subset) of attributes faced by respondent n; and K is the number of attributes per block. Assuming that ε_{ij} is distributed according to a Gumbell distribution leads to a Multinomial Logit Model (MNL) for analysis (Louviere 1994; Boxall, Adamowicz *et al.* 1996, Blamey; Bennett *et al.* 2000; Louviere, Hensher *et al.* 2000). If δ_{ij} can be expressed as two scale values h_i - h_j then the choice probability can be expressed as:

$$P\langle ij|B_n\rangle = \exp(h_i - h_j)/\sum_{ik}\exp(h_i - h_k) \qquad \text{for all K}(h_i, h_k)\text{ pairs in } i_c \qquad (28)$$

The formal measurement assumptions that apply to BW scaling are summarized by the following (following Marley and Louviere 2005):

- The latent dimension (δ_{ij}) can be decomposed into the desired scale values (h_i, h_k) and the unexplained portion of the difference (ε_{ij}).
- The respondent is able to identify the most important and least important item in choice sets that have more than 3 items.
- There is stochastic transitivity in the choice: if A is more important than B and

B is more important than *D* than A is more important than *D*.

- There is symmetry of choice: the probability that *A* is most important and *B* least important is the same as the probability that *B* is least important and *A* is most important.

The parameters in the model are the differences between one particular attribute and all others on the common underlying scale of importance. Using the Balanced Independent Block Design (BIBD), the scale value for each attribute is the number of times it is chosen most important against the number of times that it is chosen least important. The estimated scale values can be approximated by the simple score $\delta(m_i l_i)$ which is the total most important (*m*) *i* minus the total least important (*l*) *i* counts for each attribute. This approximates the unknown difference s_i - s_j for each individual. For example, in this study each attribute appeared 9 times, so the individual level scale ranges from +9 to -9. "This implies that [the scores] are linearly related to the true scale values and interval scale measures ... on the underlying continuum of [importance]" (Finn and Louviere 1992, p.14). For example, a score of +1 is obtained if a respondent rated an attribute most important 5 times and least important 4 times (Auger, Devinney *et al.* 2004).

The individual aggregate difference scores provide a crude measure for the level of importance. In this study an additional procedure is carried out (Section 7.2). The individual BW scores were used in Multi-Dimensional Scaling (MDS) analysis. Cohen and Neira (2003) compared the aggregate difference scores to MDS results concluding they both yield the same scale information. But MDS provides additional information on how similar or how different two attributes are.

MDS is a technique that uses *proximities* as input which indicates the perceived similarity or difference between attributes (Kruskal and Wish 1978). A common procedure for obtaining proximity data is to ask survey respondents to directly judge the "psychological distance" (or closeness) between stimulus objects. MDS is used to visualize these proximities in a low dimensional space. It uncovers relationships between attributes by restricting the solution to a linear combination of independent variables. The dissimilarity measures for data analysed using MDS is the *Euclidian distance* which is the square root of the sum of the squared differences between values for the variables. MDS measures how well the configuration approximates the distances between the attributes by the "stress", where

$$Stress = \sum_{ij} (d_{ij} - f(\delta_{ij}))^2 \tag{29}$$

and d_{ij} is the constructed distance between attribute i and j in the given number of dimensions, δ_{ij} is the observable distance, or difference between i and j, and f is a transformation that preserves the rank order of the input distance (Kruskal and Wish 1978). Lower stress figures indicate a better representation of the input distances in the configuration.

In the preceding sections the statistical methods used to analyse data gathered by means of the BW and Choice surveys was discussed. In the next chapter details of the survey design are reported.

6 Survey design and administration

This research explores the decision framework of private landowners surrounding participation in conservation incentive programs. The data used to develop and estimate the decision model was gathered by means of a Choice survey of Tasmanian landowners. The Choice survey instrument was also used to gather attitude data.

Prior to administering the Choice survey, a BW survey was carried out. The primary aim of the BW survey was to rank conservation incentive program attributes in order of importance and use the results to assist in developing the choice set for the Choice survey. Ordering the attributes in order of importance minimised the complexity of the Choice survey and ensured that the choice question presented an accurate reflection of the "real" decision framework. A second aim was to establish any differences in the relative importance of program attributes between landowners and professionals who administer and manage conservation schemes.

In this chapter a brief review of the BW survey method is presented, followed by a discussion of the BW survey design.[38] A detailed discussion of the Choice survey design concludes this chapter.

6.1 Best–Worst survey

BW scaling is a direct, scale-free method of measuring the weight or importance of the attributes or features of a choice (Finn and Louviere 1992; Cohen and Neira 2003; Louviere and Towhidul 2004). Developed by Louviere (1991), the BW scaling technique presents respondents with a profile, or a set of attributes, of a good or service. The respondent is asked to choose the attribute combination that is most important and least important (or best and worst).

Several advantages and strengths are associated with using the BW scaling technique (Cohen and Neira 2003). Most importantly BW scaling has been found to be very easy to use (Cohen and SHC & Associates 2003). Much research suggests that binary responses (responses with two outcomes) are simple and reliable (e.g. Buckley, Devinney *et al.* 2004). Further, when Cohen and Neira (2003) compared BW scaling

[38] The statistical tools used to analyse the BW survey results were previously discussed in Section 5.3.

to alternatives, such as the five-point scale rating method, they found that BW is preferred as it avoids context biases and is rating scale free. They concluded that overall, BW scaling was easier to understand and resulted in "better" results.

In the first application of BW scaling, Finn and Louviere (1992) examined the importance of various food safety issues of public concern. They combined BW scaling with a choice experiment. They first asked respondents to indicate their first choice and then choose their last choice from the remainder. The BW survey determined the consumers' true level of concern about food safety issues. The choice experiment then assessed "... how preference for actions [was] likely to change with characteristics of the food safety incident or problem" (Finn and Louviere 1992, p.14). The study found that BW scaling provided an appropriate research method for " ... policy makers who need consumer input to help determine how to allocate their managerial and marketing resources" (Finn and Louviere 1992, p.23).

The BW method has subsequently been applied in many different areas of research. For example Auger, Devinney *et al.* (2004) used BW scaling to investigate 16 different issues of consumer social belief. In this study cross-cultural comparison was facilitated due to the scalar inequivalence of BW scaling. Cohen and Neira (2003) used BW in an international study into the benefits of drinking coffee. BW was used in a study that measured preferences for benefits of computer servers (Cohen and SHC & Associates 2003). With respect to foreign direct investment options Buckley, Devinney *et al.* (2004) investigated managerial preferences using BW.

In a theoretical context BW is frequently compared to other SP survey techniques (e.g. Cohen and SHC & Associates 2003; Cohen and Neira 2003). In an empirical context BW is mostly used alone or in combination with a choice question (e.g. Finn and Louviere 1992). There are few empirical examples where BW is used prior to carrying out a Choice survey to inform attribute selection for a Choice survey, the approach used in this research. Only one study was found that used the BW approach, along with several other rating techniques, to explore the issue of identifying attributes for inclusion in a subsequent choice study (Sawtooth Software 2002).

Buckley, Devinney *et al.* (2004) and Flynn, Louviere *et al.* (unpublished) used BW in combination with a Choice survey to check that the results generated by the BW survey were consistent with a choice experiment. Flynn, Louviere *et al.*

(unpublished) point out that combining the "easy" BW task with a Choice survey may be appropriate for the purpose of comparisons of marginal changes in attributes used in the Choice survey. In this approach a respondent is asked to choose the best and worst of a number of options and then indicate their preference for the remainder of options (see also Louviere, Burgess *et al.* 2004). The BW task aspect is, therefore, an integral part of the question in the Choice survey, as opposed to being a separate survey as in this research.

Population segments can be identified to understand patterns in the BW data using a simple cluster analysis on the basis of additional information gathered as part of the BW survey (e.g Auger, Devinney *et al.* 2004; Buckley, Devinney *et al.* 2004). In this current research the attitude data was also gathered with the aim of determining segments in the population (Section 8.2).[39]

6.1.1 The Tasmanian Best-Worst survey

The BW survey was administered to two groups of respondents, landowners, and professionals who administer and manage incentive programs (referred to as program designers and administrators – PDAs). Both groups were given the same BW rating task. Slightly different questions were asked regarding personal characteristics of the two groups.

6.1.1.1 Survey design

Incentive program attributes included in the BW survey were determined by expert opinion, that is, a focus group composed of incentive program field staff, program managers, and landowners.[40] This group of 12 persons met in September 2004. The choice of incentive program attributes was further informed by review of existing conservation incentive schemes and the literature. The resulting 10 program attributes that were included in the final BW survey were:

(1) funding amount;

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[39] Small response numbers, however, did not allow a significant analysis of the BW attitude data to be undertaken.

[40] Program attribute levels for the Choice survey (discussed in Section 5.2.3) and a series of statements about the perceived role and impact of creating conservation reserves on private land were also developed in these focus groups.

(2) monitoring and survey requirements;

(3) funding agency;

(4) program duration;

(5) technical support availability;

(6) funding allocation process;

(7) land use restriction;

(8) legal mechanism;

(9) application procedure; and

(10) payment method.

In the BW survey respondents were asked to indicate the most and least important incentive program attribute, out of a combination of five attributes. As there were a total of 10 attributes, respondents were asked to repeat this question a number of times, each time with a different block of five of the 10 attributes.

BW uses experimental designs to place program attributes in the different blocks. All possible sets of program attributes (t) can be given by the complete factorial (2^t) but this would require a prohibitive number of blocks (k) to be presented in a survey. A Balanced Incomplete Block Design (BIBD) was used to construct the sets and determine the number of sets (as in Auger, Devinney *et al.* 2004). BIBD has been used for many years in experiments where individuals are presented with different objects and are asked to make a comparative rating (Cochran and Cox 1957).

Two variables used to construct the BIBD were predetermined in this BW survey: the 10 attributes, and the size of the block, which was five. The decision to limit the number of attributes in a choice set to five was the result of feedback received from subjects who provided comments in the pre-testing phase. Other BW surveys also seemed to favor smaller rather than larger sets. For example, Cohen SHC & associates (2003) and Finn and Louviere (1992) both use four attributes per set.

The result was a design with a total number of 18 blocks (b). Each attribute appeared nine times within those 18 blocks (r) and appeared four times in combination with each other attribute (λ). The design (and its complement) used in the survey[41] is shown in Appendix 1. Using the BIBD design ensures that each respondent makes

[41] The design was obtained from home.hccnet.nl/kees.duineveld/xbibd/bib10.18.9.5.4.view.txt viewed on 24 April 2005.

" .... a sufficient number of choices to measure his or her values for each [attribute]" (Finn and Louviere 1992, p. 14).

6.1.1.2 Survey layout

The BW survey, for both landowners and PDAs, consisted of three parts[42] (the full survey for PDAs is shown in Appendix 2). The main aim of the first part of the survey was to gain an understanding of the respondent's experience with conservation issues. Landowners were asked about their involvement with conservation and incentive schemes, general property characteristics, past management activities, and a number of personal questions. The first part of the PDA survey asked a series of multiple-choice questions which established their working situation and frequency of interaction with landowners.

The actual BW task was presented in the second part of the survey. Both landowners and PDAs were asked to indicate the most and least important incentive program attribute, out of a combination of five attributes. The introduction to the BW task was worded differently between the landowner and PDA surveys. The introduction to the BW task in the landowner's survey stated:

> Which program attribute do you think is most important and which do you think is least important when you are considering whether to join an incentive program to protect native vegetation?

The introduction to the BW task in the PDA survey stated:

> Which program attribute do you think is most important and which do you think is least important to landowners when they are considering whether to join an incentive program to protect native vegetation?

The third part of the survey explored the respondent's attitude to the role and impact of establishing conservation reserves on private land. Survey respondents were asked to express their level of agreement or disagreement with a total of 26 statements. These statements indicated behavioral beliefs and were developed on the basis of a literature review, informal interviews with landowners, and expert opinion. The statements are roughly centered around six general foci (the numbers in brackets indicate the statement number in Table 1):

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[42] A glossary defining each of the attributes was provided with the survey.

1. Impact on productive capacity of the property (13, 16, 23);
2. Impact on current income or future potential income (12, 17, 20, 21, 22, 24);
3. Personal impact on the landowner (6, 7, 8, 18, 25);
4. Environmental impact on property (3, 9, 15);
5. General environmental impact (2, 4, 5, 11[43]); and
6. Trans-boundary impact and management options (1, 10, 14).

In the rating question respondents were asked to express their level of agreement or disagreement with the statements in Table 1. A uni-dimensional five point Likert scale (Likert 1932) was used to measure attitude. The middle label on the response scale was labelled "neutral" thereby offering the option of neither agreeing or disagreeing. The other four labels included strongly disagree, disagree, agree, and strongly agree.

[43] Statement 11 explored the landowner's perception of intergenerational equity.

Table 1: Rating questions aimed at establishing landowner attitudes to the role and impact of establishing reserves on private land.

No.	Conservation reserves on private land	Code
1	Will benefit others as much as the landowner	BENOTH
2	Provide a good way to protect species from extinction	PROTECT
3	Will reduce the potential for soil erosion and salinity	EROSION
4	Add to the beauty of the landscape	BEAUTY
5	Are an effective way to ensure wildlife survival	WILDL
6	Create a good image for landowners	IMAGE
7	Give the landowner a sense of fulfilment	FULFIL
8	Will increase the landowner's understanding of the environment	LEARNING
9	Are of value for stock shelter and control	STOCK
10	Are best established where neighbours work together to protect areas	NEIGHB
11	Will mainly benefit the future generation	FUTGEN
12	Increase the opportunities to earn income from recreation/tourism	INCOP
13	Create a harbour for animals that are a pest to farming	PESTS
14	Should be left alone with minimal management	LEFTALONE
15	Increase the fire threat to the landowners' property	FIRE
16	Create a harbour for weeds	WEEDS
17	Are expensive to manage	EXPMAN
18	Take up a lot of time to manage	TIME
19	Reduce the property value	PROPVALU
20	Reduce the landowners' opportunity to diversify	DIVERSE
21	Reduce the security of future income	INCSEC
22	Reduce the potential to earn income from the rest of the property	INCRED
23	Will make the management of the remainder of the property more complicated	COMPLEX
24	Can be expensive as they lead to reduced productivity due to shading	REDPROD
25	Threaten the landowners' livelihood	LIVELY
26	Are only desirable if there is no other valuable use for the land	OTHERUSE

The last statement (26) was included as it was frequently mentioned in informal interviews with landowners. The statement establishes a relative priority of private reserves over other uses for the land. However, it does not fit neatly into the framework surrounding landowner attitudes.

6.1.1.3 Pre-testing, sampling and survey administration

The landowner survey was pre-tested by eight landowners randomly selected from the databases of the Private Forest Reserve Program (PFRP), Private Area Protected Program (PAPL), and Greening Australia (GA). Landowners were contacted by phone and, after having the survey's aims briefly explained to them, were asked if they were willing to participate in pre-testing the survey. Upon the landowner's agreement, a survey was sent in the mail with a stamped return envelope. The main comments received from the pre-testing concerned the length and repetitive nature of the survey. As a result, minor alterations were made to the final version.

The PDA survey was pre-tested by officials who filled in the survey while the researcher was present and thus provided direct feedback. A mail-out version was developed for landowners and an online version of the BW survey was developed for PDAs. The surveys were administered in June 2004 and no follow-up procedures were implemented.

The final landowner survey was mailed to 100 landowners randomly selected from the Tasmanian Farmers and Graziers Association (TFGA) database. This database contains the addresses of all primary producers in Tasmania. The sample was stratified on the basis of commodity group: wool (30), meat (30), dairy (30), and vegetables (10), representing the approximate proportion of landowners in each of these groups. The landowner survey was administered by mail as administration of the survey via email was thought to be inefficient.[44] Discussions with PDAs confirmed this, based on their experience in dealing with landowners.

An estimated 60 professionals work for the 6 different organisations that implement or develop conservation incentive programs in Tasmania. These organisations are GA, PFRP, PAPL, Private Forests Tasmania (PFT), the Forest Practice Board (FPB), and the Department of Primary Industries, Water and Environment (DPIWE). The stated focus of these organisations activities ranges from "mainly forestry" to "private land conservation". However, all the abovementioned organisations employ "conservation officers". All organisations were approached to participate and agreement was obtained from the most senior person in the organisation.[45]

The survey for PDAs was administered via the internet. The website details were emailed to a central contact person in each participating organisation. The contact person was then asked to forward the email to colleagues using their internal email system. The email contained a "live link" to a website where respondents were

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[44] The main reason for not administering the survey via email or the internet was that, even though in Tasmania more than 65 percent of rural landholders use computers (www.defra.gov.uk/corporate/ebus/maffrole/usage.htm viewed on 4 August 2005), members of the focus group believed that low responses would result.

[45] As there is currently little guidance for defining sample sizes for BW surveys where heterogeneity in respondent preferences is expected (Flynn, Louviere *et al.* unpublished), approaching all organisations was considered best.

presented with the survey. After completion of the survey respondents were asked to "submit" the survey. The survey results were saved to a predetermined location on the University of Tasmania server.

The response rate for landowners was 31 percent. A total of 32 useable PDA surveys was returned. This corresponds to a 53 percent response rate based on the estimated 60 persons working in the incentive program sector in Tasmania.

6.2 Choice survey

The main aim of the Choice survey (Appendix 3) in this research was to understand the decision framework of landowners surrounding incentive program participation and, in particular, to understand the trade-offs between incentive program attributes. It is important to gain an understanding of the decision problem most akin to the decisions that individuals make in real life when developing a Choice survey (Adamowicz, Louviere *et al.* 1998). Two steps were taken in this research to ensure an accurate interpretation of the decision problem: a focus group meeting with incentive program field staff, program managers, and landowners was held; and a BW survey was carried out to identify the most important attributes to be included in the Choice survey. Both the focus group meetings and the BW survey have been discussed previously in Section 6.1.

After development of the Choice survey, a draft version was pre-tested by 10 landowners randomly selected from the databases of the PFRP, PAPL, and GA. These landowners were contacted by phone and those who agreed to participate were sent a survey in the mail with a stamped return envelope. Some minor wording changes were incorporated on the basis of feedback received.

Two covering letters were included with the Choice survey. The first letter was from the TFGA encouraging landowners to participate (Appendix 3). The purpose of this letter was to emphasize the importance of landowner participation and the relevance of the survey to them. The letter was also aimed at increasing the credibility of the researchers. In the letter it was explained that the researchers had previously worked successfully with the TFGA, the stakeholder group representing landowners in Tasmania. The letter further emphasized the fact that participation was anonymous. At no stage did the landowner have to provide a name or contact details. Anonymity in surveys minimises respondents reporting what they think is socially desirable. This is recognised as a common problem with gathering survey data and has been extensively researched (e.g. Krosnick 1999; Nancarrow and Brace 2000).

The second letter included with the survey was printed on University of Tasmania letterhead. This letter outlined how the survey would enable landowners to influence policy with regard to private land conservation incentive programs. Clear information was provided about the aim of the survey and the benefit to the participant of filling out the survey. A so-called "hypothetical bias" may otherwise be generated if the survey is not perceived to be realistic (Frykblom and Shogren 2000).

The covering letter from the University contained contact information for the researchers. It also provided information on where and how the results of the survey could be obtained (Dillman 1978). The latest return date for the survey, 30 September 2004, was stated on the covering letter. The final survey was mailed to 500 Tasmanian landowners in early September 2004. No follow-up procedures attempting to influence the response rate were initiated[46].

6.2.1 Survey layout

The final Choice survey was divided into four parts. The first part contained 16 questions: property and business characteristics; the landowner's past conservation management activities; and past involvement in conservation incentive programs.

The second part of the survey contained eight choice questions. Each choice question presented two conservation incentive programs described by five program attributes. The five program attributes (land use restrictions; funding amount; legal implications; technical advice availability; and payment method) were set at a different level for each of the two programs (discussed in Section 6.2.3). Survey respondents were asked which of the two programs they would voluntarily join, or to indicate they would not join either of the programs. In the next part of the question respondents were asked which program was most preferred if they *had* to choose and did not have the option of not joining either program (Section 6.2.3.1). Descriptions of the

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[46] Even though a follow-up process is a standard procedure (Dillman 1978), the process was not undertaken in this current research due to financial limitations.

attributes used in the choice section were defined in a glossary. An example of how to fill out the choice question was printed on the back of the glossary (Appendix 3).

In the third part of the Choice survey respondent were asked to rate 24 statements about the role, impact and environmental outcome of establishing conservation reserves on private land. This question contained the same statements as those used in the BW survey.[47] The last part of the Choice survey contained 11 questions which established the socio-economic characteristics of the landowner.

6.2.1.1 Sample size and response rate

The final version of the Choice survey was mailed out to 500 randomly selected Tasmanian landowners[48] from the TFGA database. The sample was stratified into four different commodity groups representing the approximate proportion of landowners in each of these groups in Tasmania: wool (30 percent); meat (30 percent); dairy (30 percent); and vegetables (10 percent).[49]

The usual considerations of accuracy and collection cost guided the survey sample size (Adamowicz, Louviere *et al.* 1998). The sample comprised approximately 12.5 percent of the estimated 4,000 rural landowners in Tasmania.[50] This lies between the minimum sample (n) of between 384 and 576 for a choice probability of between 0.4 and 0.5 as recommended by Louviere, Hensher *et al.* (2000, p. 264).

A total of 10 surveys was undeliverable and returned to sender, giving an effective mail-out of 490 surveys. Over the month following the mail-out, 145 surveys were returned, comprising a 30 percent response rate. Of these, 13 surveys were incomplete and deemed unuseable. The final response rate was therefore 27 percent

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[47] Two of the statements were removed from the original 26 that were included in the BW survey. After analysis of the BW survey results, it was clear that these two statements were not statements about the outcome of reserve establishment.

[48] The landowners who had been sent a BW survey were included in the population sample for the Choice survey. Due to the random selection of the landowners and confidential nature of the survey, it is unknown if any landowners received both a BW and Choice survey. If this was the case, the numbers are likely to be small as there were a total of 4,000 landowners from which the sample was drawn.

[49] It was unknown if the individuals contained in the sample had any native forest on their land or not.

[50] The ABS Natural Resource Management Survey of Tasmanian farmers samples 728 individuals in this sector which represents a 100 percent response rate due to the compulsory nature underpinned in legislation of ABS surveys (David Rankin Pers. Comm., 2006).

(132 surveys). This response rate is adequate according to Louviere, Hensher *et al.* (2000, p. 264) who recommend a minimum number of respondents of between 48 and 72 for simple models. The incorporation of preference heterogeneity generally requires larger sample sizes. It may therefore be argued that the sample in this current research is somewhat low.

Non-response bias, caused by over-complex survey instruments, is increasingly recognised as a challenge in valuation surveys. It is possible that a certain 'type' of person is more likely to be a non-respondent to a complex survey than another (e.g. Stewart, Anderson *et al.* 1993) therefore biasing estimates. As the issue of non-response bias was not specifically addressed in this current research, it must be considered a caveat on any discussion of the results (Section 9).

6.2.1.2 Contextual statement for forest and non-forest owners

The Choice survey sample contained both landowners who currently owned forest and landowners who owned no forest at all. The choice section of the survey required that these groups be directed to a different section of the survey containing a contextual introduction relevant to their particular choice situation. As choice decisions are made on the basis of *stimuli* presented (Adamowicz, Louviere *et al.* 1998), respondents need to able to relate to the choice situation. If respondents cannot relate to the situation, or are not motivated by the information presented, they are unlikely to be able to choose between the options provided (Ajzen, Brown *et al.* 1996).

Landowners who owned native forest were asked to think about one particular area of native forest on their property and describe it in terms of its physical characteristics. They were also asked whether they thought the particular tract had conservation values. Landowners were subsequently asked what the "market value" of this area of forest was and on what basis the market value was estimated. The contextual paragraph was as follows:

> To set the scene for the next section of the survey we ask you to think about a particular area of native forest on your property that has <u>some conservation value</u> (it doesn't matter what the type of forest is or where it is on your property). If you don't own an area of forest *with conservation values* please think of any other tract of native forest on your land. Please answer these brief questions about that area of native forest.

Landowners who did not own native forest were asked to imagine that 10 percent of their farm was covered in native forest and that this area had an estimated market value of $5,000 per hectare. This represents an average per hectare value for Tasmania.[51]

The contextual paragraph for landowners with no native forest was as follows:

> Even though you currently don't own any land with native forest, we are interested in your opinion about the sort of incentive program that would appeal to you if you did own forested land.
>
> To set the scene for the next two sections please place yourself in the position of someone who owns an area of native forest. Please imagine that 10% of your property is covered with one single contiguous block of native forest.
>
> Say that similar forested land in your region has sold for around $5,000 per hectare in the past year. On this basis a *fair* market value for the area of native forest would be $5,000 per hectare times the size of the area you indicated above.
>
> Imagine that this forest has conservation value and is eligible to be enrolled in a conservation incentive scheme. Enrolling the land may mean you will have to change the use of that land but you would retain ownership of the land.

Both types of landowners were then asked to answer the same choice question with respect to the parcel of land they previously described.[52]

A well documented issue that can arise with stated preference surveys is so-called hypothetical bias. Hypothetical bias is the difference between stated and revealed values caused by the "hypothetical nature of [stated preference] surveys which [...] can result in responses that are significantly greater than actual payments" (Murphy, Allen *et al.* 2005, p. 313). Research by Murphy, Stevens *et al.* (2005) indicates that one way in which hypothetical bias can be avoided in some instances is by using

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[51] This estimate was based on discussion with landowners and PDAs as well as the real estate industry particularly focused on agricultural land. Land values are higher in the North West and lower in the Midlands of Tasmania by several thousands of dollars per hectare but the overall average was agreed to be around $5,000 per hectare.

[52] No follow up test was implemented to investigate differences in landowner cognisance of the level of the monetary attribute in a situation where landowners are explicitly shown the dollar amount in the choice question and where the dollar amount is not explicitly stated, as in this current research.

'cheap talk'. Cheap talk "... entails reading a script that explicitly highlights the hypothetical bias problem before participants make any decisions, as a means of generating unbiased responses" (Murphy, Stevens *et al.* 2005, p. 327). Other methods include debriefing or certainty statements (e.g. Blumenschein, Blomquist *et al.* 2007). No specific strategy was implemented in this current research to address the possibility of hypothetical bias. The potential implications of this type of bias can therefore not be directly assessed in this current research.

6.2.2 Specific Choice survey design issues

Many papers and textbooks have been written that deal with simple survey design issues aimed at maximising response rates (e.g. Dillman 1978; Jenkins and Dillman 1995; Greer, Chuchiniprakarn *et al.* 2000). For instance, in order to maximise response rates, the relevance of the issue to the respondent has to be ensured and the cost minimised (e.g. Greer, Chuchiniprakarn *et al.* 2000). Other issues which will maximise response rates are, for instance, the inclusion of a stamped return envelope (e.g. Veiga 1984), anonymity (e.g. Tyagi 1989), offering survey results (e.g. Kalifatix and Tsogas 1994), and inclusion of a covering letter (e.g. Jobber, Birro *et al.* 1988). The design details presented in the sections that follow is not exhaustive and will only discuss selected issues such as for example the number of profiles, choice sets, attributes, and the attribute levels.

6.2.2.1 Number of profiles

Landowners were asked to choose between participation in two conservation incentive programs. In the literature, the choice options, hereafter referred to as programs, are called "profiles": "A *profile* is a single attribute level combination in a complete factorial combination of attribute levels" (Adamowicz, Louviere *et al.* 1998, p.13).

In the Choice survey, respondents were asked to indicate in which conservation incentive program they would enroll their land: program 1 or program 2. They were also able to choose not to enroll their land in either program 1 or 2 (hereafter, where it relates to this research, referred to as the 'voluntary' option). Respondents were subsequently asked to indicate in which program they would chose to enroll their land if they *had* to choose and did not have the option of not enrolling their land in either (hereafter, where it relates to this research, referred to as the 'forced choice' option). The choice in this case was limited to program 1 or program 2.

Descriptive labels were not used for the 2 profiles, which were simply called "program 1" and "program 2". The inclusion of policy labels or headers, such as "environmental option" – "financial option" – "social option", in environmental Choice surveys appears to reduce the attention respondents pay to the attributes of the choice set (Blamey, Bennett *et al.* 2000). Simply labelling the choice options program 1 and program 2 avoided potential anchoring[53] to what respondents perceive to be the most preferable policy label.

Anchoring may also occur where an example survey question is given to explain the survey approach to the participant. The respondent is likely to anchor their estimate to values the survey designer has given in the example (Tversky and Kahneman 1974). The chance of this occurring was reduced in this research by ensuring that the example question included with the survey was not used in the choice sets subsequently presented to respondents.

6.2.2.2 Number of choice sets

Choice survey respondents are generally presented with six to 10 choice sets. A single set contains two or three alternatives and one base option (often the status quo). The literature is unclear what effect the number of choice sets presented has on responses. On the one hand it is reasonable to expect that fatigue may affect the reliability of the results. For example, Mazzotta and Opaluch (1995) and DeShazo and Fermo (2002) find that choices among alternatives become complex if there are many alternatives, or if the alternatives differ in terms of a large number of attributes. They find that this may impact on choice consistency which will in turn impact on welfare estimates.

Hensher, Stopher *et al.* (2001) also tested the effect of administering various numbers of choice sets (4, 8, 16, 24, and 32) on the ability of respondents to comprehend and respond. They found that the number of treatments placed before people did not generate a problem, even for the 32-treatment design, and thus did not support the

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[53] Anchoring is the effect of the respondent being pulled toward an anchor and is often referred to as "starting point bias" (Tversky and Kahneman 1974).

principle of fatigue effects. They did find, however, some evidence that four treatments were inadequate to allow sufficient variability in responses.

To explore the effects of fatigue in this study 12 randomly selected landowners were asked to pre-test the survey with 16 choice sets containing 10 attributes. Subjects were asked to provide the researcher with feedback about the survey.

Most landowners voiced concerns about the number of repeat questions and the number of attributes. As most subjects were unfamiliar with this type of survey, suspicions were aroused. Comments received regarding the number of repeated questions were for example:

> "I got completely disinterested by the 10th time and didn't care what I answered";
>
> "I gave up after number 8".

On the basis of the comments received and following further discussion with the subjects, the number of choice sets was limited to eight. Guidance on the number of choice sets was also taken from other studies (e.g. Whitten and Bennett 2001; Boxall and Adamowicz 2002; Rolfe and Windle 2003; Horne 2004). Comments were also received in relation to the repetitive nature of the questions. For instance:

> "Are you trying to catch us out?"
>
> "Why don't you just ask what we think a program should look like instead of all this complicated stuff?"
>
> "Are you trying to find inconsistencies in our answers?"

To avoid arousing suspicion and consequently reducing the survey response rate, the nature of the questioning was explained in the covering letter and in the survey itself. As such, it was explicitly stated that the survey was *not* aimed at finding responses inconsistencies. Due to the "informal nature" of pre-testing the survey, no further statistical analysis of the pre-test results was carried out.

6.2.2.3 Number of attributes

Users of Choice surveys have used different numbers of attributes in the profiles. Horne (2004) uses five attributes to describe alternative policy options aimed at increasing areas of land protected for conservation. Kerr and Sharp (2004) use six attributes to evaluate offsite mitigation of adverse environmental effects resulting from development on streams in New Zealand. Rolfe and Windle (2003) use five attributes to value the protection of aboriginal cultural heritage sites. Boxall and Adamowicz (2002) use five attributes to evaluate wilderness park choice.

In the pre-testing phase of the current survey, subjects were presented with 10 attributes in each choice set. The comments received regarding the number of attributes presented in the program profile suggested that 10 attributes increased survey complexity. For example:

> "I only ended up looking at the first two things – too much to remember"
>
> "By the time I'd read the last one, I'd forgotten what the first one was".

On the basis of comments received, and the literature reviewed, the number of program attributes was set at five. The five most important attributes out of the initial set of 10 were determined using the BW survey (Chapter 7).

6.2.2.4 Orthogonal design

The *design* of a Choice survey involves selecting a sample of profiles which have particular statistical properties allowing the estimation of the coefficients of a utility function. Linear model design theory underpins the published catalogue and specialized software that is used to develop designs. However, Adamowicz, Louviere *et al.* (1998) point out that care should be taken when simply applying "canned" designs as many choice problems have built in constraints.

The assistance of Dr. Leonie Burgess and Prof. Deborah Street, Department of Mathematical Sciences, University of Technology Sydney, was sought to develop the most efficient design for the choice experiment within the constraints of the application. The method, which is outlined in Burgess and Street (1999, 2005, forthcoming), starts with a Fractional Factorial Design (FFD) and adds generator(s) to create the other options in the choice sets. In this case, a FFD was constructed to allow for the estimation of all the main effects plus the two-factor interactions between the first attribute and each of the other attributes. This FFD was used as the first options in 16 choice sets, and a generator was added to the FFD to obtain the second options in the choice sets.

The design for the Choice survey allowed for five attributes, four of which have two levels and one with four levels (Appendix 4). All main effects and the interaction between the first two level attribute (land use restrictions) and the four level attribute (funding amount) can be estimated independently of each other (i.e. they are uncorrelated). The 16 sets and their complements were randomly allocated to two separate eight-set surveys.[54]

6.2.2.5 *Willingness to accept*

Choice experiments generally contain at least one attribute that is expressed in dollar value. Such as the cost of travel mode (Hensher and Sullivan 2003), or additional tax paid for conservation purposes (Whitten and Bennett 2001). This is essential if marginal utilities and implicit prices are to be estimated.

The attribute expressed in dollar value in this research was the market value of an area of land. Survey respondents were asked to estimate a fair market value for their land. The level of the estimated market value was then varied in the program profile in the choice experiment to a proportion of the original base amount. In other words, the landowner was offered either less, the same as, or more than the market value in compensation funding for joining a conservation incentive program.

This approach to determining a base level for the monetary attribute in a choice experiment has previously been applied in the transport literature. For instance Hensher and Greene (2003a) set the base amount in a stated choice experiment for urban commuting by asking respondents to identify their current trip details (including running cost and toll charges).

In the current research the landowner was asked to *accept* money for setting aside land. The landowner is asked to reveal their Willingness To Accept (WTA) a monetary reimbursement for a "loss" of potential future income.[55] The loss is the use of that land for productive purposes (agriculture or forestry). Landowners are assumed to hold rights and in a voluntary setting accept compensation to give up these

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[54] Alternative designs were investigated and deemed too complicated.

[55] The psychological foundation of loss aversion is relevant to Choice surveys of non-use value. Kahneman and Tversky (1979) first established that people dislike losses more than they value gains, which is the central theme of *prospect theory*. Even though this issue is important to Choice surveys it is beyond the scope of this dissertation to investigate this any further.

rights. Therefore, WTA estimation adopted in this dissertation is the only acceptable framework. Most other choice experiments, particularly where they focus on environmental issues, ask respondents their Willingness to Pay (WTP) for a combination of environmental characteristics. The level of their "payment" will result in a specified set of environmental "gains".

6.2.2.6 *Inclusion of status quo*

The introduction to the choice section of the survey established that the landowner could enroll the land they have in mind regardless of the current status. The landowner was able to choose not to enroll their land if neither program 1 nor 2 appealed. This part of the choice question formed the basis of a voluntary choice scenario. An *absolute* measure of value of changes in individual attributes can be determined if a "choose no or neither" option is included in the choice set (Morrison, Blamey *et al.* 1996).

Other studies (eg. Horne 2004) have found that a large proportion of respondents choose the "status quo" option. This results in significant differences in per hectare welfare estimates between the analysis that includes and excludes the status quo (e.g. Horne 2004). It was expected that a large number of survey respondents in this current Choice survey would also choose not to join a program.

In this research a model was estimated for a voluntary choice scenario, but also one where the landowner is forced to choose one of two programs (the 'forced choice' model). The second scenario was included to simulate a choice situation where, for instance, forest owners were forced to conserve their land by government regulation.

Chapter 5 presented the statistical method used to interpret the choice, BW, and attitude data. Chapter 6 presented a review of the BW and Choice survey methods. In Chapter 7 these statistical methods are applied to the BW data and the results are presented. Similarly, in Chapter 8 the results of the Choice survey are presented.

7 Best-worst survey results

This section presents the results of the Best-Worst (BW) survey. Firstly, the general results, such as experience and work focus are described. Secondly, the BW and attitude data are analysed, using the statistical methods previously discussed in Section 5.2.

7.1 Descriptive Best-Worst data

Two BW surveys were sent out: one to Program Designers and Administrators (PDAs); the other to landowners (abbreviated in the tables below as LOs). The BW survey was emailed to an estimated 60 PDAs, professionals working for six different organisations that implement or develop incentive schemes in Tasmania. A total of 32 responses was received, resulting in an estimated 53 percent response rate.

PDAs had worked in jobs related to resource conservation for an average of 12 years (the longest was 30 years and the shortest was one year). The largest proportions of PDAs described their positions as scientific (29 percent) and extension officers (23 percent). A total of 23 percent were policy officers or in management positions. The PDAs that did not fit into any of the categories listed in the survey described themselves as bureaucrats, a project officer, and an ecologist. Around one third of PDAs worked in the field and had face-to-face contact with landowners once or twice per week. For about half of the PDAs this contact occurred less than once per month. Only a small proportion of PDAs never visited landowners and properties (less than 10 percent).

For landowners the BW survey was mailed out. A total of 100 landowners received a survey, and 31 responses were returned giving a 31 percent response rate for the landowner survey.

Landowners had been engaged in conservation related activities for an average of 11 years and had owned their property for an average of 17 years. Male landowners comprised 61 percent of respondents. Overall, 83 percent of landowners identified themselves as the owner *and* manager of the property. The average age of landowners was 47 years old. Slightly more than 50 percent had completed TAFE or had tertiary qualifications. An average of 64 percent of landowners earned the majority of their income from farming. At the same time, 75 percent earned some off-farm income.

7.2 Best-Worst data

In the second part of the survey respondents were asked to identify the most and least important attributes of incentive programs out of five attributes. They were asked to repeat this 18 times, each time for a different combination of the 10 attributes.

Every respondent's assessment of the relative importance of the 10 incentive program attributes was determined by subtracting the number of times it was rated least important from the number of times it was rated most important. The potential score ranged from +9 to -9. The mean individual BW scores provide a measure of the level of importance for each of the incentive program attributes (Finn and Louviere 1992). The mean scores for all respondents are shown in column one of Table 2.

Table 2: Best-Worst score for 10 incentive program attributes for all respondents, PDAs, and landowners, and t-values (BW survey data).

		Mean score (all resp.)	Mean score (PDAs)	Mean score (LOs)	t-value	Sig. (2-tailed) #
Land use restrictions	(RESTRICT)	5.92	7.16	4.55	0.591	0.557
Funding amount	(FUNDAMOUNT)	3.56	5.06	1.90	0.966	0.338
Legal implications	(LEGAL)	0.70	0.94	0.45	**-2.024**	**0.048**
Technical support availability	(TECHSUPP)	0.34	0.13	0.59	**-1.976**	**0.053**
Payment method	(PAYMETH)	0.02	-0.53	0.62	-0.560	0.578
Program duration	(DURATION)	-0.89	-1.66	-0.03	0.966	0.338
Application procedure	(APPLICATION)	-0.89	-1.44	-0.28	**-2.231**	**0.029**
Funding allocation process	(ALLOCPROC)	-1.52	-2.09	-0.90	**3.520**	**0.001**
Monitoring & survey requirem.	(MONITOR)	-2.61	-2.22	-3.03	-1.758	0.084
Funding agency	(AGENCY)	-4.61	-5.34	-3.79	-1.778	0.081

Levene's Test for Equality of Variances was >0.05 for all variables indicating that equal variances could be assumed between the two different groups.

Table 2 shows that for all respondents (column 1) the five most important attributes in the decision framework were land use restrictions, funding amount, legal implications, technical support availability, and payment method. These same attributes were also ranked as the five most important for landowners and PDAs when considered separately (columns 2 and 3). The only difference between the two groups lies in the relative ranking of the legal implications, rated fifth for landowners and third for PDAs.

A Student's t-test for the equality of mean scores for PDAs and landowners indicates a significant difference at the 5 percent level in the rating of incentive scheme attributes for LEGAL, TECHSUPP, APPLICATION, and ALLOCPROC (shown in bold).

Table 3 shows the number of times each attribute was more important than funding amount and the second column the number of times it was less important than funding amount. The Z-score is for the Wilcoxon matched pairs signed rank test where the null hypothesis is that the attribute and the funding amount are equally important. The null hypothesis is rejected at the 1 percent level of significance for all attributes.

Table 3: Ratio of ranking higher and lower than funding amount, Wilcoxon signed rank test, and Z score (BW survey data).

	Ranking of attributes	Ranked higher than FUND AMOUNT	Ranked lower than FUND AMOUNT	Z-score
Land use restrictions (RESTRICT)	1.926	39	17	3.050
Funding amount (FUNDAMOUNT)	3.057	-	-	-
Legal implications (LEGAL)	4.910	14	41	3.625
Technical support availability (TECHSUPP)	5.303	12	46	3.968
Payment method (PAYMETH)	5.385	10	46	4.487
Program duration (DURATION)	5.959	9	49	4.876
Application procedure (APPLICATION)	6.107	8	46	5.133
Funding allocation process (ALLOCPROC)	6.623	6	52	6.122
Monitoring & survey requirem.(MONITOR)	7.238	4	54	6.412
Funding agency (AGENCY)	8.492	5	54	6.428

The ranking score for the attributes and for each respondent was scaled using MDS analysis (Table 4). The proximities were scaled at an *ordinal* level as the normalized raw stress increased when proximities were scaled at a ratio level (Section 5.3). This procedure was carried out for all respondents and each respondent group separately.

Table 4: The BW scale and normalized stress indicator for all respondent, PDAs, and landowners for incentive program attributes (BW survey data).

	BW scale (all resp.)	Norm. raw stress	BW scaling PDAs	BW scaling LOs
Land use restrictions (RESTRICT)	1.451	0.0025	1.454	1.355
Funding amount (FUNDAMOUNT)	0.827	0.0054	0.886	0.567
Legal implications (LEGAL)	0.142	0.0128	0.244	0.041
Technical support availability (TECHSUPP)	0.043	0.0157	-0.137	0.161
Payment method (PAYMETH)	-0.068	0.0090	-0.076	0.290
Program duration (DURATION)	-0.206	0.0047	-0.248	-0.014
Application procedure (APPLICATION)	-0.271	0.0049	-0.352	-0.161
Funding allocation process (ALLOCPROC)	-0.314	0.0034	-0.366	-0.278
Monitoring & survey requirem.(MONITOR)	-0.533	0.0095	-0.399	-1.090
Funding agency (AGENCY)	-1.072	0.0077	-1.006	-0.872
Resp Norm. Raw Stress	0.0076		0.0058	0.0401
Dispersion Accounted For	0.9924		0.9942	0.9600
Tucker's Coef. of Congruence	0.9962		0.9971	0.9798

The stress and fit measures indicate that the distances in the solution approximate the original distances well for all respondents. A higher stress figure was obtained for landowners. Although lower stress measures and higher fit measures (Tucker's coefficient of congruence) indicate better solutions, the figures obtained for landowners are considered acceptable.

The quantitative scale represents the psychological response of the respondent to the perceived importance of the incentive program attributes. The column of normalised stress identify TECHSUPP (0.0157) and LEGAL (0.0128) as the attributes that contribute most to the overall stress of the solution for all respondents. FUNDAMOUNT contributes most to the overall stress of the solution for landowners (not shown in the table).

Even though the ranking order of legal implications and the payment method differs between PDAs and landowners, both groups included the same attributes in their list of five most important. The five most important attributes that are included in the Choice survey (Chapter 8) are: FUNDAMOUNT (funding amount); LEGAL (legal implications); RESTRICT (land use restrictions), TECHSUPP (technical support availability); and FUNDMETHOD (funding method).

7.3 Best-Worst attitude data and analysis

The last section of the BW survey asked respondents to rate 26 statements on the role and impact of establishing conservation reserves on private land. Mean ratings and standard deviations for both PDAs and landowners are shown in Table 5. A score of 1 indicated "strongly agree", 2 indicated "agree", 4 indicated "disagree", and 5 indicated "strongly disagree". A score of three indicated that the respondent felt "neutral" about the statement. The attitude question asked in the survey and the definition of the codes in Table 5 were previously given in Table 1 of Section 5.1.1.2.

Table 5: Respondent rating of the role and impact of establishing conservation reserves on private land (BW survey data).

Question Code	Mean score (all resp.)	St. Dev. (all resp.)	Mean score (PDAs)	Mean score (LOs)	t-value	Sig. (2-tailed)
BENOTH	1.848	0.881	1.688	2.000	-1.452	0.151
PROTECT	1.848	0.685	1.906	1.794	0.662	0.510
EROSION	1.848	0.769	1.813	1.882	-0.366	0.715
BEAUTY	1.864	0.875	1.813	1.912	-0.458	0.649
WILDL	1.894	0.844	1.906	1.882	0.114	0.909
IMAGE	1.955	0.919	1.750	2.147	-1.784	0.079
FULFIL	2.030	0.822	1.906	2.147	-1.193	0.237
LEARNING	2.091	0.836	1.906	2.265	-1.769	0.082
STOCK	2.185	0.748	2.250	2.121	0.691	0.492
NEIGHB	2.197	0.789	2.094	2.294	-1.032	0.306
FUTGEN	2.545	1.112	2.906	2.206	**2.676**	**0.009**
INCOP	2.561	0.994	2.344	2.765	-1.746	0.086
PESTS	2.818	1.176	3.063	2.588	1.660	0.102
LEFTALONE	2.939	1.036	3.063	2.824	0.936	0.353
FIRE	2.970	1.037	3.219	2.735	1.932	0.058
WEEDS	3.045	1.169	3.219	2.882	1.171	0.246
EXPMAN	3.061	1.051	3.281	2.853	1.678	0.098
TIME	3.123	0.857	3.188	3.061	0.594	0.555
PROPVALUE	3.227	1.064	3.563	2.912	**2.590**	**0.012**
DIVERSE	3.364	1.002	3.500	3.235	1.074	0.287
INCSEC	3.394	0.909	3.563	3.235	1.474	0.145
INCRED	3.409	1.202	3.656	3.176	1.641	0.106
COMPLEX	3.485	0.864	3.656	3.324	1.582	0.119
REDPROD	3.667	1.043	3.938	3.412	**2.100**	**0.040**
LIVELY	3.697	1.052	3.938	3.471	1.834	0.071
OTHERUSE	3.815	1.130	4.375	3.273	**4.477**	**0.000**

A test of the equality of mean scores for PDAs and landowners indicates a significant difference, at the 5 percent level, in the rating of the following attitudes (shown in bold in Table 5): OTHERUSE (0.000); FUTGEN (0.009); PROPVALUE (0.012); REDPROD (0.040). PDAs more strongly disagreed that reserving areas of forest was only useful if there was no other use for the land. Landowners more strongly agreed that reserve establishment mainly benefited the future generation and that it reduced property values. Landowners less strongly disagreed that reserve establishment could be expensive as it leads to reduced productivity due to shading.

A PCA and VARIMAX rotation method (SPSS version 11.0.0) was used to condense the original 26 attitude variables to form a reduced number of interpretable variables (Mulaik 1972). Firstly, the communalities for all attitude variables were examined. Variables with extraction communality values smaller than 0.2 were dropped from the PCA, as this indicated that they did not fit well with the factor solution. The next step in the PCA involved determining the number of factors (Table 6). There are several methods by which this can be done, including Cattell's scree test, identifying eigenvalues greater than 1, and interpretability of the resultant factors. Using a combination of these methods, i.e. an eigenvalue greater than 1 and the component must add around 10 percent to the factor solution, resulted in two factors being extracted.[56]

Table 6: Total variance explained (BW survey data).

Component	Initial Eigenvalues*			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	**% of variance**	**Cum. %**	**Total**	**% of variance**	**Cum. %**	**Total**	**% of variance**	**Cum. %**
1	7.907	35.940	35.940	7.907	35.940	35.940	4.134	18.789	18.789
2	2.724	12.383	48.323	2.724	12.383	48.323	3.847	17.486	36.275
3	1.617	7.349	55.673	1.617	7.349	55.673	2.862	13.010	49.285
4	1.114	5.062	60.735	1.114	5.062	60.735	2.145	9.750	59.035
5	1.037	4.713	65.448	1.037	4.713	65.448	1.411	6.413	65.448

* Components with eigenvalues smaller than 1 are not shown.

Table 6 shows that the first two components explain around 48 percent of the total variation in the original variables. Variables with loadings greater than 0.400 in the rotated component matrix for two principal components were assumed to fit well within the factor solution (shown in Table 7). The PCA was also carried out separately for PDAs and landowners. No significant difference resulted in the factor solution between the two groups.

[56] Even though the third component explains 7 percent of the variance, this component was difficult to categorise into a specific impact focus. The third component was therefore not retained in the analysis (Table 7).

Table 7: Rotated component matrix (BW survey data).

	Production impact PC 1	Environment impact PC 2
BEAUTY		0.705
BENOTH		0.551
COMPLEX	0.664	
DIVERSE	0.662	
FULFIL		0.779
IMAGE		0.628
INCOP		0.503
INCRED	0.807	
INCSEC	0.739	
LIVELY	0.826	
OTHERUSE		-0.519
PROPVALUE	0.620	
PROTECT		0.796
REDPROD	0.510	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization (Kaiser 1958).
Rotation converged in 7 iterations.
Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.759[57]
Bartlett's Test of Sphericity[58]: Approx. Chi-Square = 914.167, df = 231, Sig =<0.0001

Standard tests of the adequacy of the PCA indicate that a factor analysis is useful for this reduced variable set. A 0.759 Kaiser-Meyer-Olkin Measure of Sampling Adequacy indicates a high proportion of variance in the data can be explained by the underlying factors. Further the significance level of <0.0001 for Bartlett's test of sphericity, with approximate Chi-square of 914.167 and 231 degrees of freedom, indicates significant relationships among the variables.

Table 7 shows that the first factor (PC1) includes attitudes that focus on the impact of reserves on the production capacity of an agricultural enterprise. The second factor (PC2) relates to attitudes that focus on the impact of reserves on environmental values and on the personal value to the landowner. The two factors can consequently be labelled *production impact* and *environmental impact.*

The PCA attitude data was not further analysed and a cluster analysis was not applied due to the small number of observations. In general, however, the PCA results for the BW attitude data presented above compare well to the Choice survey attitude results

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[57] The Kaiser-Meyer-Olkin Measure of Sampling Adequacy is a statistic which indicates the proportion of variance in the variables which is common variance, i.e. which might be caused by underlying factors. High values (close to 1.0) generally indicate that a factor analysis may be useful with the data.

[58] Bartlett's test of sphericity indicates whether the correlation matrix is an identity matrix, which would indicate that the variables are unrelated. A significance level of less than 5 percent indicates that there are probably significant relationships among the variables.

discussed in the next chapter. The factors are similar in that they comprise a factor focused on environmental outcomes, and one with a focus on the production impact of establishing reserves.

8 Choice survey results and analysis

In this chapter the results of the Choice survey are presented. First, a descriptive analysis of the socio-economic characteristics of survey respondents and their property is outlined. This is followed by the statistical analysis of the attitude data gathered as part of the Choice survey. Lastly, a model of landowner preferences for incentive program attributes is estimated. A discussion of the results in this Chapter and Chapter 7, as they relate to the objectives stated in Chapter 1, is reserved for the concluding Chapter 9.

As described in Chapter 6, the Choice survey was mailed out to 500 Tasmanian landowners, stratified into three different commodity groups. A total of 132 useable surveys was returned resulting in a 27 percent response rate. The response rate is consistent with that of other landowner surveys in Tasmania (Jennings and van Putten 2001, 2003) and also compares well with mail-out Choice surveys carried out elsewhere (e.g. Whitten and Bennett 2001).

8.1 Descriptive choice data

In the next section, survey respondent characteristics are outlined followed by property and business characteristics, and their native forest holding and conservation management activities. The characteristics of respondents in the sample are compared to Tasmanian landowners as described by the Australian Bureau of Statistics census data, previous landowner surveys, and the BW survey data. Where significant, differences between male and female respondents and between regions are identified. General respondent statistics (the mean and standard deviation) are shown in Table 8 below.

Table 8: Mean and standard deviation of socio-economic characteristics, property characteristics, and land management activities of survey respondents (Choice survey data).

Descriptive Statistics	Unit	Number of obs.*	Mean	Standard Deviation
The number of years the property has been owned	Years	125	32.13	34.498
Number of years involved in conservation activities	Years	132	13.98	17.124
The age of the respondent	Years	128	50.64	10.766
The size of the property	Hectares	132	2,942.83	11056
The size of native forest on the property	Hectares	132	885.41	4561.910
The number of dependent children on the property	Number	129	1.44	1.391
Annual Gross Farm Turnover	$/year	108	599,011	684303
The landowner owns and manages the property	% of total N	132	92%	0.277
Property is owned as a partnership or by the family	% of total N	132	49%	0.502
The landowner resides on the property	% of total N	132	92%	0.266
The property is situated in the southern region of Tasmania	% of total N	132	23%	0.426
The property is situated in the central region of Tasmania	% of total N	132	42%	0.495
The property is situated in the northwest region of Tasmania	% of total N	132	36%	0.481
The landowner has received assistance for fencing	% of total N	132	53%	0.501
The landowner owns an area of NF	% of total N	132	73%	0.443
The landowner does not use the area of NF for anything	% of total N	97	40%	0.493
The landowner intends to use the area of NF for commercial harvesting purposes in the future	% of total N	97	26%	0.440
There is a conservation reserve on the property	% of total N	97	22%	0.416
The survey respondent is male	% of total N	132	76%	0.430
The landowner has achieved up to tertiary education level	% of total N	132	34%	0.476
The landowner intends to pass the property on to a family member	% of total N	130	58%	0.496
Off-farm income is earned by the landowner or a family member who lives on the property	% of total N	130	66%	0.475
The majority of income is earned from farming activities	% of total N	130	77%	0.423
The landowner does not have a mortgage on the property	% of total N	129	40%	0.492

Note: * Where the number of observations (N) does not equal 132 this indicates missing data except for questions related to native forest where N=97.

Overall, the mean values for characteristics for both the Choice survey sample and BW survey sample are similar. Some minor differences are that BW survey respondents were slightly younger, fewer earned the majority of their income from farming, and they had owned their properties for a shorter period of time.

8.1.1 Landowner demographic data

Respondents were asked to identify the gender of the person filling out the survey; 76 percent indicated they were male. The gender distribution of survey respondents is similar to that found in previous surveys of farmers in Tasmania where 83 percent of respondents were male (Jennings and van Putten 2003). Of the 5,654 persons who identified themselves as farmers or farm managers in the 2001 Census of Population and Housing, 72 percent were male.

The average age of survey respondents was 49 years. Forty-six percent of survey respondents were less than 50 years of age. The oldest respondent was 80 and the youngest was 23 (Table 9). Female respondents were on average somewhat younger than males.

Table 9: Survey respondent age statistics for males and females (Choice survey data).

	Males	Females	All respondents
Number of observations	99	29	128
Survey respondents less than 50 years old	42%	59%	46%
Average age	52.1	45.7	49.1
Maximum age	80	65	80
Minimum age	29	23	23

The average age of respondents and the percentage under 50 compare well to the 2001 Census of Population and Housing, where 53 percent of farmers or farm managers were less than 50 years old.[59] While all respondents identified their gender, four respondents (three of whom were female) did not report their age.

Survey respondents were asked how many children were living on the property. Three survey respondents did not indicate whether they had any children living on the property while 40 percent of respondents indicated they had no children. This is roughly comparable to the 2001 Census of Population and Housing for farmers and farm managers[60] where 48 percent of respondents did not have dependent children. Overall, respondents had an average 2.38 children living on the property. The highest number of children living on the property was five.

Respondents were asked to indicate the highest level of education they had achieved. Forty-three percent of respondents reached secondary level, 32 percent technical or TAFE level, and the remaining 34 percent had reached university level. The number

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[59] Occupation (ASCO2) and SEXP Sex by AGEP Age.

[60] Occupation (ASCO2) by FMTF Family Type.

of farmers who had reached secondary level was higher than that found by the 2001 Census of Population and Housing where 23 percent of farmers and farm managers completed level 12.[61] The number of landowners who had achieved tertiary level education in this survey was also higher than that found in a previous Tasmanian survey by Jennings and van Putten (2003) were it was 24 percent.

There are some observable demographic differences in the current survey between male and female respondents (Table 10). Female respondents were somewhat younger and had achieved a higher level of education than male respondents. This result is consistent with Jennings and van Putten (2003).

Table 10: Demographic differences between male and female survey respondent (Choice survey data).

Variable	Number of obs Females	Number of obs Males	Mean value Females	Mean value Males	Sig. (2-tailed)*
Age	29	99	45.690	52.091	0.005
Tertiary education	32	100	0.500	0.290	0.042
No mortgage	30	99	0.600	0.343	0.016
Reside	32	100	1.000	0.900	0.001
NW region	32	100	0.250	0.470	0.021

* Only variables significant at 5% are shown.

There were significantly fewer female respondents in the Northwest of the State. Females also more frequently had no mortgage and were resident on the property.

8.1.2 Information level

To ascertain how well-informed landowners were in relation to conservation issues, survey respondents were asked if they regularly received information from any of a list of organisations. Around 40 percent of respondents indicated that they regularly received information from either Greening Australia or Landcare/Coastcare. A further 35 percent indicated they received information from PFT. More than 45 percent of respondents received information from two or more sources.

These results are similar to those found in a previous survey of Tasmanian landowners by Jennings and van Putten (2003) who found that 57 percent of respondents were members of, or received information from, Landcare and/or Greening Australia, and 40 percent of landowners were members of, or received information from, PFT.

[61] Occupation (ASCO2) by SEXP Sex and HSCP Highest Level of Schooling Completed for Persons.

8.1.3 Business and property demographics

With the aim of gathering information about the business and property characteristics, survey respondents were asked if they earned any off-farm income. Sixty-six percent of landowners indicated that they earned off-farm income. Seventy-seven percent of respondents indicated the majority of their income was derived from farming activities. Of those whose primary income source was farming, 60 percent also earned off-farm income. In a previous landowner survey by Jennings and van Putten (2003) the percentage of respondents earning off-farm income was 64 percent.

The same survey by Jennings and van Putten (2003) found that slightly over 60 percent of landowners owed no debt on their farm. This was higher than found in this research, where 40 percent of respondents did not owe any debt on their property. Thirty-three percent of respondents had a mortgage of up to 25 percent of the value of the property and 22 percent had a mortgage between 25 and 50 percent of the value the property.[62]

A total of 82 percent of landowners reported their average Gross Farm Turnover (GFT). The highest reported GFT was $3 million per annum. The average annual GFT was $599,000, or around $1,700 per hectare. Thirty percent of respondents reported an annual GFT greater than $500,000. Only 8 percent of respondents reported a GFT of less than $50,000 per annum. These figures vary somewhat from the national estimates of the Agricultural Finance Survey last carried out in 1999-2000 (Australian Bureau of Statistics 2000). In this survey 12 percent of farm businesses reported a turnover of $500,000 and more than 18 percent of farm businesses reported a turnover of less than $50,000.

Forty-two percent of respondents were from the Central region of Tasmania, whilst 23 percent were from the South and 36 percent from the North. Reported annual GFT was highest for the Central region at $714,115, followed by the Northern region at $569,634 and lowest in the Southern region at $441,045. The average property size for all respondents was around 3,000 hectares. The smallest reported size was 12 hectares and the largest was 111,000 hectares. The average farm size was largest for

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[62] A total of three respondents did not indicate their mortgage debt level. Over 85 percent of landowners who indicated their primary source of income was farming also indicated they owed a debt on the property.

the Central region at a reported 5,340 hectares, followed by 2,397 in the South and 456 in the North.

Property sizes are consistent with the pattern of economic activity in the three regions in Tasmania. In the Northern region of Tasmania the main agricultural activities are cropping and dairy. These are more intensive agricultural activities that are generally carried out on the fertile soils of the north-west region. The large extensive grazing properties are mainly located in the Central region. More recently, grazing activities are combined with cropping, with the introduction of pivot irrigation systems. This is evident in the survey data, as over 50 percent of landowners in the Central region reported undertaking three agricultural activities, growing wool, producing meat, and cropping. This is higher than the central region where 33 percent reported undertaking three activities.

Landowners were asked if they owned, managed, or owned *and* managed their property. Ninety-two percent of respondents owned *and* managed the property. Landowners indicated they had owned their property for an average of 32 years (the minimum was one year and the maximum was 181 years). The long period of ownership indicates that some landowners interpreted the question: "How long have you owned the property?" as "How long has *your family* owned the property?". Seven respondents did not indicate how long they had owned the property.

Ninety-two percent of respondents resided on the property. Thirty-eight percent of properties were privately owned, 33 percent were owned as a partnership, 18 percent as a family trust, and 16 percent as a private or public company. This pattern is consistent with the results of the previous landowner survey by Jennings and van Putten (2003).

There are some observable regional demographic differences particularly between the South and the two other regions (Table 11).

Table 11: Regional demographic differences (Choice survey data).

Variable	Number of obs South	Number of obs Central & North West	Mean value South	Mean value Central & North West	Sig. (2-tailed)*
Number of years the property has been owned**	30	95	22.242	35.258	0.034
Number of years involve in conservation	31	101	8.9352	15.525	0.020
The landowner does not have a mortgage on the property	31	98	0.677	0.316	0.001
The landowner owns and manages the property	31	101	0.7742	0.960	0.024
There is a conservation reserve on the property	25	72	0.56	0.208	0.003

* Only variables significant at 5% are shown.

** The average was not corrected for the landowners who interpreted the question as: "How long has *your family* owned the property?"

Table 11 shows that landowners in the southern region had owned their property for a shorter length of time and had also been involved in conservation for a shorter period of time than the two other regions. However, a higher number of landowners in the South had conservation reserves on their property.

8.1.4 Native forest and conservation management

Seventy-three percent of respondents indicated they had an area of native forest on their property. The average size of the native forest area was 1,200 hectares. The largest reported area was 50,000 hectares and the smallest was 12 hectares.

Fifty-nine percent of respondents who owned native forest used it for grazing, while 40 percent indicated they did not use it for anything. Twenty-one percent of respondents indicated using their native forest for commercial timber harvesting and 20 percent for hunting. Twenty-six percent of respondents indicated they had commercial native forest harvesting intentions for the future. Of those respondents who had future harvesting intentions, 85 percent had also harvested in the past. Eleven percent of respondents were unsure whether they were going to undertake any commercial harvesting in the future. These findings are consistent with those of Jennings and van Putten (2006).

Table 12 shows that 73 percent of respondents indicated they had been involved in conservation management. Almost half of respondents indicated that they managed a part of their property for specific conservation purposes. Although 27 percent of respondents indicated they had not been involved in conservation management, 69 percent of these respondents indicated they had established shelter belts or protected native vegetation. This inconsistency might indicate that the definition of what constitutes conservation management was interpreted differently by survey respondents.

Table 12: Environmental and conservation management by survey respondents (Choice survey data).

Environmental and conservation management	Number of respondents	proportion of all respondents
Respondents involved in environmental management	97	0.73
Respondents who managed part of their property for conservation	64	0.48
Respondents who received funding for fencing native vegetation	70	0.53
Respondents with formal conservation reserves on their property	29	0.22
Respondents who received funding to establish formal conservation reserves on their property	24	0.18

Respondents were asked whether they had established a formal conservation reserve on their property. As shown in Table 12, 22 percent of respondents had established such a reserve on their property, and 18 percent of all respondents had received funding to do this. Two percent of respondents were unsure about whether they had a formal conservation reserve on their property or not.

A high proportion of respondents had undertaken some form of environmental management on their property (Table 13). Two-thirds of respondents had established shelter belts on their property and almost 60 percent had protected vegetation.

Table 13: Environmental management by survey respondents (Choice survey data).

Environmental management action	Number of respondents	Proportion of all respondents
Erosion control / salinity prevention	79	0.60
Protection of vegetation	77	0.58
Shelter	99	0.75

The proportion of landowners who had undertaken at least one of the listed activities was higher than in a previous study by Jennings and van Putten (unpublished). In the latter study, only 40 percent of respondents had undertaken at least one management activity from a list of activities (most frequently 'planting trees for shelter'). Only 20 percent of respondents indicated they undertook recreational activities on their property.

Table 14 shows that 53 percent of respondents had received funding to fence native vegetation. Almost one third of respondents had rcceived trees for revegetation.

Overall, more than two-thirds of landowners had received at least one form of assistance listed in Table 14 to achieve environmental outcomes on their properties.

Table 14: Proportion of landowners who received some form of assistance to achieve environmental outcomes on their property (Choice survey data).

Assistance	Number of respondents	Proportion of all respondents
Money for fencing	70	0.53
Money for revegetation	30	0.23
Trees for revegetation	40	0.30
Labour assistance for revegetation	25	0.19
Money for improving soil management	4	0.03
Scientific advice (e.g. identification of animals)	16	0.12
Technical advice (e.g. management of animals)	17	0.13
Administrative assistance (e.g. filling out form)	15	0.11
Legal advice (e.g. implication of covenants)	11	0.08

Survey respondents indicated they had undertaken environmental and conservation management activities for an average of 19 years. Many respondents reported the time period to be the same as the number of years the property had been owned by them or their family. The longest time was reported as 120 years. It seems that this question was interpreted in a similar vein to the question asking the respondent how long they had owned the property.[63]

There are some demographic differences between survey respondents who owned native forest and those who did not (Table 15).

Table 15: Demographic differences between forest owning respondents and non-forest owning respondents (Choice survey data).

Variable	Number of respondents Forest owners	Number of respondents Non-Forest owners	Mean value Forest owners	Mean value Non-Forest owners	Sig. (2-tailed)*
The landowner resides on the property	97	35	0.897	1.000	0.001
The size of the property	97	35	3864.158	389.423	0.009
The property is situated in the North West region of Tasmania	97	35	0.289	0.543	0.011

* Only variables significant at 5% are shown.

The average size of the farm was significantly smaller for respondents who did not own native forest. Significantly more survey respondents who did not own native forest resided in the North West region of Tasmania. This may be a reflection of the

[63] These outliers were retained in the dataset used for the analysis.

economic activities carried out in this region. The North West farms are generally smaller and carry out intensive agricultural activities such as cropping and dairying. Due to the fertility of the soils in this region of Tasmania, much of the native forest has been cleared for agriculture and hence fewer and generally smaller remnants of native forest remain (Scanlan, Prinsley *et al.* 1992).

8.1.5 Joining an incentive program

In Section 2 of the survey, respondents were presented with incentive program choice questions. The orthogonal design of the survey (Section 6.2.2.4) resulted in four different versions of the survey. Of the 132 respondents, 63 answered surveys with design 1 or its complement. Sixty-nine respondents answered surveys with design 2 or its complement.

Eighty-four of the 132 survey respondents indicated at least once that they would choose to voluntarily join a program if offered the market value or more than the market value. The remaining respondents indicated they would not join an incentive program under any circumstance. The proportion of respondents who always chose the status quo of not joining under any circumstance is lower than that found in the Finnish study by Horne (2004),[64] where two-thirds of respondents expressed a preference for no additional conservation.

8.1.6 Estimated market value

Before respondents were asked to answer the choice question, they were asked to identify the size of the area of native forest to which the choice question applied. Obviously, this question only applied to the 97 respondents who owned an area of native forest. The average size of the native forest owned by these respondents was 421 hectares.

After identifying the size of the native forest area, respondents were asked to estimate a *fair* market value per hectare of their native forest. The average market value that was estimated by respondents was $6,175 per hectare. The median market value was estimated at $4,000 per hectare. The highest market value was estimated at $200,000

[64] Although this Finnish study method was different to the approach in this research, it could potentially indicate some difference between Australian and Finnish landowners in the willingness to participate in a program that adds conservation areas to the reserve system.

per hectare, based on its coastal location. The lowest estimated market value was $250 per hectare. Twelve respondents did not answer this question and an average value of $5,000 was assumed for these respondents in the model presented in Section 8.4.1.[65]

Respondents were asked to indicate the basis for their estimate of *fair* market value. The majority of respondents based their estimation on the value of similar land in the region (Table 16).

Table 16: Landowner approach to valuing the native forest on their property (Choice survey data).

Basis for estimating a *fair* market value of the land with native forest	Number of respondents* (number)	Average value of the land with native forest ($)
What the LO paid for the land	14	3,299
Value of similar land in the region	49	10,697
Government valuation	12	3,793
Value of the timber on the land	18	4,264
Other:	11	
Aesthetic/ biodiversity value	*2*	*1,500, 4,942*
Income foregone	*1*	*3,000*
Personal value	*1*	*5,000*
*Subdivision value***	*2*	*16,000, 30,000*
*Position/location***	*3*	*17,297, 50,000, 200,000*

* The total number does not add up to 85 as some respondents chose more than one option.
** Landowners who said their land valuation was due to either subdivision or position/location generally also based this value on the value of similar land in the region, explaining the high average land value for that item.

Respondents who owned native forest were asked whether they believed the area of forest had any conservation value. A total of 69 respondents believed their native forest had conservation value. Sixteen respondents did not know whether the forest had conservation value or not and 12 respondents did not answer this question.

Respondents who did not own native forest were asked to imagine that 10 percent of their property was covered in native forest and that this forest could be protected for conservation by means of joining an incentive program.[66] The average reported size of this imaginary forest was 36 hectares, which was smaller than the average area for forest owners.

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[65] The 12 landowners who had not estimated a market value for their land were not significantly different to other survey respondents in terms of their socio-economic characteristics.

[66] The assumed average value of $5,000 per hectare applied to these respondents.

8.2 Attitude data and analysis

In section 3 of the survey respondents were asked to rate 24 statements about the role and impact of conservation reserves on private land. The purpose of this part of the survey was to identify any attitudes the respondents might hold in relation to the role and outcome of reserve establishment, in particular the effect on the productive capacity of the land and the environmental outcome. These attitudes were translated into landowner types using a Principal Component Analysis (PCA). The Likert-rating scores[67] were used in the PCA to determine whether there were any significant relationships among the variables. The use of Likert-rating scores in a PCA is a commonly used approach (e.g. Boxall and Adamowicz 2002). Analysis of the attitude question data draws on the methodology previously described in Section 5.3 and previously applied to the BW survey data in Section 7.3. The PCA analysis presented below is carried out for the 97 respondents who owned an area of native forest. These 97 respondents form the basis for the 'forced choice' latent class model (Section 8.4.1).

The PCA is also carried out separately for all survey respondents (n=132) which forms the basis for the 'voluntary' model (Section 8.4.2). The PCA for this model is presented in Appendix 5 to avoid excessive duplication of presented results. A comparison of variables that make up the factors between the two PCAs was also included in Appendix 5.

The average rating and standard deviation of the 24 statements concerning the role and impact of conservation reserves on private land is shown in Table 17.[68] An explanation of the codes was previously given in Table 1.

[67] A score of 1 is strongly agree, 2 is agree, 4 is disagree, and 5 is strongly disagree. A score of 3 indicates the respondent feels "neutral" about the statement.

[68] The attitude statements in Section 3 of the survey are the same as those presented to respondents of the BW survey (Section 7.3). The BW survey contained two more statements that were dropped in the Choice survey as feedback indicated they were considered confusing and not easily classified.

Table 17: Respondent rating of the role and outcome of conservation reserves on private land (Choice survey data).

Codes	Mean	Std. Dev.	Number of respondents strongly agree	Number of respondents agree	Number of respondents neutral	Number of respondents disagree	Number of respondents strongly disagree
BEAUTY	1.896	0.810	33	44	15	4	0
BENOTH	2.417	0.954	15	39	33	5	4
COMPLEX	3.021	1.164	11	22	26	28	9
DIVERSE	2.969	1.195	14	20	25	29	8
EROSION	2.260	0.857	15	51	21	8	1
EXPMAN	2.542	1.020	16	31	33	13	3
FIRE	2.323	1.132	27	30	25	9	5
FULFIL	2.375	0.881	14	43	29	9	1
FUTGEN	2.740	1.130	9	40	24	13	10
IMAGE	2.021	0.707	22	51	22	1	0
INCOP	2.979	0.979	7	21	40	23	5
INCRED	3.219	1.092	7	20	22	39	8
INCSEC	3.042	1.172	13	16	30	28	9
LEARNING	2.354	0.878	11	52	24	6	3
LIVELY	3.281	1.161	10	13	25	36	12
OTHERUSE	2.906	1.324	16	26	20	19	15
PESTS	1.917	1.028	39	39	8	7	3
PROPVALUE	2.833	1.106	13	22	36	18	7
PROTECT	2.156	0.950	24	44	19	7	2
SHADE	3.083	1.106	10	18	29	32	7
STOCK	2.115	0.789	17	58	15	5	1
TIME	2.927	0.992	10	18	40	25	3
WEEDS	2.281	1.028	22	42	17	13	2
WILDL	2.156	1.034	26	43	18	4	5

Table 17 shows that none of the respondents strongly disagreed with the statement that establishing reserves creates a good image for landowners (IMAGE). Reserves were also perceived to be a good way to add to the beauty of the landscape (BEAUTY) as 80 percent of landowners agreed with this statement. Even though more than three quarters of respondents believed that reserve establishment created a haven for animals that are a pest to farming (PESTS), more than three quarters also believed that reserves were of value to stock for grazing purposes (STOCK).

As part of the PCA, the communalities for all attitude variables were examined (Appendix 6). Communalities are estimates of the variance of each variable accounted for by the factor solution. All variables with communality scores greater than 0.2 were assumed to fit well with the factor solution. The next step in the PCA was determination of the number of factors. There are several methods by which this is usually done, including Cattell's scree test, eigenvalues greater than 1, and interpretability of the resultant factors. Using a combination of these methods, two factors were extracted. The total variance explained by the attitude variables is shown in Table 18.

Table 18: Total variance explained in PCA for forest owners (Choice survey data).

Component	Initial Eigenvalues*			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	**% of Var.**	**Cum. %**	**Total**	**% of Var.**	**Cum. %**	**Total**	**% of Var.**	**Cum. %**
1	8.775	41.783	41.783	8.775	41.783	41.783	5.715	27.214	27.214
2	2.481	11.814	53.598	2.481	11.814	53.598	5.541	26.384	53.598

* Components with eigenvalues smaller than 1 and/or that contribute less than 5% of the variance are not shown.

Table 18 shows that the first two components explain around 54 percent of the total variation of the original variables. Standard tests of the adequacy of the PCA indicate that a factor analysis is useful for this reduced variable set. A 0.866 Kaiser-Meyer-Olkin Measure of Sampling Adequacy indicates that a high proportion of variance in the data is explained by the underlying factors. Further, the significance level of <0.0001 for Bartlett's test of sphericity, with approximate Chi-square of 22073.885 and 210 degrees of freedom, indicates relationships among the variables are significant.

The figures in Table 19 represent the partial correlation between the item and the Varimax rotated factor. The variables that have loadings greater than 0.400 (+ or -) for a particular component, called *production focus* (PC1) and *environmental focus* (PC2), are shown.

Table 19: Rotated component matrix (Choice survey data).

	Environment focus PC1	Production focus PC2
BEAUTY	0.720	
BENOTH	0.625	
COMPLEX		0.718
DIVERSE	-0.455	0.650
EXPMAN		0.693
FIRE		0.654
FULFIL	0.779	
IMAGE	0.668	
INCOP	0.517	
INCRED		0.598
INCSEC	-0.442	0.700
LEARNING	0.772	
LIVELY	-0.509	0.612
OTHERUSE	-0.628	
PESTS		0.608
PROPVALU	-0.579	0.451
PROTECT	0.781	
SHADE		0.677
TIME		0.679
WEEDS		0.748
WILDL	0.747	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

The environment focus, component PC1, has high loadings for variables related to the positive impact of reserve establishment on the environmental values of the property, such as increased beauty, wildlife protection, as well as personal fulfilment. The factor loadings are negative for the impact of reserves on property values, the effect on livelihood and on income security, suggesting that reserve establishment does not have a negative impact on these factors.

The production focus, component PC2, has high positive loadings for all variables related to the negative impact of reserve establishment on the production capacity of an agricultural enterprise. These attitudes reflect the effect of reserve establishment on both current income and property values, and future asset values.

These factors are similar to those developed for the attitude data[69] collected as part of the BW survey, although fewer variables are included in both the *production focus*

[69] Even though there were 24 questions in the BW survey and 26 in the Choice survey, overall the attitude questions were very similar. This allowed a degree of cross checking of the results. A two-tailed test of the independence of the samples (BW and Choice) showed there was no significance difference between the two groups in the rating of the attitude statements.

and *environmental focus* components in the BW survey.[70] Scores for the two factors were calculated for each survey respondent in the sample and these were included as variables (*attitude_prod* and *attitude_env*) in the latent class analysis (Section 8.4.1).

8.3 Latent class results

In the next sections the results of the choice model of Tasmanian landowner preferences for incentive program attributes are presented. Two latent class models are estimated. The first model simulates a situation where landowner enrolment in the program is compulsory (Section 8.4.1). The second model simulates a situation where entry into a program is on a voluntary basis (Section 8.4.2).

The models incorporate incentive program variables, socio-economic variables, and proxies for attitude. LatentGOLD choice (4.0) was used for the latent class analyses. Some basic statistics and the definitions for the variables used in the models are discussed in Section 8.3.1.

8.3.1 Definition of latent class variables

The continuous socio-economic variables included in the model are shown in Table 20.

[70] Both the *production focus* and *environmental focus* in the BW analysis contained seven variables that were the same as those in the choice analysis. The choice analysis contained an additional five variables for the *production focus* and three variables for the *environmental focus*.

Table 20: Statistics for the continuous socio-economic variables (Choice survey data).

Variable	Description of variable	Mean	Std. Dev.	Min	Max	Skewness 95%	Kurtosis 99%	# of obs.
number_child	Number of children living on the property (years)	1.44	1.39	0	5	.3825	1.860	129
years_own*	Number of years the property has been owned by the LO (years)	32.13	34.37	1	181*	2.332	8.828	125
farmsize	The size of the property (ha)	2,943	11,017	12	111,195	7.891	73.301	132
years_inv_cons	Number of years involved in cons. Activities (years)	13.977	17.062	0	120*	2.636	14.123	97
gft	Gross farm turnover ($/annum)	599,011	681,259	1000	$3 M	1.860	5.923	107
res_size	The size of any area of NF (ha)	885	4,545	1	49,420	9.443	99.032	97
age	The age of the LO (years)	50.64	10.73	23	80	.312	2.914	128

Note: * As discussed in Section 8.1.3, 31 percent of landowners indicated they had owned the property for more than 30 years. Some landowners may have interpreted this question in relation to the length of family ownership or involvement rather than personal ownership.

Logarithmic transformations of variables are appropriate to achieve symmetry in the central distribution (Cohen 1969). Where either the skewness and kurtosis values were outside the -3 and 3 range, the log of the variable was taken. This transformation applied to *years_inv_cons*, *years_own*, *farmsize*, *gft*, and *res_size*. The basic statistics for the discrete socio-economic variables are shown in Table 21. Much of this information was previously discussed in Section 8.1.

Table 21: Discrete socio-economic and attitude variable names and statistics (Choice survey data).

Variable name	Description of variable	# of Obs.	Mean	St Dev.
own_and_manage	LO owns and manages the property	132	0.92	0.277
partn_fam_own	Property is owned as a partnership or by the family	132	0.49	0.502
reside	The LO resides on the property	132	0.92	0.266
wool_meat_crop	The LO uses the property to grow wool, meat, and crops	132	0.33	0.473
region62	The property is situated in the southern region of Tasmania	132	0.23	0.426
off_farm_inc	Off-farm income is earned by the LO or a family member who lives on the property	130	0.66	0.475
maj_inc_farm	The majority of income is earned from farming activities	130	0.77	0.423
no_mortgage	The LO does not have a mortgage on the property	129	0.40	0.492
veg_protect	LO has protected vegetation for conservation	132	0.58	0.495
trees_or_labour	LO has received trees or labour/assistance to plant trees for conservation on the property	132	0.39	0.489
own_NF	The LO owns an area of NF	132	0.73	0.443
no_use_NF	The LO does not use the area of NF for anything	97	0.40	0.493
fut_harv_NF	The LO intends to use the area of NF for commercial harvesting purposes in the future	97	0.26	0.440
reserve_on_prop	There is a conservation reserve on the property	97	0.22	0.416
fund_4_reserve	The LO has received funding to establish this reserve in the past	97	0.18	0.387
manage_4_cons	The LO manages an area of the property for conservation purposes	97	0.66	0.502
gender	The survey respondent is male	132	0.76	0.430
tert_edu	The LO has achieved up to tertiary education level	132	0.34	0.476
GA_member	The LO receives information from, or is a member of Greening Australia	132	0.38	0.487
caregr_member	The LO receives information from, or is a member of a land or coast care group	132	0.39	0.490
pass_farm_on	The LO intends to pass the property on to a family member	130	0.58	0.496

The conservation incentive program attributes that have two levels entered the utility function as binary variables (Table 22). The two levels indicate the relative 'restrictiveness' of the attribute.[71] For example in the context of the *legal* attribute, a covenant is more restrictive than a management agreement.

[71] 'Restrictiveness' in this context also relates to the apparent 'flexibility' of the program, i.e. upfront payments are perceived as more flexible than tax relief. Not having to pay for technical assistance is perceived as a more flexible arrangement than offering assistance on a fee for service basis.

Table 22: Binary program characteristics, variable names and codes (Choice survey).

Variable name	Description of variable More restrictive	Description of variable Less restrictive
legal	The legal implication is that a permanent **covenant** is placed on the title of the land (covenant)	The legal implication is a temporary **management agreement** for the land (managreement)
landuse	**No use** of the land is permitted after reserve establishment (nousepermit)	**Limited use** of the land is permitted after reserve establishment (limiteduse)
paymethod	The compensation is paid via **tax relief** (taxrelief)	The compensation is paid via an **upfront payment** (upfrontpay)
techassist	The technical assistance available after reserve establishment is on a **fee-for-service** basis (fee4service)	The technical assistance available after reserve establishment is **free of charge** (freetechadv)

The variable *compfund* is the amount of compensation funding the landowner is offered for setting aside land for conservation. This variable used in the latent class analysis has two forms: the first is based on average land values in the 'voluntary' model (e.g. $5,000/ha, $6,250/ha, $2,500/ha, and $3,500/ha); the second is based on the estimated land value as reported by survey respondents in the 'forced choice' model (e.g. $6,175/ha, $7,719/ha, $3,088/ha, and $4,632/ha). These latter values are relative to the self-reported market value (e.g. market value, one-quarter more than the market value, half the market value, three-quarters of the market value).

As multi-collinearity is commonly found in non-experimental data, the correlation coefficients between all program attributes, socio-economic and attitude variables were determined (Appendix 7). Highly collinear variables cause regression parameters to be inefficient and can cause the signs of the regression coefficient to be counter-intuitive (Gujarati 1988). In this analysis a value of 0.5 or higher was used as the cut-off value for inclusion in the analysis.

The variable *size_nf* was excluded from the analysis as the correlation coefficient with *farmsize* was greater than 0.7 and with *years_inv_cons* was greater than 0.5. Further *farmsize* was also excluded from the analysis as the correlation coefficient with *years_inv_cons* was greater than 0.5. *Res-size* was retained as a *farmsize* related variable.

8.4 Steps followed in estimation of latent class models

Landowners are heterogeneous in terms of observable characteristics such as gender and age, and unobservable characteristics such as attitude. Landowner heterogeneity is reflected in their preferences for the attributes of conservation programs. In order to better understand landowner behaviour, landowner choice of conservation incentive program is combined with landowner attitude data, individual property and business characteristics, as well as landowner characteristics, using a latent class approach (McFadden 1986).

Two econometric models are developed. The first model, referred to as the 'forced choice' model, applies the latent class regression approach to a choice model in which survey respondents choose between two conservation incentive programs. The survey respondent is *forced* to choose between two conservation incentive programs as the option of not joining either is not included.[72] This model is estimated using choice data only for those survey respondents who currently own native forest (97 of the 132 survey respondents).[73]

In the second model, referred to as the 'voluntary' choice model, survey respondents choose between one of three options: two conservation incentive programs and a third option of not joining any program. Overall, a relatively high number of observed choices (67 percent of observations) were for the option of not joining (or status quo). Status quo observations are sometimes removed from the analysis of choice data (e.g. Horne 2004). However, when status quo observations are removed, some bias may be introduced, as only respondents who choose an alternative other than the status quo are retained. The 'voluntary' model is estimated using choice data for all survey respondents, including the 27 percent of survey respondents who did not own any native forest.

For both models different combinations of attributes were used to describe the two programs presented to the respondent in the choice question. The five incentive

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[72] Although a very different experiment, Crouch, Devinney *et al.* (2006) also applied a choice scenario where choice was restricted and no "no choice option" was provided.

[73] There were no significant demographic or socio-economic differences between non-forest owners and forest owners.

program attributes, and the levels used in the choice question were reported in Table 22.

Estimation of both the 'forced choice' and 'voluntary' models involves the following steps (based on Magidson and Vermunt (n.d.)):

1. Estimate a series of latent class models using only incentive program attributes for different numbers of classes and examine the statistical information criteria for the models;
2. Re-estimate the latent class models incorporating socio-economic and attitudinal covariates and compare the statistical information criteria for these models to those in step 1 above;
3. Select the optimal number of latent classes on the basis of the fit statistics;
4. Estimate a final latent class regression model imposing parameter restrictions across latent classes for program attributes that are not significantly different between classes;
5. Present and interpret the coefficients for the program attributes and covariates for the final model.

Sections 8.4.1 and 8.4.2 present and interpret the results of the estimated 'forced choice' and 'voluntary' models respectively.

8.4.1 'Forced choice' model

Following the procedure described in Section 8.4, the first step in developing the 'forced choice' model was to estimate latent class models using the five program attributes for different numbers of classes.[74] Table 23 shows the fit statistics for 1 to 4 latent class regression models.[75]

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[74] The way in which the classes are selected is explained on the pages that follow.

[75] LatentGOLD choice (4.0) was used to estimate all latent class models.

Table 23: Fit statistics of 1, 2, 3 and 4 latent class 'forced choice' regression model (Choice survey data).

Model	LL	BIC (LL)	AIC (LL)	Number of parameters	L^2	Degrees of freedom	p-value	Classification Error	$R^2(0)$	R^2
1-Class	-479.10	981.07	968.20	5	818.51	92	<0.001	0.000	0.146	0.145
2-Class	-423.42	897.17	868.85	11	707.16	86	<0.001	0.009	0.355	0.354
3-Class	-368.25	814.27	770.50	17	596.81	80	<0.001	0.031	0.533	0.528
4-Class	-339.63	784.47	725.25	23	539.57	74	<0.001	0.050	0.699	0.696

The statistical indicators show that all models are significant at the 5 percent level and that the 4-class model fits best, as the BIC and AIC are lowest for the 4-class 'forced choice' model. The log likelihood values (LL) show improvement of the model fit with increasing number of classes. Almost 70 percent of the variance is explained by the 4-class model.[76]

Latent class 'forced choice' models 1 to 4 were then re-estimated, including two attitude variables[77] (*attitude_env* and *attitude _prod*). Individual factor scores were included for these attitude variables in the latent class regression. The model also included dummies for a socio-economic variable (*gender*) and an 'experience' variable (*trees_fund*). A continuous property characteristic variable (*res_size*) was also included. All covariates are significant at the 5 percent level. The model was initially run with all variables listed in Tables 20 and 21 and subsequently reduced to include only those variables significant at the 5 percent level. The results for the fit statistics are shown in Table 24.

[76] The last two columns of Tables 23 and 24 show 2 different R^2 measures. The baseline for the $R^2(0)$ is the null model containing no predictors at all, where each alternative is equally likely to be selected. For the R^2 null model each alternative is predicted to be selected with a probability equal to the overall observed marginal distribution.

[77] The attitude variables were developed in Section 8.2 where a PCA of 24 attitudinal statements was undertaken. This exercise identified two factors which were labelled *prod_attitude* and *env_attitude*. Individual factor scores were included as variables in the latent class regression model.

Table 24: Fit statistics for 1, 2, 3 and 4 latent class 'forced choice' model including significant covariates (Choice survey data).

Model	LL	BIC (LL)	AIC (LL)	Number of parameters	L^2	Degrees of freedom	p-value	Classification Error	$R^2(0)$	R^2
1-Class	-474.01	970.85	958.03	5	948.03	91	<0.001	0.000	0.146	0.145
2-Class	-411.09	895.22	854.19	16	822.19	80	<0.001	0.016	0.343	0.342
3-Class	-345.59	814.43	745.19	27	691.19	69	<0.001	0.049	0.518	0.513
4-Class	-310.26	793.97	696.53	38	620.53	58	<0.001	0.037	0.677	0.675

All 'forced choice' models that include covariates in Table 24 are significant at the 5 percent level. The lower BIC indicates that the 4-class model is a better fit than the 1-class model. The BIC falls from 970.85 for the 1-class model which does not recognise landowner heterogeneity, to 793.97 for the 4-class model.[78] The AIC for the 4-class model is also lower than for the 3-class model. However, as discussed in Section 4.5.1.2, the AIC can become less reliable with increased numbers of classes. The R^2 statistic, assessing the percentage variance explained by the dependent variables, increases from 14.5 percent for the 1-class model to 51.3 percent for the 3-class model with covariates and 67.5 percent for the 4-class model.

The BIC and the R^2 statistics indicate that the 4-class model performs best. To assess if the R^2 statistic obtained for the 4-class model represents a significant improvement over the 3-class model, a p-value was estimated using the conditional bootstrap method. The bootstrap p-value can be used to confirm whether the power of the design is sufficient and the number of segments in the final model is adequate (Magidson, Eagle *et al.* n.d.). Results conclude that the gain from moving from a 3 to a 4-class model was not statistically significant for the 'forced choice' model.[79]

The third step was to select the optimal number of latent classes on the basis of the fit statistics. Comparing the fit statistics reported in Table 23 to those in Table 24, it is evident that, on the basis of the BIC and the R^2 statistic alone, the 4-class model without covariates performed best. However, the decrease in the value of the BIC

[78] A 5-class model was also estimated with no reduction in the BIC compared to the 4-class model.

[79] If the difference in model fit between the two models is not significant, the more restricted model may also be accepted as true and therefore preferred on grounds of being more parsimonious. On the other hand, if the difference is significant, the more restricted model can be rejected in favour of the less restricted model (LatentGOLD version 4 help menu).

between the low of 784.47 for the 4-class model without covariates and the 3-class model with covariates was only 39.28. Since there are no clear rules in relation to selecting the number of classes on the basis of the statistical criteria alone (Morey, Thatcher *et al.* 2006), interpretation of the coefficient estimates suggested that inclusion of the covariates added significantly to describing and understanding class membership. Therefore, step 4 was undertaken using the 3-class model with covariates.

The five covariate model was re-estimated allowing for independence for program attributes across classes that were not significantly different between groups. The formal test of equality of parameters across classes for *paymethod*, given by the p-value and the Wald(=) statistic, was greater than 0.05. As there was no significant difference between the 3 classes for this attribute, the parameter restriction was applied.

The final 3-class 'forced choice' model is significant at the 5 percent level and contains three latent classes. The final model includes six covariates and parameter restrictions for one program attribute. There is little difference in the R^2 statistic for the 3-class model shown in Table 24 and the final 3-class 'forced choice' model with both explaining around 51 percent of the variance.[80] The reported R^2 value for the final 3-class model is high in comparison to other studies where an adjusted R^2 value between 22.4 and 13.7 percent was reported by Scarpa and Thiene (2004) and between 39 and 41 percent by Popper, Kroll *et al.* (2004). The LL for the final 3-class model is 619.25.

On the basis of the BIC alone the final 3-class'forced choice' model is superior to the model without the equality of parameters for *paymethod* (Table 24). The BIC is 805.64 for the final model as opposed to 814.43 for the 3-class model without independence for program attributes.

Overall, the final 3-class 'forced choice' model does well at separating individuals into groups having a dissimilarity index of 0.91. By comparison, Morey, Thatcher *et al.* (2006) reported an entropy measure (similar to the dissimilarity index) of 84 percent. The predictive power of the final 3-class 'forced choice' model is also

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[80] The model is significant at the 5 percent level; there are 25 parameters and 71 degrees of freedom.

illustrated by the high number of observations (82 percent) that are correctly classified (Table 25).

Table 25: Classification of 'forced choice' model observations (percentage of observed program choice) (Choice survey data).

	Program 1	Program 2	Total
OBSERVED	**PREDICTED**		
Program 1	277 (81 %)	67 (19 %)	344
Program 2	68 (16 %)	356 (84 %)	424
Total	345	423	768

Table 25 above shows similar patterns of classification for program 1 and 2, with 81 percent of observed choices for program 1 and 84 percent of observed choices for program 2 correctly classified.

Covariate classification statistics indicate how well class membership can be predicted on the basis of an individual's covariate values. The final 'forced choice' model has a covariate classification error of 27 percent. The R^2 statistic for the covariates indicates that 37 percent of the variance in the dependent variable can be explained by covariates.

On the basis of the above statistical indicators, in particular the low BIC for the final 3-class 'forced choice' model and the low model prediction error, the presence of heterogeneous preferences and the need for separate utility function estimates is suggested. The utility functions for each landowner class are developed in the next section.

8.4.1.1 Utility parameters for 'forced choice' model

Each of the three latent choice classes is characterised on the basis of the covariates included in the final 3-class 'forced choice' model. These coefficients are referred to as segment membership parameters in Boxall and Adamowicz (2002). The estimated segment membership parameters ($\hat{\lambda}_s$) and the estimated utility function parameters ($\hat{\beta}_s$) for the 3-class 'forced choice' model are jointly estimated and shown in Tables 26 and 27.

Table 26: Parameters, standard error, z statistics, Wald and p-value for attitude and socio-economic variables for the 3 class 'forced choice' model (Choice survey data).

COVARIATES		λ	Stand. error	z-value	λ	Stand. error	z-value	λ	Stand. error	z-value	Wald	p-value
		Multi-objective owners Class 1			Environment owners Class 2			Production owners Class 3				
attitude_env		0.153	0.287	0.533	1.439	0.359	4.010	-1.592	0.446	-3.569	16.669	2.4 e^{-04}
attitude_prod		-0.489	0.235	-2.079	-0.266	0.289	-0.921	0.756	0.380	1.988	5.025	0.081
gender	(male=1)	0.530	0.272	1.945	-0.856	0.342	-2.506	0.326	0.348	0.937	7.459	0.024
res_size	(ha)	-0.445	0.155	-2.879	0.303	0.185	1.636	0.143	0.206	0.690	9.072	0.011
trees_fund	(1=yes)	0.505	0.223	2.266	0.044	0.265	0.165	-0.548	0.324	-1.691	5.333	0.069

Note: Shading denoted cells containing coefficients significant at the 10 percent level.

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The first two rows of Table 26 show that each of the three classes in the final 'forced choice' model can be described in terms of the member's attitude to the role and outcome of establishing reserves on private land.[81]

Estimated coefficients for both attitudinal variables are significantly different to zero at the 5 percent level for landowners in class 3. The reported signs on the attitude variables indicate that members of this class believe that establishing conservation reserves negatively affects production. Members of this class also believe that reserve establishment does not have a positive environmental outcome. Members of this class have been labelled *production owners*. This is the smallest of three classes and respondents had a 16 percent chance of being in this class. The relative size of the groups closely resembles that of Karppinen (1998) who also found that investors, who are similar to *production owners* in this study, were the smallest class. Respondents had a 13 percent chance of being in this class.

Results suggest that in contrast to *production owners*, members of class 1, labelled *multi-objective owners*, do not believe that establishing conservation reserves negatively affects production. Respondents had a 55 percent chance of being in this class. The coefficient on *attitude_env* is not significant for this class. Kline, Alig *et al.* (2000) also found that *multi-objective owners* accounted for the largest group in their sample.

The *attitude_env* variable is significant at the 5 percent level for members of class 2. Landowners in this class have been labelled *environment owners*, as they believe that a positive environmental outcome is achieved by establishing conservation reserves. Respondents had a 29 percent chance of being in the *environment owner* class. The coefficient on *attitude_prod* is not significant for this class.

The three landowner classes closely resemble those found in previous research in Tasmania. Jennings and van Putten (2006) determined that Tasmanian landowners could be separated into four groups on the basis of their stated objectives of forest ownership: the groups were labelled *income and investment owners*, *non-timber*

[81] The assignment of individuals to the three landowner classes " ... is probabilistic and every respondent has a positive probability of being a member of each of the [ ] groups" (Boxall and Adamowicz 2002, p.437).

output owners, and *multi-objective owners*[82] essentially being the same groups as in the current study.

Table 26 shows that forest owners can also be described in terms of several socio-economic and property characteristics. *Multi-objective owners* have a higher probability of being male (0.530) while *environment owners* are more likely to be female (-0.856).[83] Gender was also found to influence decision patterns in joining conservation programs in other studies (e.g. Stern and Dietz 1994). Females had more strongly held views towards environmental protection than males, and females also had more positive environmental attitudes (e.g. Jennings and van Putten 2003). Owens and Cooney (1998) explain this more positive environmental attitude by asserting that perhaps women make decisions based on 'feelings' which would increase environmental concern. Other authors found that gender does not affect attitudinal outcomes (e.g. Henderson 1998).

Multi-objective owners own smaller reserves (-0.445), and *environment owners* own larger reserves (0.303). Studies undertaken in Europe and elsewhere have found that larger farms increased the likelihood of participating in incentive schemes (e.g. Skeratt 1994; Drake, Bergström *et al.* 1999; Dupraz, Vanslembrouck *et al.* 2003). None of these studies has related the size of the parcel of land to specific landowner classes.

Multi-objective owners are more likely to have received funding to plant trees in the past (0.505). *Production owners* are less likely to have received funding to plant trees in the past (-0.548). Previous experience may mean that the landowner is more aware of the potential benefits of conservation which may affect the choice decision. The effect of past participation in incentive schemes on the increased likelihood of entry into another scheme has been well researched (e.g. Drake, Bergström *et al.* 1999; Wynn, Crabtree *et al.* 2001; and Dupraz, Vanslembrouck *et al.* 2003). However, one study by Lynch, Hardie *et al.* (2002) found no differences in the likelihood of joining an incentive program between landowners who had pre-existing experience with a particular conservation management activity and those who did not.

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[82] The fourth group were agricultural owners who were not identified in this current research.

[83] Clearly reference can only be made here to the stated sex of the survey respondent which may not be consistent with a high level of decision-making power or influence within the household.

No relationship was found in this current research between age and the likelihood of joining an incentive program, as also found by Wilson (1997). Age has been found to be significant in other studies. For instance, increasing age had a negative effect on joining agri-environmental programs in a European study (Dupraz, Vanslembrouck *et al.* 2002). Similarly, in the United States increasing age negatively affected a landowner's willingness to join a program to protect riparian zones (Lynch, Hardie *et al.* 2002).

The utility function parameters for the program attributes for the 3-class 'forced choice' model are shown in Table 27.[84] As discussed earlier in this section, the effect of one attribute (*paymethod*) was restricted to be the same between classes.

[84] The coefficients are symmetrical as the respondent was forced to choose between two options only. The coefficients for the levels of each attribute add up to zero.

Table 27: Parameters, standard error, z statistics, Wald and p-value for program attributes for a 3 class 'forced choice' model (Choice survey data).

PROGRAM ATTRIBUTES		β	Stand. error	z-value	β	Stand. error	z-value	β	Stand. error	z-value	Wald	p-value	Wald (=)	p-value	Mean	Std. Dev.
		Multi-objective owners Class 1			Environment owners Class 2			Production owners Class 3								
ASC		2.665	0.659	4.046	-0.553	0.826	-0.670	-2.112	1.034	-2.043	16.608	$2.5\ e^{-4}$				
Compfund	($1000/ha)	0.016	0.018	0.889	1.423	0.338	4.211	-0.0002	0.045	0.004	18.06	$4.3\ e^{-4}$	17.59	$1.5\ e^{-4}$	0.437	0.647
Legal	covenant	-0.767	0.096	-8.023	-0.207	0.141	-1.463	0.813	0.150	5.425	114.84	$1.0\ e^{-24}$	94.96	$2.4\ e^{-21}$	-0.356	0.555
	managreement	0.767	0.096	8.023	0.207	0.141	1.463	-0.813	0.150	-5.425					0.356	0.555
Landuse	limiteduse	0.629	0.093	6.787	0.905	0.220	4.115	-0.220	0.139	-1.586	72.26	$1.4\ e^{-15}$	32.66	$8.1\ e^{-8}$	0.581	0.362
	nousepermit	-0.629	0.093	-6.787	-0.905	0.220	-4.115	0.220	0.139	1.586					-0.581	0.362
Paymethod	taxrelief	-0.092	0.052	-1.765	-0.092	0.052	-1.765	-0.092	0.052	-1.765	3.11	0.078	0.00	.	-0.092	0.000
	upfrontpay	0.092	0.052	1.765	0.092	0.052	1.765	0.092	0.052	1.765					0.092	0.000
Techassist	fee4service	0.023	0.068	0.347	-0.572	0.185	-3.095	0.048	0.135	0.358	9.65	0.022	9.21	0.010	-0.152	0.276
	freetechadv	-0.023	0.068	-0.347	0.572	0.185	3.095	-0.048	0.135	-0.358					0.152	0.276

Note: Cells containing coefficients significant at the 10 percent level have been shaded

Table 27 shows that a higher level of compensation funding has a positive impact on utility for *environment owners* and is not significant for the other two landowner classes.[85] The effect of maintaining limited land use after reserve establishment on utility was broadly similar for *environment owners* and *multi-objective owners*. Restricting all land use options for reserved areas decreases the probability of choosing a program with this characteristic for these two landowner classes. The size of the coefficient suggests that the effect was slightly greater for *environment owners*. For *production owners* the sign of the coefficient for land use is significant and the opposite to the other two landowner classes.

The pattern for *environment owners* and *multi-objective owners* is also similar for entering into a temporary management agreement. These two landowner classes receive positive utility from entering into a management agreement, while *production owners* receive positive utility from placing a permanent covenant on title.[86]

There is no difference between the landowner classes in their preference for upfront payments of compensation funding as opposed to tax relief. Access to free technical advice after reserve establishment has a positive utility only for *environment owners*.

The ASC, the constant that captures the impact of unobserved factors not captured by the attributes (see Adamowizc *et al.* 1998), is significant and negative for *production owners* and positive and significant for *multi-objective owners*.

8.4.2 'Voluntary' choice model

In this section the results of estimating the 'voluntary' choice model are presented and interpreted. This model is based on the choice question where respondents were presented with three choice options: two conservation incentive programs; and a third option of not joining any program. A latent class regression is applied to choice data for all 132 survey respondents, including those who did not own any native forest.[87]

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[85] A small number of landowners did not provide an estimate of the average market value for their land (Section 8.1.6). For those landowners a market value for their land of $5,000 per hectare was assumed. The model results do not change significantly if the average value of $6,175 per hectare had been assumed (based on the average land value reported by other landowners).

[86] A discussion of the results is presented in Chapter 9.

[87] The 'voluntary' model was also carried out for forest owners only (respondents comprising the sample for the 'forced choice' model). Even though the covariates for the socio-economic variables

The steps presented in Section 8.4 are again used to estimate the final model. In the first step the latent class regression models for 1 to 4 classes were estimated using all five program attributes. The various fit statistics for each of the four models are reported in Table 28.

Table 28: Fit statistics for 1, 2, 3 and 4 latent class 'voluntary' regression models (Choice survey data).

	LL	BIC (LL)	AIC (LL)	Number of parameters	L^2	Degrees of freedom	p-value	Classification Error	$R^2(0)$	R^2
1-Class	-842.73	1729.41	1703.46	9	957.33	123	<0.001	0.000	0.311	0.074
2-Class	-704.76	1502.29	1447.52	19	681.38	113	<0.001	0.032	0.508	0.339
3-Class	-638.60	1418.81	1335.21	29	549.08	103	<0.001	0.029	0.590	0.449
4-Class	-603.12	1396.67	1284.24	39	478.11	93	<0.001	0.037	0.656	0.538

All four 'voluntary' models are significant at the 5 percent level. As expected, the log likelihood values (LL) show improvement of the model fit with increasing number of classes. The 4-class model explains 54 percent of the variance and the BIC for the 4-class choice model is lowest.

As outlined in step two (Section 8.4) the 1 to 4-class 'voluntary' models were re-estimated including three attitude variables. The model also included dummies for three socio-economic variables: tertiary education (*tert_edu*), gender (*gender*), and region (*region62*). All covariates are significant at the 5 percent level.[88] Fit statistics for the re-estimated models are reported in Table 29.

Table 29: Fit statistics for 1, 2, 3 and 4 latent class 'voluntary' model including significant covariates (Choice survey data).

	LL	BIC (LL)	AIC (LL)	Number of parameters	L^2	Degrees of freedom	p-value	Classification Error	$R^2(0)$	R^2
1-Class	-839.43	1722.73	1696.86	9	1678.86	122	<0.001	0.000	0.308	0.074
2-Class	-673.40	1468.67	1396.79	25	1346.79	106	<0.001	0.025	0.493	0.322
3-Class	-605.39	1410.66	1292.77	41	1210.77	90	<0.001	0.037	0.581	0.440
4-Class	-563.26	1404.41	1240.52	57	1126.52	74	<0.001	0.034	0.622	0.495

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differed between the models, the sign of the covariates for the attitude variables and the program attributes were the same for both models.

[88] The model was initially run with all variables listed in Tables 20 and 21 and subsequently reduced to include only those variables significant at the 5 percent level.

All four 'voluntary' models shown in Table 29 are significant at the 5 percent level. The BIC is lowest for the 4-class 'voluntary' model which includes all six covariates. The BIC falls from 1722.73 for the 1-class model that does not account for heterogeneity to 1404.41 for the 4-class 'voluntary' model. The lower BIC indicates that 4-class model has a better fit than the 1-class model.[89] As in the 'forced choice' model, the AIC for the 4-class 'voluntary' model is lower than for the 3-class model. However, as previously discussed, the AIC can become less reliable with increased numbers of classes.

The R^2 increases from 7.4 percent for the 1-class model, which does not allow for preference heterogeneity, to 44 percent for the 3-class model with covariates, and 50 percent for the 4-class model. To assess whether the R^2 statistic obtained for the 4-class model would be a significant improvement over the 3-class model, the p-value can be estimated using the conditional bootstrap method. The conditional bootstrap analysis indicated that the improvement of moving to a 4-class model was not statistically significant.

Step 3 described in Section 8.4 was to select the optimal number of latent classes on the basis of the fit statistics. Comparing the fit statistics reported in Table 28 to those in Table 29 it is evident that, on the basis of the BIC and the R^2 statistic alone, the 4-class model without covariates performs best. This result was also found for the 'forced choice' model. Again, the decrease in the value of the BIC between the 4-class model without covariates and the 3-class model with covariates is small.

Interpretation of the coefficient estimates suggests that inclusion of the covariates adds significantly to describing and understanding class membership. For these reasons, the next step, where the effect of three program attributes across latent classes (step 4 in Section 8.4) are constrained, uses the 3-class model with covariates.

The final 3-class, six covariate 'voluntary' model was re-estimated while imposing parameter restrictions across latent classes for program attributes for which no significant difference was identified (the Wald(=) statistic was greater than 0.05). As there was no significant difference between the 3 classes for *landuse*, *paymethod*, and *techassist*, the parameter restriction was applied.

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[89] Again, as applied in the 'forced choice' model, no further decrease in the BIC is observed going from a 4-class to a 5-class model.

The final 3-class 'voluntary' model contains three latent classes, includes six covariates and parameter restriction for three of the program attributes was applied. The final 3-class model is significant at the 5 percent level.[90] A BIC value of 1379.88 is determined for the final 3-class model. This value is lower than any of the BIC values reported in Tables 28 and 29 above.

Overall, the R^2 statistic is 43 percent for the final 3-class model. The final model performs well at separating individuals into classes with a dissimilarity index of 82 percent. The predictive power of the final model can also be assessed using the number of correctly classified respondent choices (Table 30). Overall, the final 3-class 'voluntary' model correctly predicts 79 percent of the 1048 observed choices.

Table 30: Classification of the final 3-class 'voluntary' model observations (percentage of observed program choice) (Choice survey data).

	Program 1	Program 2	Not join	Total
OBSERVED	**PREDICTED**			
Program 1	91 (54%)	23 (14%)	55 (33%)	169
Program 2	19 (11%)	103 (58%)	57 (32%)	179
Not join	41 (6%)	26 (4%)	633 (90%)	700
Total	151	152	745	1048

As Table 30 shows, the model correctly predicts 54 percent of observed choices for program 1. Of the 169 observed program 1 choices, 14 percent were misclassified into program 2 choice and 33 percent were misclassified into 'not joining'. A similar pattern of misclassification can be observed for observed program 2 choices. For program 2, a total of 58 percent of observed choices was correctly classified and 32 percent were misclassified into 'not joining'. A significantly higher percentage of observed choices were correctly classified for the option of not joining, which is 90 percent. The final 3-class model therefore has a high level of accuracy in predicting instances where the respondent chooses not to join (comprising 67 percent of the total number of observed choice options), as only 6 percent of observed choices of not joining were misclassified into choosing program 1, and 4 percent into choosing program 2.

Covariate classification statistics indicate how well class membership can be predicted on the basis of an individual's covariate values. The 'voluntary' model has

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[90] The final 3-class model includes 29 parameters and 102 degrees of freedom.

a classification error based on covariates of 31 percent. The R^2 statistic for the covariates indicates that 29 percent of the variance of the program choice can be explained by covariates.

On the basis of the above statistical indicators, in particular the low BIC for the final 3-class 'voluntary' model and the low model prediction error, the presence of heterogeneous preferences and the need for separate utility function estimates is suggested. The utility functions for the three landowner classes are reported in the section below.

8.4.2.1 Utility parameters for 'voluntary' model

Each of the three latent choice classes is characterised on the basis of the covariates included in the final 3-class 'voluntary' model. Estimated segment membership ($\hat{\lambda}_s$) parameters are shown in Table 31. The estimated utility function parameters ($\hat{\beta}_s$) for the program attributes for the final 3-class 'voluntary' model are subsequently shown in Table 32.

Table 31: Parameters, standard error, z statistics, Wald and p-value for attitude and socio-economic variables for the 3 class 'voluntary' model (Choice survey data).

COVARIATES	λ	Stand. error	z-value	λ	Stand. error	z-value	λ	Stand. error	z-value	Wald	p-value
	Multi-objective owner Class 1			Environment owners Class 2			Production owners Class 3				
Prod_attitude	-0.137	0.182	-0.754	-0.875	0.222	-3.947	1.012	0.281	3.601	16.418	$2.7 e^{-4}$
Env_attitude	-0.075	0.192	-0.389	0.806	0.245	3.289	-0.731	0.278	-2.632	10.916	0.004
Oppor_attitude	0.375	0.180	2.089	-0.502	0.221	-2.277	0.127	0.217	0.584	6.713	0.035
Gender (male=1)	0.408	0.223	1.831	-0.792	0.273	-2.903	0.383	0.290	1.323	9.288	0.010
Tert_edu (tertiary edu=1)	0.194	0.173	1.123	0.553	0.217	-2.548	-0.358	0.243	1.476	6.773	0.034
Region62 (south=1)	0.432	0.225	1.918	-0.820	0.314	-2.612	0.388	0.306	1.270	7.748	0.021

Note: Cells containing coefficients significant at the 10 percent level have been shaded.

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The first three rows of Table 31 show that each of the three classes in the final 'voluntary' model can be described in terms of member's attitude to the role and outcome of establishing conservation reserves on private land[91]. The coefficients on all three attitude variables[92] for members of class 2 (labelled *environment owners*) are significant at the 5 percent level. The reported signs on the three attitude variables suggest that members of this class agreed strongly that environmental advantages are associated with establishing conservation reserves. Members of this class strongly disagreed that reserves negatively impact on production or on future opportunities.

The estimated coefficients for two of the attitude variables for members of class 3 (labelled *production owners*) are the opposite to those of *environment owners*. The members of this class did not identify positive environmental outcomes of establishing reserves but strongly agreed that establishing reserves has a negative production impact. The coefficient on *oppor_attitude* is insignificant for this class.

Members of class 1 did not believe that establishing conservation reserves negatively affects production. This was also found in the 'forced choice' model. Even though members also indicated a concern that reserve establishment would reduce future opportunities (which they did not in the 'forced choice' model), this class has been labelled *multi-objective owners*.[93] Overall landowners had a 45 percent chance of being in the class labelled *multi-objective owners*, a 43 percent chance of being in the class labelled *environment landowners*, and a 12 percent chance of being in the class labelled *production owners*.

Table 31 also shows that *multi-objective landowners* can be described in terms of gender (they are more likely to be male) and region (they are more likely to own property in the south of the State). *Environment landowners* are more likely to be female, live in areas other than the south of the State, and to have achieved tertiary education. *Production landowners* are more likely to be male and to have lower education levels.

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[91] The construction of the attitudinal variables for inclusion in the voluntary model based on PCA was shown in Appendix 5. The three variables reflect environment focus, production focus, and focus on long term opportunity.

[92] As outlined in Section 8.2, the 'voluntary' model has three variables that resulted from the PCA, where as the 'forced choice' model had two variables (Appendix 5).

[93] Although it may be argued that this class of landowner is a "weak" *multi-objective owner*.

The estimated utility function parameters for the program attributes for the final 3-class 'voluntary' model are shown in Table 32. As discussed previously, all three attributes (*landuse*, *paymethod*, and *techassist*) were restricted to be the same between classes.

Table 32: Parameters, standard error, z statistics, Wald and p-value for program attributes for a 3 class 'voluntary' model (Choice survey data).

PROGRAM ATTRIBUTES		β	Stand. error	z-value	β	Stand. error	z-value	β	Stand. error	z-value	Wald	p-value	Wald (=)	p-value	Mean	Std. Dev.
		Multi-objective landowners Class 1			Environment landowners Class 2			Production landowners Class 3								
ASC		0.893	0.248	3.597	0.182	0.314	0.579	-1.075	0.359	-2.994	14.709	$6.4\ e^{-4}$				
Compfund	($1000/ha)	0.801	0.078	10.330	0.727	0.314	2.315	-0.136	0.110	-1.230	117.25	$3.0\ e^{-25}$	47.52	$4.8\ e^{-11}$	0.654	0.298
Legal	covenant	-2.064	0.234	-8.817	-2.989	0.680	-4.399	1.181	0.254	4.655	159.84	$6.4\ e^{-32}$	143.88	$4.2\ e^{-30}$	-2.061	1.289
	managreement	-0.885	0.203	-4.356	-2.058	0.761	-2.705	0.080	0.266	0.300					-1.268	0.746
	NOlegalagreem	2.948	0.391	7.532	5.047	1.185	4.258	-1.260	0.451	-2.797					3.329	1.980
Landuse	limiteduse	0.218	0.137	1.594	0.218	0.137	1.594	0.218	0.137	1.594	2.540	0.280	0.000	.	0.218	0.000
	nousepermit	-0.566	0.878	-0.645	-0.566	0.878	-0.645	-0.566	0.878	-0.645					-0.566	0.000
	UNlimiteduse	0.349	0.367	0.951	0.349	0.367	0.951	0.349	0.367	0.951					0.349	0.000
Paymethod	upfrontpay	0.032	0.045	0.711	0.032	0.045	0.711	0.032	0.045	0.711	0.023	0.990	0.000	.	0.032	0.000
	taxrelief	0.020	0.132	0.152	0.020	0.132	0.152	0.020	0.132	0.152					0.020	0.000
	NOpayment	-0.052	0.101	-0.515	-0.052	0.101	-0.515	-0.052	0.101	-0.515					-0.052	0.000
Techassist	fee4service	-0.123	0.131	-0.939	-0.123	0.131	-0.939	-0.123	0.131	-0.939	0.882	0.640	0.000	.	-0.123	0.000
	freetechadv	0.247	0.534	0.463	0.247	0.534	0.463	0.247	0.534	0.463					0.247	0.000
	NOadvice	-0.123	0.179	-0.687	-0.123	0.179	-0.687	-0.123	0.179	-0.687					-0.123	0.000

Note: Cells containing coefficients significant at 10 percent have been shaded.

Table 32 shows that for all three landowner classes none of the payment methods or technical assistance was significant at the 5 percent level. The table also shows that maintaining limited land use after joining a program had a positive effect on utility for all three landowner classes, as the variable was restricted for all groups.

Compensation funding and the legal implications of programs were broadly similar for *environment* and *multi-objective landowners*. Compensation funding is significant and positive for both classes indicating that higher levels of compensation funding had a positive impact on utility. All three levels of the legal attribute are significant for both *environment* and *multi-objective landowners* at the 5 percent level. Both placing a permanent covenant on title and entering into a temporary management agreement had a negative impact on utility. A positive utility is associated with not having any legal implications.

Similar to the 'forced choice' model, the estimated coefficient for compensation funding is not significant at the 5 percent level for *production landowners*. A positive impact on utility is associated with entering into a covenant and a negative impact on utility with entering into a legal agreement for this class.

The ASC is significant and negative for *production owners* and significant and positive for *multi-objective owners* in the 'voluntary choice' model. The negative ASC for *production owners* indicates that a status quo bias or so-called 'endowment effect' may apply (Kahneman and Knetsch 1992 quoted in Adamowicz *et al.* 1998).

Program attribute coefficients presented in the preceding sections can be used to determine the welfare impact of joining incentive programs with different levels of restrictiveness. The next section focuses on deriving welfare impact estimates.

8.4.3 Welfare impact of program restrictions

Traditionally, choice models are used to estimate the welfare impact as a consequence of changing attribute levels. An estimate of an attributes' dollar value contribution to utility can be made by taking the ratio between the attribute coefficient and the coefficient for the attribute that is expressed in dollars (Adamowicz, Louviere *et al.* 1998).[94] In this current study the attribute expressed in dollars is compensation

[94] The covariates are at their mean values.

funding. It is possible to estimate the utility of a particular scenario based on different combinations of attributes and levels (e.g. Rolfe and Bennett 1996).

In this current study the welfare impact for both the 'forced choice' and the 'voluntary choice' models is estimated for incentive programs with different levels of 'restrictiveness'. The welfare impact for both models is estimated using methods as traditionally presented in other studies (Chapter 3).

Interpretation of welfare impacts in this current study is somewhat limited for both models because the estimated coefficient for compensation funding was not significantly different to zero for all landowner groups. For instance, for the 'forced choice' model (Section 8.4.1), the estimated coefficient for compensation funding $\beta_{compfund}$ was not significantly different to zero for *production owners* or *multi-objective owners*. Consequently, Equivalent Variation (*EV*), calculated using equation 15 in Section 5.1.1, was not significantly different to zero for these owner groups. The above implies that the estimated utility of a particular scenario, based on different combinations of attributes and levels, can only be interpreted with any confidence for *environment owners*. Similarly, for the 'voluntary choice' model (Section 8.4.2), the results can be interpreted with confidence only for *multi-objective owners* and *environment owners*. The figures presented in Tables 33 and 34 that follow, have to be interpreted with care.[95]

The interpretation of the welfare impact for the 'voluntary choice' model follows that traditionally presented in choice studies (e.g. Rolfe and Bennett 1996; Horne, Boxall *et al.* 2005). The estimated welfare impact for an attribute in the 'voluntary' model (Table 34) is relative to the status quo of not joining an incentive program.

For the 'forced choice' model the estimation of the welfare impact is more limited and not equally meaningful as that estimated for the 'voluntary choice' model. For the 'forced choice' model the choice was restricted to two programs and did not include the option of not joining any program. The estimated welfare impact for an attribute is therefore the difference between the restrictive level of the attribute and the less restrictive level. A comparison of the welfare impact between the two models

[95] The limited number of observations for both models is also potentially cause for concern in the interpretation of the welfare impact.

(Chapter 9) is therefore limited due to the different interpretation of the welfare estimates.

The interpretation of the ASC for the 'forced choice' model also differs from the more traditional choice model, the 'voluntary choice' model. In the 'voluntary choice' model the ASC is a dummy variable that equals one when the status quo option is chosen. If the ASC is negative it indicates that the utility associated with selecting either program, therefore moving away from the current situation, is negative. If the ASC is negative in the 'forced choice' model it indicates a negative utility associated with greater restrictiveness of the program.[96]

With the above in mind, in Table 33 below the welfare impact of two different incentive programs with different levels of 'restrictiveness' are estimated for the 'forced choice' model and compared to the most restrictive scenario. The description of the level of restrictiveness for each of the four binary program attributes was previously described in Table 22.[97]

[96] The less restrictive attributes are coded zero and the more restrictive attributes coded one in the datasheet that underlies the calculations for the 'forced choice' model.

[97] A covenant was more restrictive than a management agreement (*legal*), no use of the land was more restrictive than limited use (*landuse*), tax relief was more restrictive/less flexible than upfront payment (*paymethod*), and fee for service was more restrictive than free of charge technical assistance (*techassist*).

Table 33: Welfare impacts for changes in incentive program restrictiveness for the 'forced choice' model, and the lower and upper 95% confidence interval (Choice survey data).

Restrictiveness scenario	Multi-objective owner	Environment owner	Production owner
Baseline-most restrictive program ($/ha)	-$93,536	**-$1,247**	-$5.00 m
Lower 95%	-$204,712	**-$1,653**	-$1,317 m
Upper 95%	$17,641	**-$840**	$1,306 m
1 Restrictive legal & land use ($/ha)	-$81,961	**-$315**	-$5.39 m
Lower 95%	-$193,138	**-$721**	-$1,317 m
Upper 95%	$29,215	**$92**	$1,306 m
WELFARE GAIN – scenario 1		**$932**	
2 Only restrictive legal ($/ha)	-$2,905	**$957**	-$3.18 m
Lower 95%	-$114,081	**$550**	-$1,315 m
Upper 95%	$108,272	**$1,363**	$1,308 m
WELFARE GAIN – scenario 2		**$2,203**	
3 Unrestrictive program ($/ha)	$93,536	**$1,247**	$5.00 m
Lower 95%	-$17,641	**$840**	-$1,306 m
Upper 95%	$204,712	**$1,653**	$1,317 m
WELFARE GAIN – scenario 3		**$2,494**	

Baseline = Covenant, no use permitted, tax relief, fee for service technical advice
Scenario 1 = Covenant, no use permitted, upfront funding, free technical advice
Scenario 2 = Covenant, limited use permitted, upfront funding, free technical advice
Scenario 3 = Management agreement, limited use permitted, upfront funding, free technical advice
* For the figures shown in grey the variable for funding amount (Table 27) was not significant at the 5 percent level.

Table 33 shows the welfare change (gain) in moving from the baseline, which is the most restrictive incentive program, to a less restrictive scenario. As expected, more restrictive incentive programs are less attractive to all forest owner groups. The welfare gain for *environment owners* from moving from the restrictive program to one where the funding method and technical advice availability attributes are less restrictive is $932 per hectare. The gain in welfare would be $2,494 for *environment owners* moving from the restrictive to the unrestrictive program.

The welfare impact of incentive programs with different levels of restrictiveness are also estimated for the 'voluntary choice' model in Table 34.

Table 34: Welfare impacts for changes in incentive program restrictiveness for the 'voluntary choice' model, and the lower and upper 95% confidence interval (Choice survey data).

Restrictiveness scenario	Multi-objective owner	Environment owner	Production owner
1 Most restrictive program ($/ha)	**-$3,399**	**-$5,020**	-$3,850
Lower 95%	**-$4,941**	**-$6,595**	-$22,168
Upper 95%	**-$1,856**	**-$3,445**	$14,468
2 Restrictive legal & land use ($/ha)	**-$2,951**	**-$4,527**	-$6,492
Lower 95%	**-$5,105**	**-$6,186**	-$23,512
Upper 95%	**-$797**	**-$2,868**	$10,529
3 Only restrictive legal ($/ha)	**-$1,972**	**-$3,448**	-$12,268
Lower 95%	**-$3,194**	**-$5,109**	-$28,997
Upper 95%	**-$751**	**-$1,787**	$4,469
4 Unrestrictive program ($/ha)	**-$500**	**-$2,166**	-$4,156
Lower 95%	**-$1,702**	**-$2,680**	$15,399
Lower 95%	**$702**	**-$1,651**	$7,086

Scenario 1 = Covenant, no use permitted, tax relief, and fee for service technical advice
Scenario 2 = Covenant, no use permitted, upfront funding, free technical advice
Scenario 3 = Covenant, limited use permitted, upfront funding, free technical advice
Scenario 4 = Management agreement, limited use permitted, upfront funding, free technical advice
* For the figures shown in grey the variable for funding amount (Table 32) was not significant at the 5 percent level.

Table 34 shows the WTA compensation estimates for joining a program with different levels of restrictiveness. Even though not joining an incentive program is the most attractive option to all landowner classes in the 'voluntary choice' model, the *EV* for joining a restrictive program is less than the average agricultural land value in Tasmania (Section 8.1.6). As expected, welfare gains are smaller with more restrictive programs for *multi-objective owners*. The *EV* for joining a restrictive program is greater for *environment owners* than for *multi-objective owners*.

Although the majority of landowners prefer not to join an incentive program the ASC was significant and positive for *multi-objective owners* (Table 32) indicating there was no status quo bias or so-called endowment effect (Kahneman and Knetsch 1992 quoted in Adamowicz *et al.* 1998).

The range for the *EV* estimates as shown in Tables 33 and 34 were calculated with an approximation formula (equation 34) as " ... there are no simple exact formulas for the mean and variance of the quotient of two random variables in terms of moments of the two random variables" (Mood, Graybill *et al.* 1974, p.180):

$$\mathrm{var}\left[\frac{X}{Y}\right] \approx \left(\frac{\mu_X}{\mu_Y}\right)^2 \left(\frac{\mathrm{var}[X]}{\mu_X^2} + \frac{\mathrm{var}[Y]}{\mu_Y^2} - \frac{2\mathrm{cov}[X,Y]}{\mu_X \mu_Y}\right) \quad (34)$$

The standard errors for each of the ratios between an attribute coefficient and the coefficient for the compensation funding attribute (expressed in dollars) are shown in Appendix 9.

8.4.4 A two-step estimation procedure of landowner preferences

In this research a PCA was used to describe forest owner groups on the basis of their attitude toward the role and outcome of establishing reserves on private land. As outlined in Section 8.2 the measurement of attitude was undertaken using Likert scale rating scores. Two factors were estimated for the 'forced choice' model. In Sections 8.4.1 and 8.4.2 preferences for program attributes were estimated for respondents, characterised by their attitude using a latent class analysis.

In this section the latent class approach is compared to a two-step estimation process, consisting of cluster analysis and logit regression.[98] Both the latent class and the two-step approaches group together similar cases and explain the association among a set of observed variables. Individuals in the same class cannot be distinguished from each other on the basis of their observed responses.

In the two-step approach, firstly the factor scores obtained in the PCA (Section 8.2) were used as the grouping variables in a K-means cluster analysis. Cluster analysis is commonly used to classify individuals into groups on the basis of their attitude (e.g. Kuuluvainen, Karppinen *et al.* 1996; Kline, Alig *et al.* 2000; Jennings and van Putten 2006). A brief outline of cluster analysis is presented in Appendix 10.

For each cluster of landowners (as opposed to class of landowner) the preferences for incentive program attributes are subsequently estimated using a straightforward logit approach. An outline of binary choice models is presented in Appendix 11. A logit or multinomial logit approach has previously been used in other studies for this type of analysis by for instance Stevens, White *et al.* (2002), Söderqvist (2003), and Horne (2004). The results of latent class analysis have been contrasted to mixed logit by Hensher and Greene (2003b) for the choice of road types in New Zealand, and to conditional logit by Scarpa, Drucker *et al.* (2003) for the choice of piglet breeds. The study by Hensher and Greene (2003b) found that no "... unambiguous

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[98] The 'voluntary' model will not be compared to the two-step estimation method, but results of the cluster analysis for all 132 respondents indicated similar results to those for the 97 forest owners.

recommendations could be made as to the superiority of any of the two approaches" (Scarpa and Thiene 2004, p.3).

The results presented in Section 8.4.5 after a discussion of some difference between latent classes and clusters.

8.4.4.1 Some differences between clusters and latent classes

As mentioned above, in cluster analysis (specifically k-means cluster analysis) an *ad-hoc* distance measure is used for classification. The probabilities in latent class analysis are used to define "closeness" to each "class" or "cluster" centre and thus formalise the K-means clustering approach in terms of a statistical model. In the latent class analysis individuals in the same class share a common probability distribution among the observed variables, estimated by maximum likelihood methods.

An important difference between latent class and K-means clustering is that latent class provides various diagnostic tools to determine the optimal number of classes (e.g. BIC as shown in Section 5.1.2). In K-means cluster analysis the number of clusters into which the data are to be grouped is determined prior to the analysis.

Another difference between the methods is that the latent class model can include exogenous variables referred to as covariates (see, for instance, Section 8.4.1) thus allowing classification and description to be carried out simultaneously using a single uniform maximum likelihood estimation algorithm. For K-means cluster analysis, discriminant analysis has to be used to determine differences between clusters.

8.4.5 Two step estimation results

As discussed in Section 5.3 a unique factor score was computed for each survey respondent for two principal components. These scores are now used as the grouping variables in a K-means cluster analysis. The aim of this is to identify groups of landowners on the basis of their systematic attitude to the role and outcome of establishing reserves on private land. The results suggest that landowners in Tasmania can be classified into three clusters, as shown in Table 35. Cluster labels generally reflect the attitude associated with the principal components with the highest positive score. The cluster results are significant at the 5 percent level.

Table 35: Final cluster centres and number of cases in cluster (Choice survey data).

PCA factor	Cluster 1 CLmulti-objective owners	Cluster 2 CLenvironment owners	Cluster 3 CLproduction owners
attitude_env	0	1	-1
attitude_prod	-1	0	1
Total respondents in cluster	39 (41%)	34 (35%)	23 (24%)

Table 35 shows that the largest cluster (C1) represents 41 percent of the sample. Members of this cluster have a negative score on the production factor. This suggests that members of this group do not believe that the establishment of reserves on private land has a negative impact on production. Members of this cluster are labelled *CLmulti-objective owners.*

The second largest cluster (C2) represents 35 percent of the sample. It appears that members of this cluster viewed conservation on private land exclusively as having a positive environmental effect. Members of this cluster are referred to as *CLenvironment owners.*

The members of the smallest cluster (C3), making up 24 percent of the forest owners, viewed conservation on private land as having a negative effect on income and future wealth and security. Negative mean scores on all other factors suggest that these individuals may not have viewed financial outcome as being complementary to the restrictions put on the land. As in the latent class approach the members of C3 are referred to as *CLproduction owners.*

The scores show the same attitude pattern as the groups that were formed on the basis of the latent class analysis (Table 26). However, some differences in class sizes can be observed between the two approaches. For instance, *production owners* make up only 15 percent of respondents in the latent class analysis as opposed to *CLproduction owners* who make up 24 percent in the cluster approach. The largest groups in the analyses are the *multi-objective owners* and *CLmulti-objective owners*, but in the latent class approach they make up 55 percent of the total whereas in the cluster analysis they make up 41 percent. Overall, the size of the classes is more evenly distributed in the cluster analysis compared to the latent class.

Even though the same attitude groups were developed using the cluster and the latent class analysis, only 37 percent of observations were classified into the same group using both methods[99] (Table 36).

Table 36: Cross classification of respondents into landowner classes and clusters by the latent class and cluster methods (Choice survey data).

	CLmulti-objective owners	CLenvironment owners	CLproduction owners	Total
Predicted by latent class method	**Predicted by cluster method**			
Multi-objective owners	26 (49%)	17 (32%)	10 (19%)	53
Environment owners	4 (14%)	11 (39%)	13 (46%)	28
Production owners	9 (60%)	6 (40%)	0 (0%)	15
Total	39	34	23	96

Table 36 shows that none of the respondents who were classified as *production owners* in the latent class approach were similarly classified in the cluster method. In contrast, almost half of the *multi-objective owners* were classified into the same group in both methods.

For each of the forest owner clusters a logit model was estimated. The number of correctly classified observations and the statistical indicators of the logit model fit for each of the forest owner clusters are shown in Table 37.

Table 37: Program choice classification and model statistics for forest owner clusters (Choice survey data).

Classification	Cluster 1 CLmulti-objective owner	Cluster 2 CLenvironment owner	Cluster 3 CLproduction owner
Correct classification of program 1	181 (65%)	168 (64%)	133 (69%)
Correct classification of program 2	213 (62%)	179 (63%)	125 (71%)
Total correct classification	394 (63%)	347 (64%)	258 (70%)
LR chi2(5)	56.67	68.45	96.62
Prob > chi2	0.000	0.000	0.000
Log likelihood	404.188	-342.844	-206.770
Pseudo R2	0.066	0.091	0.189

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[99] Note that the respondents were classified on the basis of probabilities using the latent class method. The following is an example of the probabilities for four landowners into the classes and the subsequent modal classification.

Prob Multi-obj (class 1)	Prob Env (class 2)	Prob Prod (class 3)	Modal Classification
0.5751	0.4248	0.0001	1
0.431	0.5689	0.0001	2
0.9089	0.0888	0.0023	1
0.1591	0	0.8409	3

As shown in Table 37, the logit regression models for the three forest owner clusters are significant at the 5 percent level. Around 65 percent of observations are correctly classified for the three forest owner clusters. This is lower than the number of correctly predicted observation in the latent class model, which was 81 percent for program 1 and 84 percent for program 2 with overall 82 percent correctly predicted observations. The R^2 statistic for each of the forest owner clusters is low at 7 percent, 9 percent, and 19 percent, for clusters 1, 2, and 3 respectively.[100]

The logit regression coefficient estimates for each of the three forest owner clusters are shown in Table 38. None of the socio-economic and property characteristics was significant in the logit models.

[100] The R statistic of the latent class model cannot be compared to this statistic as it is not 0-1- bounded.

Table 38: Parameters, standard error, z statistics, and p-values for logit models program attributes for three clusters of forest owner groups (Choice survey data).

	CL multi-objective owner - Cluster 1				CL environment owners - Cluster 2				CL production owner Cluster - 3			
	β.	Std. Err.	z-value	P>|z|	β.	Std. Err.	z	P>|z|	β.	Std. Err.	z	P>|z|
Compfund ($1000/ha)	0.000	0.000	0.94	0.345	0.022	0.012	1.79	0.073	0.000	0.000	2.91	0.004
Legal	-0.482	0.084	-5.73	0.000	-0.452	0.092	-4.93	0.000	-0.536	0.124	-4.33	0.000
Landuse	-0.370	0.084	-4.39	0.000	-0.534	0.092	-5.80	0.000	-0.990	0.124	-7.98	0.000
Paymethod	-0.138	0.084	-1.64	0.101	-0.041	0.091	-0.45	0.653	-0.008	0.120	-0.07	0.948
Techassist	0.000	0.084	0.00	0.996	-0.186	0.092	-2.03	0.042	-0.054	0.120	-0.45	0.653
Constant	-0.052	0.100	-0.52	0.606	-0.095	0.104	-0.91	0.364	-0.316	0.159	-1.99	0.047

Note: Cells containing coefficients significant at 5 percent have been shaded.

The results of Table 38 show that there is little difference between the three landowner clusters in the coefficients and the signs of the coefficients. Overall, the coefficients indicate that all landowner clusters prefer less restrictive programs. Cluster differences lie mainly in the size of the coefficients.

There are a number of similarities between Table 38 and Table 27 for the latent class results. For instance, in the modelling approaches the coefficient for the legal arrangement has the greatest effect for *multi-objective owners* and *CLmulti-objective owners* and the land use restrictions has the greatest effect for *environment owners* and *CLenvironment owners*. Getting free technical advice has a positive utility for only one forest owner group in the models namely *environment owners* and *CLenvironment owners*. Compensation funding does not significantly contribute to *multi-objective owner* or *CLmulti-objective owner* preferences for program attributes in the two modelling approaches.

Nevertheless, there are some important differences in the results produced using the two approaches. The most important is *CLproduction owners* are more similar in terms of their preferences for program attributes to the other two groups in the two-stage logit regression. In the two-stage approach this landowner group received positive utility from being forced to enter less restrictive incentive programs (the same as the other two groups). In the latent class analysis, however, unlike other landowners, *production owners* had higher utility associated with increasing levels of program 'restrictiveness' (i.e. the land use and legal implications). The coefficient for compensation funding is not significant in the latent class model for *production owners*, but, although only small, the coefficient is positive and significant in the logit model.

Several socio-economic landowner characteristics, such as gender, were significant in the latent class approach. Latent class can include these exogenous variables as it allows classification and description of the landowners to be carried out simultaneously using a maximum likelihood estimation algorithm. Even though the logit approach allows the inclusion of socio-economic variables as independent variables in model estimation, none were significant.

The utility coefficients for the program attributes presented in analysis above can be used to determine the welfare impact of joining more restrictive incentive programs, as in Section 8.4.3 for the latent class model.

8.4.5.1 Welfare impact for logit model

The welfare impact for the cluster analysis in combination with a logistic regression was calculated using the coefficients shown in Table 38. Table 39 below shows the welfare impact for the same restrictiveness scenarios that were previously presented for the 'forced choice' latent class model in Table 33.

Table 39: The welfare impact of program attributes for changes in the restrictiveness of the incentive program attribute for the logit regression model (Choice survey data).

Restrictiveness scenario	CLmulti-objective owners	CLenvironment owners	CLproduction owners
1 Most restrictive program ($/ha)	$116.28* (-$1,220/$1,452)**	$56.02 (-$240/$352)	$21.57 (-$34/$77)
2 Restrictive in terms of legal aspect and land use permitted ($/ha)	$83.86 (-$1,014/$1,219)	$35.02 (-187/278)	$19.89 (-$25/$67)
3 Only restrictive on legal aspect ($/ha)	$3.01 [illegible]	-$14.29 (-$86/$128)	-$7.02 (-$9/$24)

scenario 1 = Covenant, no use permitted, tax relief, and fee for service technical advice
scenario 2 = Covenant, no use permitted, upfront funding, free technical advice
scenario 3 = Covenant, limited use permitted, upfront funding, free technical advice
* For the figures shown in grey the variable for funding amount (Table 37) was not significant at the 5 percent level.
** The figure shown in brackets is the confidence interval

Table 39 shows that the most restrictive incentive programs are least attractive to all forest owner groups. The coefficient for compensation funding is only significant at the five percent level for *CLproduction owners* only.

The greatest difference between the two estimation methods can be observed for *production owners* and *CLproduction owners*, [101] although the coefficient for compensation funding is only significant in the logit method. The welfare change estimated using the logit regression method is only around $29 (21.57+7.02). Overall, the logit regression results for *production owners* would seem counter intuitive for a group of landowners who feel that establishing reserves will have a negative impact on production and believe that it has no beneficial environmental outcome.

[101] Although this is not surprising as the *production owners* in the latent class model were not the same *production owners* as in the logit model.

The premise in this dissertation was that landowners have well defined preferences for incentive program attributes. These preferences are latent and the answers to both the choice and attitude questions are manifestations of those preferences. If this is true, it makes sense to use both the choice and attitude data to estimate the preferences.

The similarity in preferences for program attributes between the groups in the logit approach and the counter intuitive relative welfare implications for *CLproduction owners* also suggests that the latent class approach is more powerful in differentiating between the groups. After all, latent class analysis can simultaneously estimate the utility function using exogenous variables (attitudes and socio-economic characteristics) as well as choice data.

Although both approaches are straightforward computationally, the information that is inherent in the choice data and contributes to the difference between *production owners* and the other two groups cannot be incorporated in the logit regression method. The logit estimation may, therefore, be less informative and lack richness and thus may potentially be a less accurate model of landowner preferences for incentive program attributes.

9 Discussion and conclusions

Conservation incentive programs that encourage landowners to set aside areas of privately owned forest have existed in Australia for more than two decades (Figgis 2004). Nevertheless, a comprehensive analysis of landowners' decision framework has not previously been undertaken. This dissertation provides such an analysis by combining information on the socio-economic characteristics of landowners, their attitudes and property characteristics, with incentive program choice data, within an econometric model of landowner behaviour.

Chapter 8 reported the results of estimating two models describing landowners' decision framework for the enrolment of forested land in conservation incentive programs using the latent class econometric technique. Chapter 9 further discusses these results with respect to the research objectives set out in Section 1.2. Specifically, it focuses on landowner preferences for incentive program attributes and the welfare implications of program design; it compares landowner preferences where entry is voluntary and forced; and it compares landowners' and program designers' perceptions of attribute importance. This chapter also focuses on a number of methodological issues and suggests direction for future research. The discussion begins with a brief summary of the latent class results for the 'forced choice' model.

9.1 Landowner preferences for program attributes: the forced choice case

The 'forced choice' model had high explanatory power and correctly classified more than 80 percent of observations which is high when compared to other studies (e.g. Scarpa and Thiene 2004; Popper, Kroll *et al.* 2004; Morey, Thatcher *et al.* 2006). An optimal number of three latent classes, *multi-objective owners*, *environment owners*, and *production owners*, was determined, and separate utility functions were estimated for three landowner classes.

Landowner classes could be characterised by their attitudes to the role and outcome of establishing conservation reserves on private land as described by two principal component attitude factors (Section 8.2). The largest landowner class, *multi-objective owners*, believed that establishing reserves did not negatively affect farm productivity.

In contrast, the smallest class, *production owners*, believed that reserve establishment negatively affected productivity. They also believed there were no positive environmental outcomes associated with establishing reserves. A third class, *environment owners*, believed there was a positive environmental outcome from establishing reserves (the results were reported in Table 26).

Landowner classes were also described by their socio-economic characteristics. *Environment owners* were more likely to be female; *multi-objective owners* were more likely to be male. A relationship was found between the size of the native forest area and participation in incentive programs. *Environment owners* were shown to be more likely to own larger tracts of forest than other types of landowners. The largest forest owner class, *multi-objective owners,* was most likely to own smaller native forest areas. *Production owners* were least likely and *multi-objective owners* were most likely to have been involved in any conservation initiatives in the past.

Separate utility functions were estimated for the three landowner classes, and results indicated that the characteristics of landowner choice differed between classes. The overall utility function was significant at the 5 percent level for all landowner classes (Table 24). The following discussion focuses on three facets of landowner choice: utility function coefficients; the relative importance of incentive program attributes; and estimated welfare measures.

Economic theory suggests that incentive programs that offer higher levels of funding will be more attractive (Section 3.2.1). Higher participation rates in programs that offer greater monetary rewards were found empirically by, for instance, Osmond and Gale (1995), Lynch, Hardie *et al.* (2002) and Stevens, White *et al.* (2002). Surprisingly, in this research, where entry was forced, compensation funding had a significant impact on program choice for *environment owners* only (Table 27). Compensation funding was not a driver of program choice for the other two landowner classes.

However, payment method did have a significant impact on program choice for all landowner classes. Moreover, this effect did not vary between landowner classes. All landowners preferred programs that make compensation payments available upfront rather than via tax relief. This is consistent both with the notion that landowners have a positive rate of time preference (e.g. Gallagher and Andrew 1997) and with the possibility that landowners place value on the "transaction" (Tversky and Kahneman 1984; Thaler 1985). That is, the transaction connects the action of setting aside an area of land and the payment for that action. Another possible explanation is that landholders did not pay enough tax to be able to take advantage of tax relief provisions.

It was expected that less restrictive programs would be more appealing to landowners. Empirical evidence reviewed in Chapter 3 confirmed that shorter commitment periods were more attractive (e.g. Esseks and Kraft 1986; Gasson and Hill 1990; Stevens, White *et al.* 2002; Horne 2004) as they allowed landowners to retain greater flexibility in terms of succession (Eggertsson 1990). Also, more land use options were retained with less restrictive programs, reducing the opportunity cost of reservation (e.g. Wilson 1997).

Results confirm that program attributes that describe "restrictiveness" (legal arrangement and land use options) were significant determinants of choice for all three landowner classes. Both *multi-objective owners* and *environment owners* preferred programs that allowed them to keep land use options open for the future. However, *production owners* preferred incentive programs involving more stringent legal arrangements and allowing no alternative land use after reserve establishment.[102]

The results of the attitudinal survey indicated that *production owners* believed that reserve establishment negatively impacted productivity. Further, 80 percent of *production owners* believed establishing reserves would make management of their property more complex. Possibly, if forced to join a program, *production owners* preferred certainty of land use and permanency of legal arrangement as this allowed them to more easily incorporate the production consequences of reservation in farm plans. *Production owners* also favoured minimal ongoing third party involvement in management decisions regarding their property, and thus favoured programs that provide less flexibility. Even though more restrictive programs allow only "conservation uses" of the land, the outcomes are certain and require no further negotiation with incentive program staff or government officials. Another possible

[102] There is a probability of 59 percent that a forest owner who chooses to implement a legally-binding covenant on their forest is a *production owner*. Similarly, there is a 63 percent chance that if full restrictions on the use of the land are accepted, this is by *production owners*. These probabilities are calculated on the basis of the probability means shown in Appendix 8.

explanation may be that *production owners* preferred to "fence and forget" while other groups understood that active management was required.

Although not significant for *production owners* or *multi-objective owners*, *environment owners* preferred incentive programs that offer access to free technical advice. The technical knowledge necessary to manage a conservation area can be specialised and extensive. Accordingly, landowners may not have the ability to manage reserves for environmental outcomes and, once committed to a scheme, may find their current knowledge inadequate. This is supported by anecdotal evidence from existing programs where landowners are given legal and administrative assistance to establish conservation covenants. Program managers often describe landowners as being concerned about the complexities of protecting land (e.g. changing the details on the title of the land or determining the optimal management options). These factors may therefore constitute real barriers to participation in programs (Jim Mulcahy, 2006, pers. comm.). Additionally, over 70 percent of *environment owners* surveyed believed that establishing a reserve increases landowner understanding of the environment, hence may simply want to learn more about environmental management. *Environment owners* did not appear concerned about ongoing third party involvement in farm management.

Overall, there is clear evidence that program attributes do influence landowner choice behaviour in the context of forced entry. While choice behaviour was generally as expected, compensation funding seems to play a smaller role in program choice than anticipated. There is also clear evidence of significant differences in the choice behaviour of different landowner classes. In particular, only *environment owners* were driven in their program choice by compensation funding and free technical advice, suggesting a focus on the financial implications of incentive programs. While compensation funding was not a significant driver for *production owners*, they were the only class who preferred more restrictive land use and legal arrangements.

The differences between landowner classes in their preferences for program attributes can be further explored by examining the relative importance of program attributes on program choice (Figure 5). The amount of compensation funding was most important for *environment owners*,[103] contributing over 95 percent to program choice. Program attributes that reflect the relative "restrictiveness" of the program together contributed less than 5 percent to their choice of program.[104]

Figure 5: Relative importance of program attributes by landowner class for the 3-class 'forced choice' model.

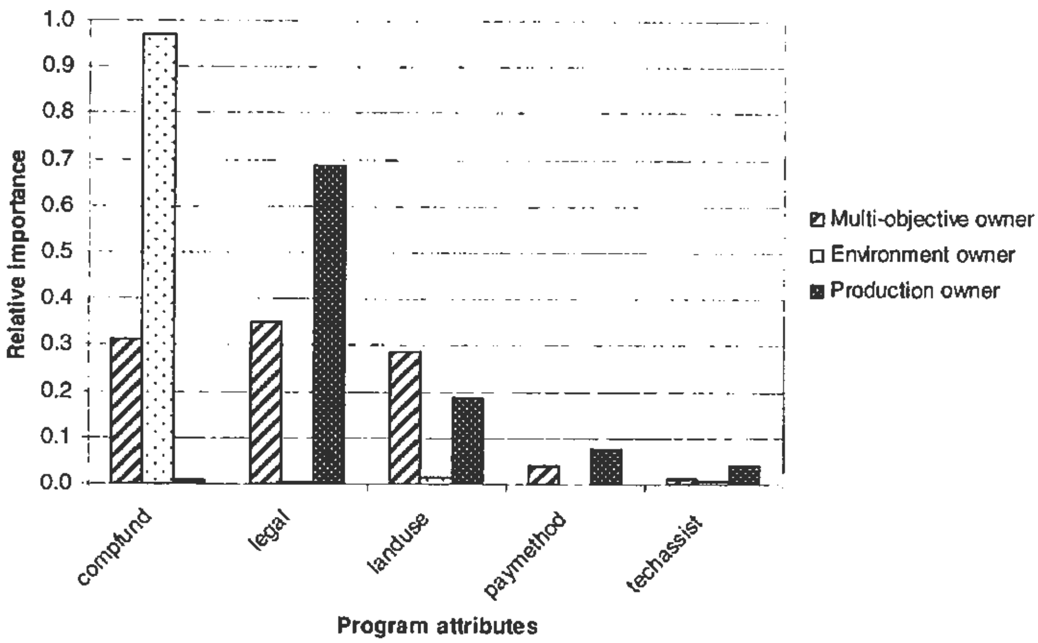

Figure 5 shows that the "restrictiveness" of the program, in particular the legal aspect, contributed almost 70 percent to *production owner* choice. Compensation funding contributed less than 1 percent to the choice. The legal mechanism, land use implications, and compensation funding each contributed approximately 30 percent to *multi-objective owners*' choice. Combined, payment method and technical advice contributed less than 10 percent to program choice for all landowner classes.

Estimated utility function coefficients (Table 27) were used to derive the welfare change in moving from a restrictive incentive program to a less restrictive incentive program (Table 33). The estimated welfare change was only significantly different to zero for *environment owners*. Although *environment owners* were driven in their

[103] Relative importance values are calculated on the basis of the probability means shown in Appendix 8. The relative importance is independent of the level of the attribute.

[104] This importance measure is similar to that measured by the BW survey, in which the attributes were ranked according to their importance. In the BW results landowners ranked the land use implications as the most important, followed by compensation funding. The legal arrangements were ranked below technical advice which was ranked third most important. These results were for all respondents and were not estimated separately for landowner attitude groups due to the small sample size.

program choice by compensation funding, the welfare gain from moving from a restrictive program to an unrestrictive program was only $2,494, less than half of the estimated average agricultural land value in Tasmania. This suggests that, if entry in incentive programs is forced, with relatively low amounts of compensation, *environment owners* are still likely to join 'restrictive' conservation programs. Although compensation funding for the other two landowner groups was not significant in their choice, the welfare gain in moving to less restrictive programs is real.

9.2 Landowner preferences for program attributes: the voluntary case

One of the aims of this research was to compare landowner choice behaviour in 'voluntary' and 'forced choice' scenarios (Section 1.2). This involved presenting landowners with a second choice experiment in which it was possible to elect not to join either of the programs. As with the 'forced choice' model, the three landowner classes were characterised by their attitude to the role and outcome of establishing conservation reserves. [105] The estimated utility function coefficients for the 'voluntary' model were reported in Table 32 (Section 8.4.2). The utility function was significant at the 5 percent level for all landowner classes (Table 29).

When presented with the option of not joining either program, 67 percent of landowners chose not to join (Table 30).[106] This may be because landowners, for a variety of reasons, are reluctant to change the basis of their land management (e.g. Morris and Potter 1995; Wynn, Crabtree *et al.* 2001; Hazell and Williams 2003). Of all landowner classes, *environment owners* were most likely to join a program. *Production owners* were least likely to join any program. Other studies have also found that individuals who had a strong conservation or environmental ethic are more likely to join a conservation program (e.g. Horne 2004).

Table 40 shows the signs of the estimated utility function coefficients for the 'voluntary' and 'forced choice' models.

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[105] Around 50 percent of respondents were classified into the same landowner group for both models. The size and attitude of the three landowner classes was similar in the two models.

[106] In the context of this research it represents the status quo.

Table 40: The signs of the estimated utility coefficients for the 'forced choice' and 'voluntary' model (Choice survey data).

	Multi-objective owners		Environment owners		Production owners	
	Forced	Voluntary	Forced	Voluntary	Forced	Voluntary
Compensation funding	ns	+	+	+	ns	ns
Legal arrangements	-	-	-	-	+	+
Land use options	-	-	-	-	+	-
Payment method	-	ns	-	ns	-	ns
Technical advice	ns	-	-	-	ns	-

ns = not significant at the 5 or 10 percent level.

Landowner preferences for program attributes were broadly similar in the 'voluntary' and 'forced choice' models. For instance, compensation funding and legal arrangements remained significant drivers of program choice for *environment owners* when choice was voluntary. *Production owners*' preference for more restrictive legal arrangements was also consistent across models. Overall, *environment owner* and *multi-objective owner* preferences showed strong similarities in both models, and *production owners* remained markedly different.

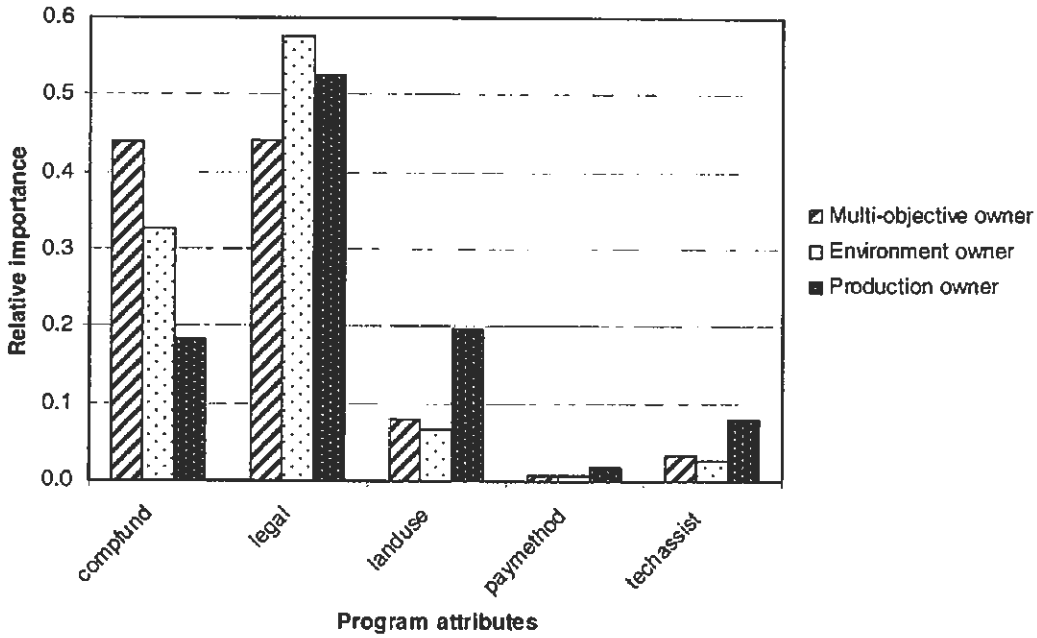
However, there were a number of notable differences in the results. While compensation funding was not a significant driver of choice behaviour in the 'forced choice' scenario for *multi-objective owners*, results suggest that this class of landowner preferred higher levels of compensation funding when entry to programs was voluntary.

In the 'voluntary' model both the direction and magnitude of landowner preferences for land use restrictions, payment method, and technical advice did not vary between landowner classes (Table 32). All landowner classes preferred to join programs where technical assistance was provided free of charge, whereas, when enrolment was forced, technical advice was not a significant driver of choice for *environment owners* and *production owners*. In addition, although payment method did not significantly influence choice in the 'voluntary' scenario for any of the landowner classes, more flexible payment arrangements were preferred in the 'forced choice' scenario.

Environment owner and *multi-objective owner* preferences for less restrictive land use options did not vary between the models, however, *production owner* preferences differed. In the 'voluntary' scenario *production owners* preferred programs that retained limited use of the land; in the 'forced choice' scenario they preferred to use the reserved land exclusively for conservation purposes.

Differences between the two models can also be observed in the relative importance of the attributes (Figure 6).

Figure 6: Relative importance of program attributes by landowner class for the 3-class 'voluntary' model.



Overall, there was greater homogeneity between landowner classes in the relative importance of program attributes in the 'voluntary' scenario than in the 'forced choice' scenario (Figure 5). For instance, in the 'voluntary' scenario the legal implications contributed around 50 percent to the choice for all landowner classes. In the 'forced choice' scenario, the legal attribute made only a negligible contribution to the choice for *environment owners.* A possible explanation may be that this group assumed that being forced to join was synonymous with having legally binding restrictions, and therefore ascribed less importance to this attribute.[107]

A major change in the relative importance of compensation funding was observed for *environment owners.* When *environment owners* were forced to join a program, compensation funding contributed over 90 percent; in the 'voluntary' scenario this percentage fell to around 30. In contrast, compensation funding became more important to *production owners* in the 'voluntary' situation.

[107] It may also be that the differences between the model coefficients and the importance may be due to some "psychological reaction" when placed in a situation of being forced to choose versus one where the choice is voluntary. It is beyond the scope of this current research to further speculate on this issue.

In both choice scenarios, and for all landowner classes, the legal arrangements and compensation funding amount were more important to the choice than land use restrictions. Payment method and technical assistance contributed less than 10 percent to the choice in both scenarios.

Overall, the relative importance of program attributes remained largely the same for *multi-objective owners*. In the 'voluntary' scenario both compensation funding and the legal arrangements were equally important to *environment owners*. The relative importance of compensation funding and legal arrangements increased for *production owners* in the 'voluntary' scenario.

The estimated utility coefficients were used in Section 8.4.3 to derive the welfare impact of different incentive program scenarios for both models (Tables 33 and 34). There is limited opportunity to compare the welfare changes between the two models for the different restrictiveness levels due to the different interpretation of the welfare change (Section 8.4.3). In the 'forced choice' model, the welfare gain from moving from a restrictive program to an unrestrictive one, for *environment owners*, was lower than the average agricultural land values.

In the 'voluntary choice' scenario, the *EV* for joining a restrictive program for *environment owners* was also lower than the average agricultural land values in Tasmania perhaps indicating some non-monetary utility from joining. The *EV* of joining a less restrictive program for *multi-objective owners* was smaller in the 'voluntary' scenario than the *EV* for *environment owners*. This may be due to the lack of productive intentions that *environment owners* may have had for the land, hence experiencing relatively greater gains from more restrictive programs. Overall, for the small proportion of landowners who voluntarily joined a program the welfare losses were lower than the average agricultural land values, even though their preferences for program attributes differed.

As shown above, landowner preferences for program attributes differed when they were forced to join a program compared to a situation where choice was voluntary. The difference in landowner preferences between choice scenarios and between landowner classes will be of interest in the design of incentive programs. The implication of the results of this research for program design is the subject of the next section.

9.3 Concluding remarks

One of the contributions of this dissertation was the way in which the Best-Worst (BW) survey added to the analysis. Firstly, the BW survey assisted in reducing the number of program attributes to a 'manageable' number for the subsequent Choice experiment. The ten program attributes determined by the focus group were ranked in order of importance using the BW approach.[108] The five most important were used in the Choice survey.

Secondly, the BW survey formed the basis for testing policy makers' understanding of landowner preferences for program attributes. After all, if policy makers do not understand which program attributes are important in a landowner's decision process, poorly designed and implemented programs and promotion efforts may result. For this purpose, the BW survey was administered to both policy makers and landowners. Policy makers were asked to rate the most and least important attributes from a landowner's point of view. This allowed testing of policy makers' ability to reproduce landowner ranking of attributes.

Results indicated no statistical difference in the ranking of attributes between groups. Both landowners and policy makers ranked land use implications as most important and compensation funding amount as second most important. The only difference in ranking suggests that policy makers believed landowners gave more weight to the legal implications of joining a program than landowners revealed they did (Table 3). At least in a BW experiment, based on this it may be concluded that policy makers had a good understanding of how landowners rank program attributes.

As noted previously, most conservation incentive programs in Australia and Tasmania are based on voluntary participation (Section 2.4). However, in this research only 33 percent of landowners were willing to take up these incentives and the obligations that went with them. Low participation in voluntary programs is one reason why Tasmanian reservation targets have not been met (Resource Planning and Development Commission 2003). The results of the current research confirm that

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[108] In this current research the design of the Choice survey, using the BW ranking approach, was not compared to what the design may have been had the traditional focus group been used. Moreover, it is not known if members of the focus group and their respective 'class membership' may have biased the relative ranking of attribute importance.

relying on voluntary conservation programs may not attract sufficient participation to meet protection targets.[109]

Increasing the amount of compensation funding offered by incentive programs has been perceived as the main, and most direct, avenue of addressing low program uptake by landowners. This research showed that when choice is voluntary, increasing participation was best achieved by offering programs that allowed flexibility in terms of the legal arrangements and other program attributes. The WTA compensation for joining programs with this level of restrictiveness was lower than the average Tasmania land values for two of three landowner groups (around $4,500 per hectare for *environment owners* and $3,000 per hectare for *multi-objective* owners). This research also suggests that, when forced to enter, *environment owners* were the only class for whom compensation was important, and the welfare gain from having less restrictive program attributes was only small.

The results of this research also have implications for the design of conservation programs when entry is compulsory. In particular, the results suggest that welfare losses to landowners can be minimised by offering flexible schemes. Although compensation funding contributed to program choice only for *environment owners*, welfare gains from offering less restrictive programs were small. This landowner class appeared to be engaged in issues concerning conservation and seemed to need limited financial support, gaining more from legal and administrative assistance. Compensation was not a main driver of program choice for *production owners* but they differed in their preferences for the restrictiveness of the other program attributes. *Production owners* preferred programs that did not require them to combine conservation with productive land use and found more restrictive programs attractive.

9.4 Recommendations for future research

The research presented in this dissertation suggested a number of important directions for further enquiry, related to both policy and methodological objectives.

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[109] In this it is assumed that low participation means low acreage protected. Obviously in some cases, where a small area is required for protection to meet conservation targets, 30 percent participation may be sufficient.

Firstly, the focus of this research was on investigating the way in which landowners traded off incentive program attributes in the conservation incentive program choice environment. While this improved understanding of landowner choice behaviour can inform the process of program design, there is clearly a need for comprehensive benefit cost analyses of both conservation targets and specific conservation policies and programs. The research presented here has shown that conservation targets may not be achieved by relying on the voluntary uptake of conservation programs alone, and that forcing entry, perhaps through the compulsory acquisition of land of high biodiversity value, might be required. In either case, landowners may be subject to high welfare costs and the question of appropriate compensation would require further investigation. In other words, is there a net gain to society from protection?

Secondly, landowner beliefs about the role and impact of establishing conservation reserves on private land were shown to be important in determining participation and in explaining preferences for program attributes. Further research is needed to establish the way in which underlying values and general environmental attitudes help to shape these beliefs and to explore ways in which landowner beliefs can be modified, perhaps through better education and information provision about the links between reserve establishment and private and social outcomes.

The use of choice modelling to explore responses to changes in the policy environment is still quite novel. This dissertation has shown how choice modelling can be usefully applied to exploring landowners' behavioural responses to changes in the design of conservation programs. Extending the application of choice modelling for this purpose, in resource and environmental policy and in other areas, represents a third area of future research. This method may also aid in program attribute development in other disciplines, such as the health sciences. Moreover, investigation into the effect of the 'psychological reaction' to placing survey respondents in a situation of 'forced' versus 'voluntary' choice on attribute preference may provide further insights that may be relevant to many disciplines.

Fourthly, the use of a Best-Worst survey to complement the choice experiment in this research has highlighted the need for further work in understanding the evaluative processes involved in alternative stated-preference decision environments. While the attribute rankings of landowner and program designers as revealed by the BW experiment were not significantly different, landowner's ranking of attributes in the choice experiment did not mirror that of the BW.

Finally, this research has demonstrated the potential of latent class regression analysis in the context of choice of environmental programs. The results suggest that it can provide a richer interpretation of choice behaviour than more traditional estimation methods[110], as was also found by Boxall and Adamowicz (2002) with respect to wilderness recreation behaviour. Future research may further establish the gains of using latent class over traditional methods.

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[110] The curiosity that the scores from the cluster analysis showed the same attitude pattern as latent class analysis, but that only about one third of the sample were classified in the landowner groups, is also worthy of further research.

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Pers Comm

Mr. Jim Mulcahy, Conservation Agreements Officer, Protected Areas on Private Land program, Tasmanian Land Conservancy, Hobart.

Dr. David Rankin, Research Officer, Environment and Energy, Australian Bureau of Statistics, Hobart,

Appendix 1 – Best-Worst experimental design

The experimental design contains a total of 18 sets, 10 attributes, and 5 attributes per set. The design is shown below.

t=10, k=5, b=18, r=9, λ=4, E=0.8889

BIBD					
1	1	3	4	9	5
2	2	9	10	6	3
3	10	4	5	7	3
4	3	6	1	8	4
5	1	5	7	2	4
6	4	2	6	8	5
7	3	7	9	6	5
8	5	8	10	7	6
9	4	6	9	8	7
10	7	10	3	1	8
11	5	8	3	9	2
12	6	10	1	4	9
13	7	4	2	10	9
14	8	9	1	5	10
15	10	5	2	6	1
16	6	7	3	2	1
17	9	1	7	8	2
18	10	2	8	3	4

COMPLEMENT					
1	2	6	7	8	10
2	1	4	5	7	8
3	1	2	6	8	9
4	2	5	7	9	10
5	3	6	8	9	10
6	1	3	7	9	10
7	1	2	4	8	10
8	1	2	3	4	9
9	1	2	3	5	10
10	2	4	5	6	9
11	1	4	6	7	10
12	2	3	5	7	8
13	1	3	5	6	8
14	2	3	4	6	7
15	3	4	7	8	9
16	4	5	8	9	10
17	3	4	5	6	10
18	1	5	6	7	9

Where:

(t) = program attributes

(k) = number of attributes presented in a block

(b) = total number of blocks

(r) = Number of times the attribute appears in the experiment

(λ) = Number of times an attribute appears in combination with each other attribute

E = design efficiency factor

Appendix 2 – Best-Worst survey

Question 1

Which organisation do you work for? ....

Question 2

Approximately how many years have you worked in jobs related to resource conservation? ....Years

Question 3

How would you best describe you position?
(tick only one)

- ☐ Scientific officer
- ☐ Extension officer
- ☐ Policy officer
- ☐ Administration
- ☐ Management
- ☐ Other ....

Question 4

How often do you spend time out in the field, working on properties of conservation significance?
(tick only one)

- ☐ Frequently (3 times or more per week)
- ☐ Regularly (once or twice per week)
- ☐ Not very often (on average less than once per month)
- ☐ Never

Question 5

How often do you have face-to-face interactions with landowners who own land of conservation significance?
(tick only one)

- ☐ Frequently (3 times or more per week)
- ☐ Regularly (once or twice per week)
- ☐ Not very often (on average less than once per month)
- ☐ Never

SECTION 3 – OUTCOMES OF INCENTIVE PROGRAM

In this section we would like you to indicate *what you think landowners believe* the least important and the most important attributes of a conservation incentive program are. You are asked to do this 18 times, each time you are presented with a different set of 5 program attributes. Asking you to repeat this process 18 times will allow us to find out how you value each attribute in comparison to every one of the others.

For example **Tick only one**

Part XX

Most important	Tick only one Program attribute	Least important
☐	Application procedure	☐
☐	Technical support availability	☑
☑	Land use restriction	☐
☐	Legal mechanism	☐
☐	Program duration	☐

Tick only one

Which program attribute do you think is most important and which do you think is least important to a landowner who is thinking about joining an incentive program to protect native vegetation?

Part 1

Most important	Tick only one Program attribute	Least important
☐	Funding amount	☐
☐	Funding agency	☐
☐	Program duration	☐
☐	Application procedure	☐
☐	Technical support availability	☐

Part 2

Most important	Tick only one Program attribute	Least important
☐	Payment method	☐
☐	Application procedure	☐
☐	Monitoring & survey requirements	☐
☐	Funding allocation process	☐
☐	Funding agency	☐

Part 3

Most important	Tick only one Program attribute	Least important
☐	Monitoring & survey requirements	☐
☐	Program duration	☐
☐	Technical support availability	☐
☐	Land use restriction	☐
☐	Funding agency	☐

Part 4

Most important	Tick only one Program attribute	Least important
☐	Funding agency	☐
☐	Funding allocation process	☐
☐	Funding amount	☐
☐	Legal mechanism	☐
☐	Program duration	☐

Part 5

Most important	Tick only one Program attribute	Least important
☐	Funding amount	☐
☐	Technical support availability	☐
☐	Land use restriction	☐
☐	Payment method	☐
☐	Program duration	☐

SECTION 3 – OUTCOMES OF INCENTIVE PROGRAM

Which program attribute do you think is most important and which do you think is least important to a landowner who is thinking about joining an incentive program to protect native vegetation?

Part 6

Most important	Tick only one Program attribute	Least important
☐	Program duration	☐
☐	Payment method	☐
☐	Funding allocation process	☐
☐	Legal mechanism	☐
☐	Technical support availability	☐

Part 7

Most important	Tick only one Program attribute	Least important
☐	Funding agency	☐
☐	Land use restriction	☐
☐	Application procedure	☐
☐	Funding allocation process	☐
☐	Technical support availability	☐

Part 8

Most important	Tick only one Program attribute	Least important
☐	Technical support availability	☐
☐	Legal mechanism	☐
☐	Monitoring & survey requirements	☐
☐	Land use restriction	☐
☐	Funding allocation process	☐

Part 9

Most important	Tick only one Program attribute	Least important
☐	Program duration	☐
☐	Funding allocation process	☐
☐	Application procedure	☐
☐	Legal mechanism	☐
☐	Land use restriction	☐

Part 10

Most important	Tick only one Program attribute	Least important
☐	Land use restriction	☐
☐	Monitoring & survey requirements	☐
☐	Funding agency	☐
☐	Funding amount	☐
☐	Legal mechanism	☐

Part 11

Most important	Tick only one Program attribute	Least important
☐	Technical support availability	☐
☐	Legal mechanism	☐
☐	Funding agency	☐
☐	Application procedure	☐
☐	Payment method	☐

Part 12

Most important	Tick only one Program attribute	Least important
☐	Funding allocation process	☐
☐	Monitoring & survey requirements	☐
☐	Funding amount	☐
☐	Program duration	☐
☐	Application procedure	☐

SECTION 3 – OUTCOMES OF INCENTIVE PROGRAM

Which program attribute do you think is most important and which do you think is least important to a landowner who is thinking about joining an incentive program to protect native vegetation?

Part 13

Most important	Tick only one Program attribute	Least important
☐	Land use restriction	☐
☐	Program duration	☐
☐	Payment method	☐
☐	Monitoring & survey requirements	☐
☐	Application procedure	☐

Part 14

Most important	Tick only one Program attribute	Least important
☐	Legal mechanism	☐
☐	Application procedure	☐
☐	Funding amount	☐
☐	Technical support availability	☐
☐	Monitoring & survey requirements	☐

Part 15

Most important	Tick only one Program attribute	Least important
☐	Monitoring & survey requirements	☐
☐	Technical support availability	☐
☐	Payment method	☐
☐	Funding allocation process	☐
☐	Funding amount	☐

Part 16

Most important	Tick only one Program attribute	Least important
☐	Funding allocation process	☐
☐	Land use restriction	☐
☐	Funding agency	☐
☐	Payment method	☐
☐	Funding amount	☐

Part 17

Most important	Tick only one Program attribute	Least important
☐	Application procedure	☐
☐	Funding amount	☐
☐	Land use restriction	☐
☐	Legal mechanism	☐
☐	Payment method	☐

Part 18

Most important	Tick only one Program attribute	Least important
☐	Monitoring & survey requirements	☐
☐	Payment method	☐
☐	Legal mechanism	☐
☐	Funding agency	☐
☐	Program duration	☐

Section 3 – Outcomes of incentive program

In this section we ask you to indicate how strongly you agree or disagree with 26 statements about the role and impacts of establishing reserves on private land.

Conservation reserves on private land are:

		Please tick ☑ **only 1** of the 5 options				
		++ Strongly Agree	+ Agree	+/- Neutral	- Disagree	-- Strongly Disagree
A	An effective way to ensure wildlife survival	☐	☐	☐	☐	☐
B	Can be expensive as they lead to reduced productivity due to shading	☐	☐	☐	☐	☐
C	Reduce the potential to earn income from the rest of the property	☐	☐	☐	☐	☐
D	Create a good image for landowners	☐	☐	☐	☐	☐
E	Expensive to manage	☐	☐	☐	☐	☐
F	Will benefit others as much as the landowner	☐	☐	☐	☐	☐
G	Threaten the landowners' livelihood	☐	☐	☐	☐	☐
H	Give the landowner a sense of fulfilment	☐	☐	☐	☐	☐
I	Add to the beauty of the landscape	☐	☐	☐	☐	☐
J	Will mainly benefit the future generation	☐	☐	☐	☐	☐
K	Will increase the landowner's understanding of the environment	☐	☐	☐	☐	☐
L	Provide a good way to protect species from extinction	☐	☐	☐	☐	☐
M	Create a harbour for weeds	☐	☐	☐	☐	☐
N	Increase the fire threat to the landowners' property	☐	☐	☐	☐	☐
O	Of value for stock shelter and control	☐	☐	☐	☐	☐
P	Increase the opportunities to earn income from recreation/tourism	☐	☐	☐	☐	☐
Q	Take up a lot of time to manage	☐	☐	☐	☐	☐
R	Should be left alone with minimal management	☐	☐	☐	☐	☐
S	Reduce the landowners' opportunity to diversify	☐	☐	☐	☐	☐
T	Best established where neighbours work together to protect areas	☐	☐	☐	☐	☐
U	Will reduce the potential for soil erosion and salinity	☐	☐	☐	☐	☐
V	Reduce the property value	☐	☐	☐	☐	☐
W	Will make the management of the remainder of the property more complicated	☐	☐	☐	☐	☐
X	Reduce the security of future income	☐	☐	☐	☐	☐
Y	Only desirable if there is no other valuable use for the land	☐	☐	☐	☐	☐
Z	Create a harbour for animals that are a pest to farming	☐	☐	☐	☐	☐

If you think that the "Funding amount" is most important and "Monitoring & survey requirements" are least important to you, your answer would look like the following:

Tick only one

For example

Part XX

Most important	Tick only one Program attribute	Least important
☐	Land use restriction	☐
☐	Monitoring & survey requirements	☑
☐	Funding agency	☐
☑	Funding amount	☐
☐	Legal mechanism	☐

Tick only one

Application procedure

The administrative procedure involved in applying for incentive program funding. For example the landowner may need to discuss reservation options with a negotiator employed by an incentive program or may simply need to fill out an application.

Funding allocation process

The way in which the program determines eligibility for the funding. For example the agency may choose the best application or the best and cheapest application.

Funding agency

Whether the agency that delivers the incentive program is public or private sector.

Funding amount

The amount of money paid to the landowner for participation in an incentive program as a proportion of a "fair market value"

Land use restriction

The restrictions defining what the landowner is and isn't allowed to do with the land after reserve establishment. For example the landowner may be allowed to graze the reserve area occasionally or no productive use at all may be permitted.

Legal mechanism

The nature of the legal restrictions that are placed on the land after reserve establishment. For example the conservation values of the land may be protected by a *permanent* covenant or a *temporary* management agreement.

Monitoring & survey requirements

The flora and fauna monitoring and survey requirements for a landowner after reserve establishment

Payment method

The method by which the money (funding amount) is paid to the landowner. For example the money may be paid in a lump-sum or in instalments.

Program duration

How long the landowner is expected to participate in the program (i.e. representing the timeframe over which funding payments are made and over which monitoring is required)

Technical support availability

The availability and cost of technical support after reserve establishment.

Appendix 3 – Choice survey

What is the survey about?

In Tasmania, government and non-government organisations have been running different incentive programs for landowners for many years. For example there exist a number of *environmental* programs that provide incentives to landowners to fence native vegetation, to plant trees to prevent erosion, and protect riverbanks. There are also *conservation* programs that offer money incentives to landowners to set aside areas of native vegetation as "formal reserves".

Landowners across Tasmania are likely to respond differently to the different details (also called attributes) of the conservation incentive programs. Some landowners will base their decision of whether to join a program or not only on the amount of money they receive for the land they are setting aside as reserve. Other landowners may be guided more by the land use restrictions that would apply to the land if they were to join a program (they may not be able to graze the area any longer). Some landowners will want more money the more severe they believe the restrictions are. Other program attributes that are likely to have an impact on the decision to join a program or not, may be the way the incentive money is paid (in a lump sum or installments), or the technical support that's available after the reserve is established.

We believe it is important to understand the landowners' views on these issues. In this survey we are interested in the opinion of both landowners who have native forest and those who don't and this includes *your* opinion. We want to know how a program would look that *you* would join, and what your overall requirements and standards are. You may feel that there is no program that you would join regardless of what's on offer. If so, we need to know.

We hope you will take the time to participate in this survey so that incentive programs available in the future can take your views and opinions on board.

How long it will take you

We estimate that it will take you **10 to 15 minutes** to complete the survey. Participation in this survey is entirely **voluntary**. The survey is **anonymous**, the researchers will be unable to identify participants and no participant will be identifiable in any of the research output.

Returning the survey

After you have filled out the survey please place it in the stamped envelope that is provided and mail it back to us by the 19th of August 2005.

Thank you for helping make incentive programs more responsive to your needs.

Researcher contact details

Dr. Sarah Jennings (sarah.jennings@utas.edu.au or (03) 6226 2828) and Ingrid van Putten (i.vanputten@utas.edu.au or (03) 6226 2820) can be contacted for questions and comments on the survey. Results from the study will be posted on the publicly accessible School of Economics website after completion of the study (see fcms.its.utas.edu.au/commerce/econ).

Type of survey questions

To make it easier for us to understand your views, and to limit our demands on your time, this survey contains mostly multiple-choice questions. We use a repeated choice technique in section 2 which asks you to answer the same multiple choice question a number of times but each time with slightly different details. This approach is used because it makes your choice easier to understand. It is **not** used to test you or to test the consistency of your answers.

We have included a separate sheet that explains some of the terms used in this survey.

how the survey is laid out

The survey consists of 4 sections. The questions in the 1st section are about your property and the management of your property. In the 2nd section we want to hear your opinion on the details that make up an incentive program that would appeal to you. In the 3rd section you are asked to rate a number of statements about private nature reserves. The last section contains a few questions about you.

Ethics approval

The study has been approved by the Human Research Ethics Committee (Tasmania) Network. If you have any concerns of an ethical nature about the study, please contact the Executive Officer of the Human Research Ethics Committee (Tasmania) Network, Amanda McAully (Ph (03) 6226 2763).

Thank you for helping make incentive programs more responsive to your needs.

UTAS

Question 1

Are you? *(tick only one)*

- ☐ The owner *and* manager of the property
- ☐ The owner (but not the manager) of the property
- ☐ Other ....

Question 2

How long have you owned this property? ....Years

Question 3

What are the ownership details of the property? *(tick only one)*

- ☐ Private ownership
- ☐ Partnership
- ☐ Family trust
- ☐ Private or public company
- ☐ Other ....

Question 4

Do you reside on the property? *(tick only one)*

- ☐ Yes
- ☐ No

Question 5

Approximately how large is your property? *(delete one)*

....Hectares/Acres

Question 6

What agricultural activities do you undertake on your property? *(tick any that apply)*

- ☐ Don't use it for any agricultural activity
- ☐ Wool
- ☐ Meat
- ☐ Dairy
- ☐ Cropping
- ☐ Horticulture
- ☐ Other ....

Question 7

Which two numbers does your telephone number start with?

- ☐ 62
- ☐ 63
- ☐ 64

Question 8

How many years have you been involved in resource conservation and management? *(tick any that apply)*

....Years

- ☐ I have not been involved

Question 9

Do you manage areas on your property for the following non-commercial purposes? *(tick any that apply)*

- ☐ Erosion control / salinity prevention
- ☐ Protection of vegetation on waterways
- ☐ Shelter
- ☐ Recreation
- ☐ Personal firewood collection
- ☐ Other ....

UTAS

Question 10

Have you received any of the following forms of support for managing areas on your property in the past 5 years?

(tick any that apply)

- ☐ Money for fencing
- ☐ Money for revegetation
- ☐ Trees for revegetation
- ☐ Labour assistance for revegetation
- ☐ Money for improving soil management
- ☐ Scientific advice (eg. identification of animals)
- ☐ Technical advice (eg. management of animals)
- ☐ Administrative assistance (eg. filling out form)
- ☐ Legal advice (eg. implication of covenants)
- ☐ Other ....

Question 11

Is there any native forest on your property?

- ☐ Yes **(Please go to the next question - 12)**
- ☐ No **(Please go to question 19 on page 4)**

Question 12

Approximately how large is the area of native forest on your property?

(delete one)

....Hectares/Acres

Question 13

Do you manage areas of native forest on your property for the following *commercial* uses?

(tick any that apply)

- ☐ Don't use it for anything
- ☐ Grazing
- ☐ Commercial timber harvesting
- ☐ Hunting
- ☐ Commercial seed collection
- ☐ Other ....

Question 14

Do you have any plans to harvest any of your native forest for *commercial* purposes in the future?

(tick only one)

- ☐ Yes
- ☐ No
- ☐ Don't know

Question 15

Is there a *formal* conservation reserve anywhere on your property?

(tick only one)

- ☐ Yes
- ☐ No
- ☐ Don't know

Question 16

Have you received funding to establish a conservation reserve on your property?

(tick only one)

- ☐ Yes
- ☐ No
- ☐ Don't know

Question 17

Do you manage any part of your property specifically for conservation without it being formally protected?

(tick only one)

- ☐ Yes
- ☐ No
- ☐ Don't know

Please proceed to the next page and answer Question 18

Question 18

For landowners WHO OWN an area of native forest

To set the scene for the next section of the survey we ask you to think about a particular area of native forest on your property that has <u>some conservation value</u> (it doesn't matter what the type of forest is or where it is on your property). If you don't own an area of forest *with conservation values* please think of any other tract of native forest on your land. Please answer these brief questions about that area of native forest.

Approximately how large is the area of native forest you are thinking of?	***(delete one)*** ....Hectares/Acres
In your opinion, what would be a *fair* market value for this area of native forest?	***(delete one)*** $..................................per Hectare/Acre
The estimate of the fair market value of this area of native forest was made on the basis of	*(tick any that apply)* ☐ What I paid for the land ☐ Value of similar land in the district ☐ Government valuation ☐ What I could get if I sold the timber ☐ Other ....
In your opinion, does this area have conservation value?	☐ Yes ☐ No ☐ Don't know

For the next section please assume you could enrol the area of native forest you described above in a conservation incentive program. Enrolling the land may mean you will have to change the use of that land but you would retain ownership of the land.

Please now proceed to page 5 and answer all 8 parts of question 20

Question 19

For landowners who DON'T OWN an area of native forest

Even though you currently don't own any land with native forest, we are interested in your opinion about the sort of incentive program that would appeal to you if you did own forested land.

To set the scene for the next two sections please place yourself in the position of someone who owns an area of native forest. Please imagine that 10% of your property is covered with one single contiguous block of native forest.

	(delete one)
Approximately how large would the area of native forest be?	....Hectares/Acres

Say that similar forested land in your region has sold for around $5,000 per hectare in the past year. On this basis a *fair* market value for the area of native forest would be $5,000 per hectare times the size of the area you indicated above.

Imagine that this forest has conservation value and is eligible to be enrolled in a conservation incentive scheme. Enrolling the land may mean you will have to change the use of that land but you would retain ownership of the land. Please keep this area of native forest in mind.

Please now proceed to page 5 and answer all 8 parts of question 20

Question 20

We would like you to tell us which of two incentive programs you would prefer if you could enrol the forested land described previously in a conservation incentive program. You are given the option of choosing between two programs that are different in a maximum of 5 possible ways. You are asked to repeat this exercise 8 times. The repetition will help you to think about the difficult tradeoffs between the various aspects of programs and help us to design programs that make better use of taxpayer's money.

Please refer to the back of the glossary insert for an example of this question.

There are two incentive programs you can enrol your land in (program 1 and 2 below). Which one would you choose?

Part 1	Program 1	Program 2
Funding amount	½ the market value	¾ of the market value
Legal mechanism	Temporary management agreement	Permanent covenant
Land use restriction	No use permitted	Limited use permitted
Payment method	Tax relief	Up-front lump sum payment
Technical support availability	Free of charge	Fee for service

A Of these two programs my preferred one is ☐ 1 ☐ 2

B I would *voluntarily* enrol my land in program ☐ 1 ☐ 2 ☐ Neither 1 nor 2

Please check you have answered both A and B above

Part 2	Program 1	Program 2
Funding amount	Exactly the market value	1¼ of the market value
Legal mechanism	Temporary management agreement	Permanent covenant
Land use restriction	No use permitted	Limited use permitted
Payment method	Up-front lump sum payment	Tax relief
Technical support availability	Free of charge	Fee for service

A Of these two programs my preferred one is ☐ 1 ☐ 2

B I would *voluntarily* enrol my land in program ☐ 1 ☐ 2 ☐ Neither 1 nor 2

Please check you have answered both A and B above

UTAS

Part 3	Program 1	Program 2
Funding amount	1¼ of the market value	½ the market value
Legal mechanism	Permanent covenant	Temporary management agreement
Land use restriction	No use permitted	Limited use permitted
Payment method	Tax relief	Up-front lump sum payment
Technical support availability	Fee for service	Free of charge

Of these two programs my preferred one is ☐ 1 ☐ 2

I would *voluntarily* enrol my land in program ☐ 1 ☐ 2 ☐ Neither 1 nor 2

Please check you have answered both A and B above

Part 4	Program 1	Program 2
Funding amount	¾ of the market value	Exactly the market value
Legal mechanism	Temporary management agreement	Permanent covenant
Land use restriction	Limited use permitted	No use permitted
Payment method	Tax relief	Up-front lump sum payment
Technical support availability	Free of charge	Fee for service

Of these two programs my preferred one is ☐ 1 ☐ 2

I would *voluntarily* enrol my land in program ☐ 1 ☐ 2 ☐ Neither 1 nor 2

Please check you have answered both A and B above

Part 5	Program 1	Program 2
Funding amount	Exactly the market value	1¼ of the market value
Legal mechanism	Permanent covenant	Temporary management agreement
Land use restriction	No use permitted	Limited use permitted
Payment method	Up-front lump sum payment	Tax relief
Technical support availability	Free of charge	Fee for service

Of these two programs my preferred one is ☐ 1 ☐ 2

I would *voluntarily* enrol my land in program ☐ 1 ☐ 2 ☐ Neither 1 nor 2

Please check you have answered both A and B above

Part 6	Program 1	Program 2
Funding amount	¾ of the market value	Exactly the market value
Legal mechanism	Temporary management agreement	Permanent covenant
Land use restriction	No use permitted	Limited use permitted
Payment method	Up-front lump sum payment	Tax relief
Technical support availability	Fee for service	Free of charge

A Of these two programs my preferred one is ☐ 1 ☐ 2

B I would *voluntarily* enrol my land in program ☐ 1 ☐ 2 ☐ Neither 1 nor 2

Please check you have answered both A and B above

Part 7	Program 1	Program 2
Funding amount	1¼ of the market value	½ the market value
Legal mechanism	Permanent covenant	Temporary management agreement
Land use restriction	Limited use permitted	No use permitted
Payment method	Up-front lump sum payment	Tax relief
Technical support availability	Free of charge	Fee for service

A Of these two programs my preferred one is ☐ 1 ☐ 2

B I would *voluntarily* enrol my land in program ☐ 1 ☐ 2 ☐ Neither 1 nor 2

Please check you have answered both A and B above

Part 8	Program 1	Program 2
Funding amount	¾ of the market value	Exactly the market value
Legal mechanism	Permanent covenant	Temporary management agreement
Land use restriction	Limited use permitted	No use permitted
Payment method	Tax relief	Up-front lump sum payment
Technical support availability	Free of charge	Fee for service

A Of these two programs my preferred one is ☐ 1 ☐ 2

B I would *voluntarily* enrol my land in program ☐ 1 ☐ 2 ☐ Neither 1 nor 2

Please check you have answered both A and B above

UTAS

Question 21

We ask you to indicate how strongly you agree with 24 statements about the role and impacts of establishing conservation reserves on private land.

Conservation reserves on private land:

Please tick ☑ **only 1** of the 5 options

		++ Strongly Agree	+ Agree	+/- Neutral	- Disagree	-- Strongly Disagree
A	Reduce the property value	☐	☐	☐	☐	☐
B	Are of value for stock shelter and control	☐	☐	☐	☐	☐
C	Reduce the potential to earn income from the rest of the property	☐	☐	☐	☐	☐
D	Create a good image for landowners	☐	☐	☐	☐	☐
E	Are expensive to manage	☐	☐	☐	☐	☐
F	Will benefit others as much as the landowner	☐	☐	☐	☐	☐
G	Threaten the landowners' livelihood	☐	☐	☐	☐	☐
H	Give the landowner a sense of fulfilment	☐	☐	☐	☐	☐
I	Add to the beauty of the landscape	☐	☐	☐	☐	☐
J	Will mainly benefit the future generation	☐	☐	☐	☐	☐
K	Will increase the landowners' understanding of the environment	☐	☐	☐	☐	☐
L	Provide a good way to protect species from extinction	☐	☐	☐	☐	☐
M	Create a harbour for weeds	☐	☐	☐	☐	☐
N	Increase the fire threat to the property	☐	☐	☐	☐	☐
O	Can be expensive as they lead to reduced productivity due to shading	☐	☐	☐	☐	☐
P	Increase the opportunities to earn income from recreation/tourism	☐	☐	☐	☐	☐
Q	Take up a lot of time to manage	☐	☐	☐	☐	☐
R	Reduce the landowners' opportunity to diversify	☐	☐	☐	☐	☐
S	Will reduce the potential for soil erosion and salinity	☐	☐	☐	☐	☐
T	Are an effective way to ensure wildlife survival	☐	☐	☐	☐	☐
U	Will make the management of the remainder of the property more complicated	☐	☐	☐	☐	☐
V	Reduce the security of future income	☐	☐	☐	☐	☐
W	Are only desirable if there is no other valuable use for the land	☐	☐	☐	☐	☐
X	Create a harbour for animals that are a pest to farming	☐	☐	☐	☐	☐

Some of the questions in this section are of a personal nature. This information adds to the completeness of our analysis. We assure the confidentiality of the information you provide. Even if you don't complete the whole section below, please mail us the rest of the survey as it will still provide valuable information.

Question 22

Gender of the person who filled out this survey

(tick only one)
- ☐ Male
- ☐ Female

Question 23

How would you best describe your main occupation?

....

Question 24

How old are you?

.... years

Question 25

What is the highest education level you achieved

(tick only one)
- ☐ Up to secondary
- ☐ TAFE or trade training
- ☐ University or postgraduate

Question 26

Please indicate if you regularly receive information from any of the following organisations?

(tick any that apply)
- ☐ Greening Australia
- ☐ Local Coastcare / Landcare group
- ☐ Private Forests Tasmania
- ☐ Other...

Question 27

What do you intend to do with your property when you no longer want to manage it?

(tick only one)
- ☐ Pass it on to a family member
- ☐ Sell up
- ☐ Not sure
- ☐ Other ....

Question 28

Number of dependent children

....

Question 29

Do you or a family member living on the property earn off-farm income?

(tick only one)
- ☐ Yes
- ☐ No

Question 30

Do you earn the majority of your income from farming?

(tick only one)
- ☐ Yes
- ☐ No

Question 31

How big is the mortgage you have on the property?

(tick only one)
- ☐ I don't have a mortgage on the property
- ☐ Less than 25% of the property value
- ☐ Between 25% - 50% of the property value
- ☐ Between 50% - 75% of the property value
- ☐ More than 75% of the property value

Question 32

What is you average annual gross farm turnover?

$ .... per year

Thank you very much for participating in this survey!

Example

This is what the two programs look like

Part	Program 1	Program 2
Funding amount	1¼ of the market value	½ the market value
Legal mechanism	Permanent covenant	Temporary management agreement
Land use restriction	No use permitted	Limited use permitted
Payment method	Tax relief	Up-front lump sum payment
Technical support availability	Fee for service	Free of charge

You are asked to answer two parts A and B. In part A you are asked to indicate if you *prefer* program 1 or 2 (even if in reality you would not consider enrolling your land in either of them).

You like program 1 best – tick this box

A Of these two programs my preferred one is ☑ 1 ☐ 2

In part B you are then asked to indicate which program in reality you would enrol your land in. If you would choose not to enrol your land, you can choose "neither 1 nor 2".

If you would enrol your land in program 1 – tick this box

B I would *voluntarily* enrol my land in program ☑ 1 ☐ 2 ☐ **Neither 1 nor 2**

If you don't like either program – tick this box

Funding amount

The amount of money paid to the landowner for participation in an incentive program expressed as a proportion of the estimated "fair market value".

Land use restriction

The restrictions defining what the landowner is and isn't allowed to do with the land after reserve establishment. For example the landowner may be allowed limited use such as occasional grazing of the reserve area. If no use is allowed, the landowner will have to manage the area for conservation only.

Legal mechanism

The nature of the legal restrictions that are placed on the land after reserve establishment. For example the conservation values of the land may be protected by a *permanent* covenant, which means that the title of the land is changed. The land will be identified on the title as conservation reserve for ever. This title change will be retained when the land is sold. A *temporary* management agreement is a contract between government and the landowner that changes the use and management of the land for a maximum of 20 years.

Payment method

The method by which the money (funding amount) is paid to the landowner. For example the money may be paid in a lump-sum or by means of tax relief.

Technical support availability

The availability and cost of technical support after reserve establishment.

Appendix 4 – Choice survey experimental design

This design has 5 attributes, the first 4 attributes have 2 levels and the last one has 4 levels. All main effects and the interaction between the first 2 level attribute and the 4 level attribute can be estimated independently of each other. There are 2 options (plus "do nothing") in each of the 16 choice sets and each row in the table below represents 1 choice set.

	Land use restriction	Legal mechanism	Tech. support availability	Payment method	Funding amount		Land use restriction	Legal mechanism	Tech. support availability	Payment method	Funding amount
	Design 1 survey 1						Design 2 survey 3				
1	0	0	0	0	0	1a	1	1	1	1	1
2	0	1	1	1	0	2a	1	0	0	0	1
3	0	0	1	1	1	3a	1	1	0	0	2
4	0	1	0	0	1	4a	1	0	1	1	2
5	0	1	0	1	2	5a	1	0	1	0	3
6	0	0	1	0	2	6a	1	1	0	1	3
7	0	1	1	0	3	7a	1	0	0	1	0
8	0	0	0	1	3	8a	1	1	1	0	0
	Design 1 survey 2						Design 2 survey 4				
9	1	0	0	0	0	9a	0	1	1	1	1
10	1	1	1	1	0	10a	0	0	0	0	1
11	1	0	1	1	1	11a	0	1	0	0	2
12	1	1	0	0	1	12a	0	0	1	1	2
13	1	1	0	1	2	13a	0	0	1	0	3
14	1	0	1	0	2	14a	0	1	0	1	3
15	1	1	1	0	3	15a	0	0	0	1	0
16	1	0	0	1	3	16a	0	1	1	0	0

As 8 choice sets were included in each survey, and the design above shows 32 choice sets, this was divided into 4 different surveys that were mailed out. A random order in the 16 choice sets of both designs was generated.[111] The first 8 of design 1 were then included in survey 1, 9 through 16 of design 1 were included in survey number 2. 1a to 8a choice sets of design 2 were included in survey number 3, and 9a through 16a of design 2 were included in survey number 4.

[111] For design number one this was 2, 1, 4, 5, 12, 9, 11, 10, 15, 6, 13, 14, 16, 8, 7, and 3

Appendix 5 – Principal component analysis

A PCA and the VARIMAX rotation method (SPSS version 11.0.0) was used to condense the original 26 attitude variables to form a reduced number of interpretable variables (Mulaik 1972). Variables with extraction communality values smaller than 0.2 were dropped from the PCA (Table i). STOCK, FUTGEN, and EROSION did not fit well with the factor solution.

Table i: Communalities for all attitude variables (Choice survey data).

	Extraction
BEAUTY	0.531
BENOTH	0.426
COMPLEX	0.645
DIVERSE	0.630
EROSION	0.167
EXPMAN	0.482
FIRE	0.454
FULFIL	0.716
FUTGEN	0.114
IMAGE	0.446
INCOP	0.268
INCRED	0.412
INCSEC	0.686
LEARNING	0.663
LIVELY	0.634
OTHERUSE	0.516
PESTS	0.375
PROPVALU	0.539
PROTECT	0.656
SHADE	0.562
STOCK	0.066
TIME	0.474
WEEDS	0.559
WILDL	0.583

With all communalities now greater than 0.2 the next step in the PCA is determination of the number of factors. There are several methods by which this is usually done, including Cattell's scree test, eigenvalues greater than 1, and interpretability of the resultant factors. Using a combination of these methods it was decided to extract 2 factors.

Table ii: Total variance explained in PCA for all respondents (Choice survey data).

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	**% of Var.**	**Cum %**	**Total**	**% of Var.**	**Cum %**	**Total**	**% of Var.**	**Cum %**
1	8.698	36.240	36.240	8.698	36.240	36.240	5.568	23.200	23.200
2	2.519	10.497	46.737	2.519	10.497	46.737	5.139	21.414	44.613
3	1.873	7.804	54.540	1.873	7.804	54.540	2.382	9.927	54.540

* Components with eigenvalues smaller than 1 and/or that contribute less than 5% of the variance are not shown.

The first two components explain around 55 percent of the total variation of the original variables. Standard tests of the adequacy of the PCA indicate that a factor analysis is useful for this reduced variable set. A 0.878 Kaiser-Meyer-Olkin Measure of Sampling Adequacy indicates a high proportion of variance in the data explained by the underlying factors. Further the significance level of 0.000 for Bartlett's test of sphericity, with approximate Chi-square of 44371.977 and 276 degrees of freedom, indicates there are significant relationships among the variables.

The attributes with loadings greater than 0.400 (+ or -) in the rotated component matrix for two principal components are shown in Table iii.

Table iii: Rotated component matrix (Choice survey data).

	Production impact PC1	Environmental impact PC2	Long term opportunity impact PC3
PROPVALUE	0.457	-0.469	
INCRED	0.643		
EXPMAN	0.686		
LIVELY	0.652		
WEEDS	0.747		
FIRE	0.597		0.494
SHADE	0.699		
TIME	0.725		
DIVERSE	0.671		
COMPLEX	0.713		
INCSEC	0.706		
PESTS	0.498		
BENOTH		0.514	
IMAGE		0.647	
FULFIL		0.737	
BEAUTY		0.728	
LEARNING		0.750	
PROTECT		0.799	
WILDL		0.775	
OTHERUSE		-0.494	0.562
INCOP			-0.486
STOCK			-0.633
FUTGEN			0.649

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 3 iterations.

The first component (PC1) has high positive loadings for all of the variables concerned with the perceived negative impact of reserve establishment on the production capacity of an agricultural enterprise. These attitudes reflect the effect of reserve establishment on both current income and property values, and future asset values.

The second component (PC2) has high loadings for variables related to the positive impact of reserve establishment on the environmental values of the property such as increased beauty, wildlife protection, as well as personal fulfilment. The factor loading for the impact PROPVALUE in PC2 is in the opposite direction to PC1 suggesting a strong disagreement with the negative impact reserve establishment has on overall property values.

The third component (PC3) has high loadings for variables indicating that respondents in this group do not believe the establishment of reserves on their property will be of benefit to them directly either in terms of agricultural production or environmental outcomes. This group focuses mainly on the longer term outcomes of reserve establishment. Additionally, the factor loading for OTHERUSE is in the opposite direction to PC2 indicating that the PC3 group believe that reserves are only desirable if there is no other valuable use for the land.

The first two components are similar to those developed for the BW survey attitude data[112], although there are fewer variables included in both the *production impact* and *environmental impact* components in the BW survey.[113]

Scores for the three factors were calculated for each of the survey respondents in the sample and these were included as variables (*prod_attitude*, *env_attitude*, and *oppor_att*) in the latent class analysis (Section 8.4).

The *env_attitude* and *prod_attitude* components are compared to the *att_env* and *att_prod*, and components from the PCA used in the 'voluntary' model in Table iv.

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[112] As the attitude questions were included in both the BW and Choice survey this allowed a degree of cross checking of the results. A two tailed test of the independence of the samples (BW and choice) showed there was no significance difference between the two groups in the rating of the attitude statements.

[113] Both the *production impact* and *environmental impact* in the BW analysis contained seven variables that were the same as those in the choice analysis. The choice analysis contained an additional five variables for the *production impact* and three variables for the *environmental impact*.

Table iv: Comparison of components used in the 'voluntary' and 'forced choice' models (Choice survey data).

	ENVIRONMENT		PRODUCTION	
	'voluntary'	'forced choice'	'voluntary'	'forced choice'
beauty	0.728	0.720		
benoth	0.514	0.625		
complex			0.713	0.718
diverse		-0.455	0.671	0.650
expman			0.686	0.693
fire			0.597	0.654
fulfil	0.737	0.779		
image	0.647	0.668		
incop	*in oppor	0.517		
incred			0.643	0.598
incsec		-0.442	0.706	0.700
learning	0.750	0.772		
lively	0.652	-0.509		0.612
otheruse	-0.494	-0.628		
pests			0.498	0.608
propvalu	-0.469	-0.579	0.457	0.451
protect	0.799	0.781		
shade			0.699	0.677
time			0.725	0.679
weeds			0.747	0.748
wildl	0.775	0.747		

Note: *incop*, *fire*, *otheruse*, *stock*, and *futuregen* comprised the future opportunity used in the 'voluntary' model and do not appear in the table.

Table iv shows that the results for the two PCA are similar in terms of the variables that make up the environment and production groups.

Appendix 6 – Communalities for principal component analysis

Table v: Communalities for all attitude variables (Choice survey data).

	Extraction
PROPVALUE	0.474
INCRED	0.461
IMAGE	0.382
EXPMAN	0.427
BENOTH	0.358
LIVELY	0.625
FULFIL	0.606
BEAUTY	0.590
LEARNING	0.604
PROTECT	0.627
WEEDS	0.560
FIRE	0.448
SHADE	0.570
INCOP	0.283
TIME	0.482
DIVERSE	0.630
WILDL	0.609
COMPLEX	0.674
INCSEC	0.697
OTHERUSE	0.506
PESTS	0.290
EROSION	0.209
STOCK	
FUTGEN	

All communalities greater than 0.2 were retained.

Appendix 7 – Correlation coefficients

Table vi: Correlation coefficients (Choice survey data).

	Years_own	farmsize	region62	gft	years_cons	veg_protect	trees_labour	size_nf	fut_harvest	reserv-p	fund_4-e	Manage_cons	ga_member
caregr_memberr	-	-	-	-	-	0.367	0.347	-				0.319	0.4891
env_owner											0.3414	0.3483	
farmsize	0.320	1											
fund_4_reserve	-	-	0.427	-	-	-	-	-		0.774			
ga_member	-	-	-	-	-	-	0.343	-				0.305	
manage_4_cons											0.311		
no_mortgage	-	-	0.315										
own_nf	-	-	-	-	-	0.363	-						
prod_owner									0.3528				
reserve_on_prop	-	-	0.336	-	-	-	-	-					
size_nf	-	0.896	-	0.350	0.560	-	-	1					
size_reserve_f	-	0.860	-	-	0.552	-	-	0.928					
tert_edu	-	-	-	-	-	-	0.316	-				0.365	
trees_or_labour	-	-	-	-	-	0.418	1						
veg_protect	-	-	-	-	0.317	1							
years_inv_cons	0.370	0.534	-	-	1								

Appendix 8 – Probability means

The re-scaled parameters shown as column percentages in Table vii above can also be presented as row percentages. Row percentages provide information regarding the dimensions of the groups by showing class membership probabilities. The probabilities sum to one across landowner classes. Vermunt & Magidson (2005) report the formulas to obtain the reported probability means in detail. In summary, the probability of being in latent class *x* given choice *a* on "set" *p*.

$$\hat{P}_p(x \mid a) = \frac{\hat{P}(x)\hat{P}_p(a \mid x)}{\sum_{x'=1}^{K} \hat{P}(x')\hat{P}_p(a \mid x')}$$

Table vii: Probability means for the 3-class 'voluntary choice' model (Choice survey data).

		Multi-objective landowners	Environment landowners	Production landowners
Compfund*	NOfund	0.0454	0.0653	0.8893
	$2,500	0.245	0.293	0.462
	$3,750	0.3738	0.4075	0.2187
	$5,000	0.4598	0.4568	0.0834
	$6,250	0.5098	0.4615	0.0287
Legal	covenant	0.0324	0.0015	0.966
	managreement	0.2447	0.0091	0.7462
	NOlegalagreem	0.5008	0.4906	0.0087
Landuse	limiteduse	0.4489	0.4281	0.123
	nousepermit	0.4489	0.4281	0.123
	UNlimiteduse	0.4489	0.4281	0.123
Paymethod	upfrontpay	0.4489	0.4281	0.123
	taxrelief	0.4489	0.4281	0.123
	NOpayment	0.4489	0.4281	0.123
Techassist	fee4service	0.4489	0.4281	0.123
	freetechadv	0.4489	0.4281	0.123
	NOadvice	0.4489	0.4281	0.123
Covariates*		Multi-objective landowners	Environment landowners	Production landowners
Gender	(female=0)	0.4185	0.4554	0.126
	(male=1)	0.4587	0.4193	0.122
Tert_edu	(no tertiary edu=0)	0.3616	0.5338	0.1046
	(tertiary edu=1)	0.6157	0.2263	0.158
Region62	(not in south=0)	0.3852	0.5143	0.1005
	(south=1)	0.6543	0.1505	0.1952

Note: * Values for the attitude covariates are not shown as the probability means are given at the mean value and cannot be interpreted in a meaningful way.

Table viii: Probability means for the 3-class 'forced choice' model (Choice survey data).

		Multi-objective forest owners	Environment owners	Production owners
Compfund	$1,000 - $32,000	0.7531	0.0000	0.2469
	$33,000 - $50,000	0.7556	0.0000	0.2444
	$51,000 - $70,000	0.7594	0.0000	0.2406
	$71,000 - $97,000	0.7671	0.0000	0.2329
	$98,000 - $137,000	0.7827	0.0128	0.2045
Legal	covenant	0.2812	0.3472	0.3716
	managreement	0.6854	0.2761	0.0384
Landuse	limiteduse	0.5718	0.3475	0.0807
	nousepermit	0.4714	0.1650	0.3636
Paymethod	upfrontpay	0.6462	0.1680	0.1858
	taxrelief	0.4698	0.4017	0.1285
Techassist	fee4service	0.5461	0.3006	0.1533
	freetechadv	0.5461	0.3006	0.1533
Covariates*		Multi-objective forest owners	Environment owners	Production owners
Gender	(female=0)	0.343	0.445	0.212
	(male=1)	0.610	0.255	0.135
Tert_edu	(no tertiary edu=0)	0.453	0.344	0.203
	(tertiary edu=1)	0.661	0.247	0.093
Logsize	1-8 (ha)	0.633	0.229	0.138
	9-15 (ha)	0.847	0.031	0.122
	16 - 27 (ha)	0.641	0.209	0.150
	28 - 37 (ha)	0.340	0.456	0.204
	38 - 51 (ha)	0.293	0.562	0.146

Note: * Values for the attitude covariates are not shown as the probability means are given at the mean value and cannot be interpreted in a meaningful way.

Appendix 9 – Standard errors

Table ix: Standard errors for the quotient of two variables for the 'forced choice' model (Choice survey data).

LATENT CLASS (FC)	SE[x/y]	lower 95%		upper 95%	
Cov/$ (multi)	55.018	$	(103.24)	$	6.80
nouse/$ (multi)	44.695	$	(5.17)	$	84.22
tax/$ (multi)	7.219	$	(12.98)	$	1.46
fee4ser/$ (multi)	4.245	$	(4.27)	$	4.22
Cov/$ (env)	0.108	$	(0.25)	$	(0.04)
nouse/$ (env)	0.122	$	0.51	$	0.76
tax/$ (env)	0.040	$	(0.10)	$	(0.02)
fee4ser/$ (env)	0.136	$	(0.54)	$	(0.27)
Cov/$ (prod)	908,961	$	(913,027)	$	904,895
nouse/$ (prod)	246,253	$	(245,151)	$	247,355
tax/$ (prod)	102,367	$	(101,909)	$	102,825
fee4ser/$ (prod)	53,973	$	(54,214)	$	53,732

Table x: Standard errors for the quotient of two variables for the 'voluntary choice' model (Choice survey data).

LATENT CLASS (VC)	SE[x/y]	lower 95%		upper 95%	
Cov/$ (multi)	0.221	$	(2.80)	$	(2.36)
Man/$ (multi)	0.201	$	(1.31)	$	(0.90)
Limuse/$ (multi)	0.168	$	0.10	$	0.44
Nouse/$ (multi)	1.100	$	(1.81)	$	0.39
Tax/$ (multi)	0.057	$	(0.02)	$	0.10
Upfront/$ (multi)	0.165	$	(0.14)	$	0.19
fee4ser/$ (multi)	0.164	$	(0.32)	$	0.01
freeadvice/$ (multi)	0.668	$	(0.36)	$	0.98
Cov/$ (env)	1.284	$	(5.40)	$	(2.83)
Man/$ (env)	0.138	$	(2.97)	$	(2.69)
Limuse/$ (env)	0.112	$	0.19	$	0.41
Nouse/$ (env)	0.110	$	(0.89)	$	(0.67)
Tax/$ (env)	0.074	$	(0.03)	$	0.12
Upfront/$ (env)	0.152	$	(0.12)	$	0.18
fee4ser/$ (env)	0.107	$	(0.28)	$	(0.06)
freeadvice/$ (env)	0.113	$	0.23	$	0.45
Cov/$ (prod)	5.963	$	(14.66)	$	(2.74)
Man/$ (prod)	0.477	$	(1.06)	$	(0.11)
Limuse/$ (prod)	3.745	$	(5.35)	$	2.14
Nouse/$ (prod)	4.036	$	0.14	$	8.21
Tax/$ (prod)	4.453	$	(4.69)	$	4.22
Upfront/$ (prod)	3.019	$	(3.17)	$	2.87
fee4ser/$ (prod)	3.866	$	(2.96)	$	4.77
freeadvice/$ (prod)	4.002	$	(5.82)	$	2.18

Appendix 10 - Cluster analysis

Cluster analysis is a multivariate analysis technique that seeks to organise information about variables into groups, or clusters, which are highly internally homogenous and highly externally heterogeneous. The cases are initially assigned randomly to K clusters. Cases are then moved around between clusters iteratively in order to minimise some measure of cluster variability. Cluster variability is measured with respect to the mean value of the cluster for the classifying variables, hence the name *K-means clustering.* If more than one classifying variable is used to define the clusters, the distance (dissimilarities) between clusters is measured in multi-dimensional space (e.g. Euclidean distance).

More formally, the heterogeneity between the data for a given partition $P(M,K)$ of M cases into K clusters, where each of the M cases lies in just one of the K clusters, is measured by an error $e[P(M,K)]$. Suppose the ith case of the jth variable has value A(i,j) such that i= 1,....M and $j = 1,...N$. The mean of the jth variable over all the cases in the lth cluster, such that l = 1,...K, is denoted by B(l,j). The number of cases in the lth cluster is N(l). The distance between any two clusters n and l is:

$$D(I,L) = (\sum_{j=1}^{N}[A(I,J) - B(L,J)]^2)^{1/2} \tag{30}$$

and the error of the partition is:

$$e[P(M,K)] = \sum_{i=1}^{M} D[I,L(I)]^2 \tag{31}$$

where L(i) is the cluster containing the ith case. The general procedure in K-means clustering is to search for a partition with a small error by moving cases from one cluster to another. The search ends when no such movement reduces e (Hartigan 1975).

Appendix 11 - Binary-choice models

Binary-choice models assume that individuals are faced with a choice between two alternatives and that the choice made depends on identifiable characteristics of the decision-maker and/or the choice. The objective in binary-choice modelling in this instance would be to predict the likelihood of an individual choosing to join an incentive program with given characteristics. More generally, the aim of binary-choice modelling is to find a relationship between a set of attributes describing a choice and the probability that the individual will make a given choice.

Following Gujarati (1988) and Pindyck and Rubinfeld (1998), the Linear Probability Model (LPM) of binary-choice expresses the dichotomous dependent variable (Y_i)[114] as a linear function of the explanatory variables (X_i). The conditional expectation of Y_i, given X_i, can be interpreted as the conditional probability that the event will occur given X_i; in other words $P_i = E(Y=1|X_i)$. However, although it is the case *a priori* that the conditional probability must lie between 0 and 1, estimated probabilities in the LPM often lie outside the unit interval.

In addition, as the name suggests, the LPM assumes that the conditional probability of an event occurring increases linearly with X. In other words, the marginal or incremental effect of X is constant throughout the range of X. In reality, one would expect that the conditional probability of a particular event occurring would be non-linearly related to X, reflecting the fact that at both ends of the distribution of X the probability of an event occurring will be virtually unaffected by small increases in X.

This suggests the need for a binary-choice model where (i) the conditional probability of an action being taken increases as X increases but never steps outside the unit interval and (ii) the relationship between P_i and X is non-linear.

The binary logit and binary probit[115] models achieve non-linearity and restrict predicted probabilities to the unit interval by using an S-shaped cumulative density

[114] Y_i is equal to 1 if a particular action is taken or choice is made; Y_i is equal to 0 if the action is not taken or the choice is not made.

[115] The probit model (known also as the normit model) transforms the data using the cumulative normal probability function. The higher computational demands of this model and the generally weak theoretical justification for employing a probit specification mean that the logit model is more widely

function to transform the dichotomous 0 – 1 dependent variable of the binary choice model. In the case of the logit model the transformation uses the cumulative logistic probability function and is specified as:

$$P_i = \frac{1}{1+e^{-Z_i}} \tag{32}$$

where e is the base of natural logarithms and Zi = a + βX. A and β are the estimated parameters of the logit model.

The regression equation estimated in logit analysis is derived after simple manipulation of equation 33 giving

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = Z_i \tag{33}$$

where the dependent variable in the regression equation is the natural logarithm of the odds that a particular choice will be made and the right hand side of the regression is linear in the parameters of the model. When only one or a few observations on each decision maker is available, estimation of the parameters of the logit model must be made using the maximum likelihood estimation procedure. The maximum likelihood procedure has a number of desirable properties. All parameter estimates will be consistent and efficient asymptotically. In addition, all parameter estimates are asymptotically normal, so that a *t* test of parameter significance can be applied. Tests of the significance of all, or a subset, of the coefficients can be performed using the likelihood ratio (LR) test.

Estimated coefficients of equation 34 do not indicate the increase in the probability of the event occurring, given a one unit increase in the value of the independent variable. Rather, these coefficients reflect the effect of a change in an independent variable on $\ln[P_i/(1-P_i)]$ or the log of odds ratio. The marginal probability effects for the logit model are derived as follows:

$$\frac{\partial P_i}{\partial X_{ij}} = \frac{\beta_j \cdot e^{Z_i}}{\left(1+e^{Z_i}\right)^2} \tag{34}$$

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used in empirical work. The predictive powers of the logit and probit specifications are generally comparable.

where j denotes a particular independent variable. Given the non-linearity of the logit model specified in equation 39, the marginal effects will depend on the original probability and the values of all other independent variables and their coefficients.