Chapter 1

THE NATURE OF THE PROBLEM

1.1 Introduction

'Eucalypt dieback' is the term used to describe the decline and death of eucalypt woodland. This phenomenon has been observed in Australia since the mid 19th century. Boyd (1976), on the roles of trees in managed ecosystems, states that "trees were an integral part of the original ecosystems of the New England Tablelands and as such were in an equilibrium (or quasi-equilibrium) with the other components of the ecosystems (soil, soil organisms, other vegetation, animals, aboriginal man)."

Since about 1832, man's activities have brought about numerous changes in the ecosystems, including the elimination of some components (such as some woodland species) and increases in the quantities of others (such as phosphate, sulphur, nitrogen, and alien species, including weeds and pests and sheep and cattle). The extent of the changes, and the rapidity with which they have been and still are occuring, are responsible for the present somewhat unstable situation. Indeed eucalypt dieback has now become more prevalent in the New England Region of New South Wales, and has become sufficiently acute to arouse local concern. The extent of the dieback is described in a recent study of grazing land in the New England area [Sinden, Jones, and Fleming (1983)], and the results indicate that the condition of woodland, mainly eucalypt, in the region has deteriorated over the last decade. In 1973, the study reports, '43 per cent of the woodland was suffering from some dieback ... In 1980, 55 per cent of the woodland existing at that time was suffering from some dieback'.

When a new equilibrium is eventually reached there may be no place for many of the native tree species in the intensive grazing system. However many people now argue that trees, whether native or introduced, must continue to be integral parts of grazing ecosystems as shelter for stock, windbreaks and woodlots.

There is need for a careful assessment of the policies relating to decline of the trees, the potential roles of native trees, and of that of natural and introduced species in woodland and forest in the New England Tablelands. There is also a need to obtain evidence about the conditions necessary for the maintenance and regeneration of those native species which should be retained for various purposes. Where native timbered areas cannot be retained or regenerated for wind-breaks or shelter-belts, it would be necessary to find introduced species, such as other eucalypts, other hardwoods or pines as replacements. These species must be able to tolerate the effects of animal production techniques or other conditions which adversely effect native species, and should not reduce the fertility of the soil or have other adverse effects on the ecosystem (Boyd, 1976).

1.2 Social Relevance of the Dieback Problem

The death of eucalypt trees and the decline in the biological conditions of eucalypt woodland has now aroused great public concern. However popular debates achieve little because the populace in general has little or no understanding of the causes and effects of dieback. Nonetheless eucalypt dieback has become an issue of national debate. For example, The Australian of 14th March, 1979, ran an editorial under the capition, "Save the Gums"; the Sydney Morning Herald of 19th March, 1984, gave prominence to an article, "New England Becomes the Graveyard of the Gum"; and the Journal of Ecos of February, 1979 published an article, "Requiem for the Rural Gum Tree". Particular attention has been given to the problem by the ABC's recent television programmes of 'Heartlands' and 'Countrywide' (Skeleton Remains), and the local media's news items such as 'Eucalypt Dieback - Some Economic Effects' (Armidale Express, 10th June, 1983).

Although dieback may be of immediate financial benefit to the grazier, because higher stocking rates follow depletion of woodland, it is not seen of ultimate benefit to the country community. Thus, eucalypt dieback has become an issue of local and national concern. The basis for this general public concern rests almost entirely on perceived, external costs. The media asserts there are aesthetic costs because the woodland has changed or disappeared, heritage costs

because native woodland is declining, and environmental costs stemming from soil erosion and changes to water quality and movement. None of these costs have yet been substantiated, although all may exist now or become apparent in the long term.

The benefits from control of dieback accrue, in varying magnitude, to the following persons:

(a) to local population who use the areas for recreation,

(b) to those who like native woodland preserved as part of their heritage,

(c) to individuals who benefit from the knowledge that healthy woodland exists, and

(d) perhaps to graziers if control of dieback increases the health of woodland and this, in turn, provides useful stock shelter.

1.3 Potential Solutions and Control Measures

Research work into the problem of eucalypt dieback, has been a major concern of botanists, and others in the Northern Tablelands of New South Wales in recent years. Eucalypts affected by dieback are indigenous to the area and dieback seems to be more widespread where livestock grazing is a major activity. According to The Working Group of the Parliament of New South Wales (Humphreys et al 1979, p. 3), the most likely immediate cause of the problem is the excessive grazing of tree foliage by native insects. Others emphasise the importance of secondary causes, or predisposing factors. For example, Day (1981), and Sniekers (1980, p. 6), state that by clearing vast tracts of land, applying copious quantities of fertilizer and introducing new pasture species, man may have disrupted the natural balance. This disruption allows the rapid growth of the population of leaf-eating insects. As Miller (1978, p. 292) suggests in the broad context of endangered species, the causes of most recent extinctions are almost entirely the result of the activities of man. According to Sinden, Jones, and Fleming (1983, p. 2) 'there are many other possible causes being studied including Phytophthora root rot,

mistletoe, fertilizer (Phostphate) poisoning, soil compaction, black beetles and old age'. They, quote a conclusion from Humphreys et al. (1979), "that such causes may contribute to the death of individual trees, especially if these trees are already stressed". This view is further enhanced by Anon, (1979, p. 13) who argues that eucalypt dieback was initiated by man's changes to the ecological equilibrium.

Some research has been carried out on the nutritional problems of eucalypts, and further important areas of biological research have been identified:

(a) the deficiency of knowledge concerning mineral cycling in woodlands;

(b) the influence of soil fertility on the distribution of eucalypts on the Northern Tablelands;

(c) the ascertaining of the effect of phosphorus fertilisers on the total carbohydrate storage capacity of eucalypts;

(d) the role of boron in eucalypt nutrition; and

(e) the nutritional status of eucalypts showing rural dieback.

The range of potential biological and management research was reviewed by Boyd (1976). His recommendations, which were adopted by The Working Group may be summarised as follows.

(a) Examine the balance between pasture and forestry, and how to achieve such a balance on individual properties in the New England Region.

(b) Investigate modifications of the microclimates and soil climates of the tree-clad areas themselves and of adjacent areas.

(c) Compare reductions in lambing losses in areas with adequate shelter with similar areas without adequate shelter-belts.

(d) Examine ways to increase production of ground cover, especially in hot dry years, when suitable windbreaks are provided, and the roles of this extra vegetation in the stabilisation of production and the conservation of soil.

(e) Find out how to improve growth rates of young live stock.

(f) Assess the financial yield of timber and other products (e.g. fruits, nuts, honey, beeswax) from well managed windbreaks and shelter-belts.

(g) Estimate off-site benefits (and damages) of various land management practices.

(h) Assess the importance of production of timber and fuel essential for the economy of the region.

(i) Examine the rehabilitation of damaged watersheds (reduction of sedimentation in reservoirs, production of clear water, reduction of floodpeaks).

(j) Determine how to provide a variety of habitats for a variety of animal and plant species (e.g. the natural habitat of native birds).

The other main areas for research are aesthetic in that the perceived beauty of the New England Tablelands, its trees, birds and wildlife will be lost forever eg. 'if dieback is not controlled'.

The only economic study available on this issue is by Sinden, Jones, and Fleming (1983), who examine the relationships between eucalypt dieback and farm income, stocking rate and land value in Southern New England. The implications of their results are that paddocks with sparse, live woodland provide no obvious financial incentive for the grazier to clear woodland further. In these situations, increases in dieback do not seem to be associated with increases in animal stocking rate. However, in densely-wooded paddocks, there appears to be a financial incentive to clear woodland and to accept dieback. In these particular situations, economic conditions encourage the grazier to reduce the amount of live tree cover and to avoid dieback control.

Sinden, Koczanowski and Sniekers (1982), on public attitudes to eucalypt woodland, eucalypt dieback and dieback research in the New England region of New South Wales found strong preferences

by graziers for eucalypt over pine woodland. Overall, pine is not perceived as a substitute for eucalypt for firewood, construction or aesthetic purposes by the graziers. But, pine is perceived as a substitute for eucalypt for stock shelter, which is an important role for woodland in New England.

1.4 The Centre of Research

Armidale is a key centre in the New England Region and it is central to the area of this study. The city and the surrounding area is inhabited by an urban population. Many biological research projects of various aspects of the dieback problem has already been undertaken and some are continuing under the auspicious of CSIRO and the University of New England. Economic research have been concentrating on the farm population, and the importance of studying off-farm population was indicated in many research papers. The continuous involvement of the local research institutions on the issue of dieback that has a high occurence in the surrounding woodland paved way to select Armidale for this cross sectional study. The inhabitants of this city recently donated a sum of $100,000 to a dieback research appeal. Therefore this study of the perceptions of an urban population should indicate what they think about eucalypt dieback, preferences for control measures and their choices of preservation of certain types of eucalypt woodland.

1.5 Objectives of the Present Research

This research is concerned with the social benefits from the control of eucalypt dieback. Within this general area the study will focus on the following specific objectives.

(a) Determine the relative importance of different attributes and characteristics of the dieback problem, as perceived by a relevant urban population.

(b) Compare relative benefits that individuals receive from recreation visits to woodland, from existence of woodland, and from retention of future options.

(c) To determine:

(i) preferences for alternative dieback control measures,

(ii) whether individuals consider dieback control measure type 1 and type n are substitutes or complements, and

(iii) whether individuals consider preservation of eucalypt woodland and preservation of other species are substitutes or complements.

(d) To determine:

(i) which characteristics of woodland are the most influential in determining preferences and choice of woodland to preserve, and

(ii) whether price is a more important determinant than these characteristics.

1.6 Plan of the Dissertation

The theory of benefit estimation and environmental preservation is discussed in Chapter 2, with an emphasis on demand and willingness to pay. These concepts are derived from neo-classical theory and Lancaster's characteristics model of utility formation. In Chapter 3, methods of preference measurement and valuation are reviewed in detail, including the Smith Auction method, and Hardie and Strand's procedures to derive demand curves. Regression methods are reviewed in Chapter 4 including specification of the problem, and identification of variables. Data collection is also discussed in this chapter.

Results are presented in Chapters 5, 6, and 7. Chapter 5 reports on the direct-question method used to estimate the willingness-to-pay for recreation, existence and option benefits. Willingness-to-pay is shown to vary with distance and socio-economic characteristics such as income. In Chapter 6, a budget allocation game used to estimate demand for alternative measures

to control dieback is reported. Eight control measures are considered, and systems of demand equations were derived. In Chapter 7, the budget allocation game is applied again to estimate the demand for characteristics of goods, all of which refer to eucalypt woodland. The demand for eucalypt woodland is shown to vary with health rating, rarity, ecology, visibility and price. The overall conclusions of the study are in Chapter 8. It also reveals the results of the main research enquiries in the context of the theoretical foundations.

Chapter 2

ECONOMIC THEORY OF BENEFIT ESTIMATION

2.1 Introduction

The problem concerns the preservation of woodland, some of which contains relatively rare and endangered eucalypt species. These species include Peppermint gum, Red gum and Yellow box, all of which are indigenous to New England area (Snickers, 1980 p. 7). Analysis of the problem requires a comparison of the benefits and costs of preservation although this research is mainly concerned with benefits of woodland. The economic theory must therefore provide the basis for concepts and methods of benefit estimation. That theory is now discussed.

2.2 Social Benefits and Costs

2.2.1 The general model

As this study rests on social comparisons, the concept of social benefits and willingness to pay must first be explained.

Net social benefit is defined as consumer's surplus (CS) plus producer's surplus (PS). Consumer's surplus (CS) is defined as the excess of the price which a consumer would be willing to pay for something rather than go without over the expenditure (CE) which he actually pays. The total-willingness-to-pay (TWTP) of the consumer is therefore:

$$TWTP = CE + CS$$

Total consumers expenditure (CE) becomes the total revenue (TR) of producers. To the producer, revenue is allocated between producer's surplus (PS) and marginal costs.

Because the consumers TWTP indicates the total benefit (TB) to all consumers, it can be termed as Total Social Benefit (TSB). Total Social Costs indicate the costs of producing the benefits, to all producers, and it can be termed TSC. Therefore the net social benefit is:

$$NSB = CS + PS$$

2.2.2 Consumer's surplus concepts

So far, the concepts have been presented in terms of Marshall's demand theory. For further precision, Hicks's several concepts of consumer's surplus must be introduced. Randall (1981) suggests that none of the four measures of consumer's surplus used in Hicks (1943) study is identical to the Marshallian measures. The terminology is presented in tabular form as follows:

Nature of Market	Appropriate Measure of Consumer's Surplus			
	Change in Price			
	fall		rise	
Consumer is free to purchase at a given price (price into quantity)	(a)	Price compensating variation	(c)	Price equivalent variation
	Change in Quantity			
	rise		fall	
Consumer must take a given quantity but is free to offer any price (quantity into price)	(b)	Quantity compensating variation	(d)	Quantity equivalent variation

The price compensating and price equivalent variations are the only surplus concepts which allow the consumers to choose freely the quantity of purchases subject to given prices. Hence, by definition, these two variations should be used to study the analysis of different situations.

2.3 Application of the Benefit Concepts

The general concept of net benefit to the consumer has already been introduced as consumer's surplus. This surplus value is now applied in the context of the study.

2.3.1 Recreational value (RV)

Recreational value reflects the net utility people receive from visiting a place of interest. In this study, eucalypt woodland is associated with other attractions such as parks and wildlife.

2.3.2 Existence value (EV)

Another, hopefully, measurable benefit of preservation is existence value. According to Bishop (1978, p. 15) existence value (EV) is not a reflection of risk preferences (as is option value) nor does it result from the prospect of new information (as does quasi-option value). Rather, existence value reflects the utility that people receive from simply knowing that something such as eucalypt habitat exists.

2.3.3 Option value (OV)

Option value is the willingness-to-pay or payment of a kind of insurance premium to retain an existing or potential option of possible future recreation use (Walsh et al. 1984). Option value (OV) is defined as the difference between option price and expected consumer's surplus (CS). In Brookshire et al. (1983) option price (OP) is defined as the maximum amount a grizzly-bear hunter would pay to keep the right to hunt grizzly bear in the future at a fixed set of costs.

For the purpose of this study, Brookshire et al. can be blended with Krutilla and Fisher (1973, in Bishop p. 14). Quasi-option value' is explained not as a risk premium but rather as the extra value of choosing not to take irreversible steps if new information about the outcome of alternative decisions becomes available. In this way an approximation of true preservation benefits can possibly be calculated by allowing the community access to new information pertaining to dieback control. Bishop, (1978, p. 15) maintains that once option value is used in this quasi sense, it is possible to determine socially-optimal steps to prevent irreversibility associated with destruction of natural environments.

2.3.4 Overall benefits

Therefore the total value of woodlands (TVW) in equation form:

$$TVW = RV + EV + OV + Others.$$

Some of the many other values include net benefits of education and research. The scientists involved in environmental research often dedicate their work to strengthen the stock of scientific knowledge on conservation. This study concentrates on the first three benefits and comparisons between them. Information even on these would materially advance knowledge of the problem.

2.4 Some Relevant Aspects of Benefit Valuation

It is important to ascertain the characteristics by which benefit values vary, (individual's WTP) given the array of information of the species concerned. The following observations seem relevant to the problem of the eucalypt woodlands.

2.4.1 Do benefit values for preservation vary with accessibility?

Bennett (1982), in his estimation of the existence value of the Mudgee nature reserve observed that a majority of those questioned appeared willing to pay for its preservation, even though constrained from making any visits to it whatever. The evidence that non-visit benefits from parks can exceed visit benefits (Majid, Sinden and Randall, 1982 p. 23) suggests further inquiry into the question of whether accessibility influences the benefit values for preservation. Wellham (1982) found contrary evidence. More compensation was required for loss of koala habitat with public access allowed than where access was not allowed.

2.4.2 Does benefit value vary with the species?

In his study to determine if society values all wildlife species equally, Wellham (1982), found that subjects placed different values on different species (cuddly koala versus nasty snake). Further, the availability of access to the animals influenced these values differently. Access to the koalas increased the value of saving the animal whereas access to the snakes decreased this value. Therefore 'access value' appears to interact with 'species value'. An interesting question for study is therefore - do recreation values vary with the condition of woodland of recreation sites.

As a part of the study on eucalypts society's preferences for the native versus the introduced species will be tested in an attempt to estimate the cross price of demand (eucalypts versus pine).

2.4.3 Does benefit value vary with the rarity of species

As Helliwell (1973) envisages, a priority should be given to the conservation of species which are rare. Hollis (1982) shows that people are willing to pay more for the preservation of a rare wallaby than the preservation of the common mouse.

Following Helliwell, Hollis found that not only were different values placed on wildlife but the rarity status of the species in question influenced the amount of money donated to the fund. She indicates that more money was given to the extremely rare species than to the endangered ones if research was to be undertaken. So the concern here is with the eucalypt species once so common and indigenous to the area that are endangered by dieback.

2.4.4 The new demand theory as applied to the preservation problem

The relationship between characteristics and utility is explored more fully as a first step to applying Lancaster's characteristics model. Miller (1978), in the Journal of Environmental Economics, argues that the relationship between management inputs and characteristics of objects to be preserved can be set out in a standard production context. Following his example, the characteristics might include the area (stock) of the woodland, or the health of the woodland, or the rarity of its species.

Miller defines the input axis as quantities of units of "composite management input". In the present context, these inputs might be money inputs, such as fencing out stock and replanting to manage the preserved species.

To apply Randall's adaptation of the model (with his w = stock of environmental goods and u = flow of goods and services) we need to define the relevant goods and services available from eucalypt woodland. They include,

(a) as goods:

(i) shelter,
(ii) honey production,
(iii) grazing for livestock,
(iv) building material,
(v) firewood and pulpwood,

(b) as services:

(i) recreation,
(ii) landscape observation, and
(iii) environmental benefits such as a pollution reducer, open-space saver and a soil conserver.

These goods and services have characteristics which provide utility. The utility from recreation can be measured as recreation value, the utility of the environment can be measured partly as existence value, the utility of landscape observation can be measured by willingness to pay for it. Consumers may be willing to pay for an option on all these services in the future, so all involve option values.

2.5 A Utility Model

2.5.1 Nature of the theory

A "new" approach to consumer theory was set out by Lancaster (1966). He (p. 133) argues that its chief technical novelty lies in breaking away from the traditional approach that goods are the direct objects of utility and, instead, supposes that it is the properties or characteristics of the goods from which utility is derived. It is assumed, in Lancaster's model, that consumption is an activity in which goods are inputs and in which the immediate output is a collection of characteristics. Utility is derived directly from these characteristics and preference orderings are assumed to rank collections of characteristics directly and only to rank collections of goods indirectly.

This model of utility formation provides a useful basis for this study of benefit estimation from preserving eucalypt

woodland. In applying it to value increments to national parks, Randall et al (1974) call it 'New Demand Theory'. In more detail it rests on the following arguments.

(a) Utility (U) is derived from "characteristics".

(b) Characteristics (c) are derived from "activities".

(c) Activities (a) are derived from a combination of:

(i) purchasable goods (G),

(ii) household production technologies (H) and,

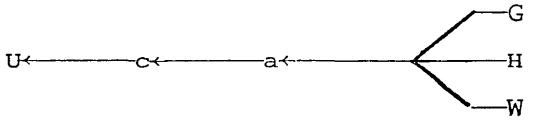
(iii) non-rival or public (environmental) goods (W).

(i) purchasable goods (G),

(ii) household production technologies (H) and,

(iii) non-rival or public (environmental) goods (W).

Thereby, a sequence of steps of utility formation can be depicted:



These arguments yield the following indirect utility function. For a given individual i:

$$\text{Utility}_i = f[P_g, H, W, \text{Income}],$$

where P_g is price of purchased goods g.

From the above Randall (1981), derives the following willingness-to-pay model for a change in the environmental good W:

$$WTP_i = f[P_g, W^0, W^1, H, U_i],$$

where,

W^0 is the initial level of the environmental good,

W^1 is the new level of the environmental good.

These willingness-to-pay ideas can apply to the dieback problem in the following way. In the study area farmers have the right to clear their land for improvement, but it appears that in so doing they neglect the appeal to control dieback. If the public wishes to preserve the woodlands, they may have to subsidise the farmers. The maximum that an individual will contribute to such an effort is his willingness-to-pay (WTP).

An analyst must try to determine which of the characteristics are important to the kinds of utility he is trying to value. In some cases, as in the case of eucalypt woodlands, the analyst may have to consider the whole woodland resource. In others he may consider all characteristics such as rarity of species or erodability of the soil, but he may give them different weighting. Following the above authors, isolation of certain significant characteristics, measurement of only the response to these may be acceptable if it does not analyse characteristics that have little or no influence on the utility realised by the relevant people.

2.6 Research Inquiry

The theory of the previous sections indicates the appropriateness of the following set of research questions.

(a) What is the nature of the output: is it a public or private good? Must purchased goods be combined with these environmental good outputs?

(b) How important are recreation values, relative to existence values and option values.

(c) What are the outcomes of alternative strategies for coping with the dieback problem?

(d) Are there any substitutes or complements among them?

(e) Whether the introduced tree species (eg. pines) are preferred to eucalypts?

(f) How exactly are the environmental goods combined with household production technology to give recognition to important characteristics?

(g) In terms of Lancaster's model what are the important characteristics which provide utility?

Chapter 3

METHODS OF VALUATION AND DEMAND ESTIMATION

3.1 Introduction: Valuation in General

Meaningful values are only determined in the context of decisions. People appraise the values of things in particular situations usually at the time a decision must be made. According to Sinden and Worrell (1979, p. 82), decision situations fall into three broad types:

(i) either do / or retain the status quo situations,
(ii) compensation situations, and
(iii) alternative choice situations.

An either/or decision concerns only whether the thing or action would have value. A compensation decision needs to ensure that the individual is at least as well off as he was before. An alternative-choice decision needs only to determine which of the possible alternatives would have the greater value.

Perhaps slightly different but complementary to the above approach to valuing is what Bishop (1978) calls irreversible situations, decisions which involve determining once and for all the safe minimum standard of supply of a good or service. In valuing the existence of a natural ecosystem, Bennett (1982) outlines the importance of choices which involve wilderness as an alternative land use. These problems of choice will set the pattern for this study from the favourable difference a thing can make to someone's life. They can be expressed as:

Value of something	=	Utility of its use	-	Disutility of obtaining and using it.

Values are indicators of relative importance and can be used to guide choices among alternatives. Economics is concerned with choices, and so its principles apply to valuation. The conceptual definition of value in the above equation can be given operational content by employing two economic principles: willingness-to-pay

(WTP), which can measure utility and recognise income constraints, and opportunity cost (OC), which measure disutility. In equation form this is expressed as:

$$V_i = WTP_i - OC_i \ .$$

An important task in this study is to find ways to measure WTP.

As outlined in Chapter 2, the theory of benefit estimation can be applied to preservation of eucalypt woodland that involves several concepts, which can be applied through several methodological approaches. Methods of valuation and demand curve estimation are detailed in the following sections.

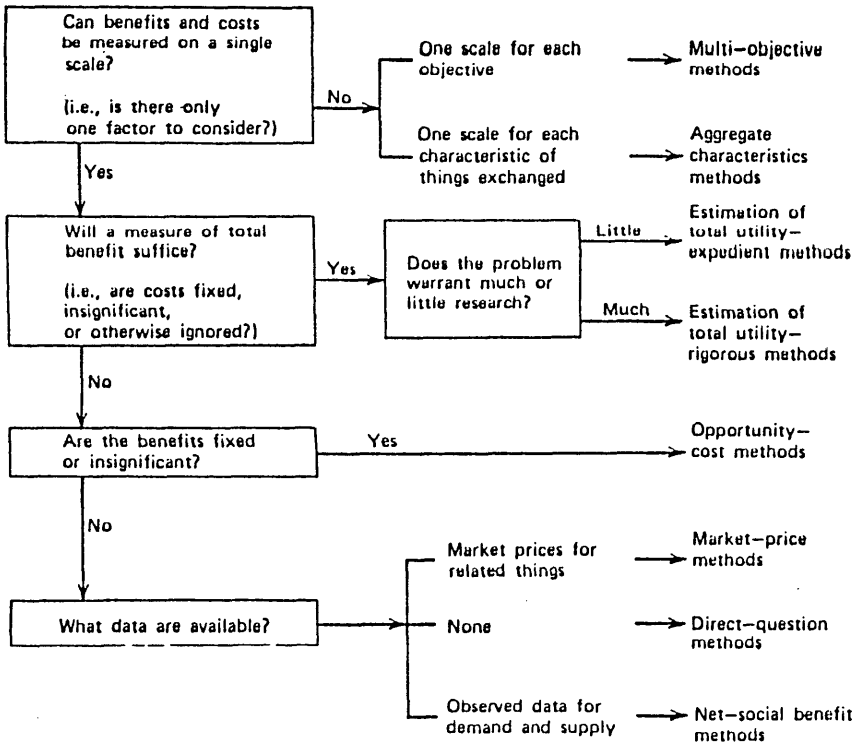
3.2 Choice of Valuation Method

The appropriate method depends on the nature of the decision and the value information required. According to Sinden and Worrell (1979, p. 121), important aspects of the decision are the existence of multiple or single objectives; the need for individual, group, or social values; and the existence of fixed costs and benefits. The search for an appropriate method can be proceeded on the aforementioned argument that may lead to the following specific groups of methods.

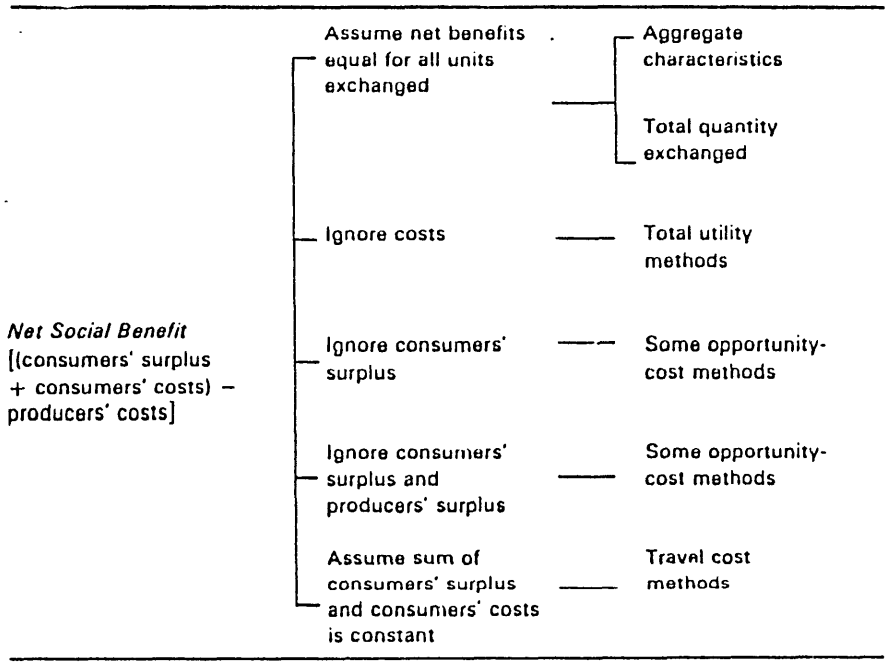
Specific decisions or problems require specific kinds of methods. No one method will satisfy all situations as envisaged in Sinden and Worrell (p. 123). The choice of a method should rest on how well it suits the decision and not on its intrinsic merits. Some methods that give no value information in the form of net utility, can sometimes provide related information that is helpful for decisions. Some of the following groups of methods can only provide values in very specific situations. However the choice should depend on whether such situations exist, rather than on the inherent merits of the method.

The following diagrams shows the relationships of some groups of methods to net social benefit. However different groups of methods implement the value model in different ways. The full model as discussed in Chapter 2, with its estimation of social utility and disutility, is implemented only by the net-social-benefit methods.

SELECTION OF A VALUATION METHOD



A schematic diagram of the selection of a group of methods.



Relationship of some groups of methods to net social benefit.

Source: Sinden and Worrel 1979, p.122

Figure 3.1 The Selection of a Valuation Method: The Relationship of Some Groups of Methods to Net Social Benefit.

In addition to selecting and applying appropriate methods, it is necessary to justify the results of valuations. Validation (of values) is the process of checking results to make sure that they measure what they are supposed to measure.

The content tests that can be carried out by structuring questions with built-in checks provide a useful way to perform the validation of values test. Bohm (1971) and Tideman (1972) illustrate two kinds of built-in checks. They structured their methods to reduce bias so that a rational individual would then not perceive any advantage in understating or overstating his values.

3.3 Valuation of Benefits for Public Goods

Benefits are valued here to determine how people value what they receive for preservation of eucalypt woodland. Similarly, another objective is to estimate the existence and recreation values for woodland, as perceived by the individual and the society. Finally, it is intended to ascertain the option values for avoiding the risk of further dieback. The following section describes several methods that are used for valuation of benefits for public goods.

Land is defined as an economic good consisting of a bundle of value-determining attributes (Samuel, 1982 p. 2). Most of these attributes are inputs into the production of agricultural products, while the remainder are inputs into the production of environmental products for social utility. Eucalypt woodland is a private good to the grazier as it is a source of his farm income in providing stock shelter. Land value may tend to increase as dieback threatens woodland hence a benefit to the grazier. On the other hand, eucalypt woodland provides public good (off-farm) benefits which may be perceived as preservation benefits (recreation, existence benefits, and retention of options for future use). Therefore its a mixed good in this context of valuation of benefits.

3.3.1 Smith auction method

Smith (1979), compared three public good decision mechanisms on the basis of their characteristics of collective excludability, common consumption, its attributes and budget balance. One of

his methods is 'the auction mechanism'. Smith claims that it produces approximately pareto-optimal quantities of a public good, because it provides explicit incentives to discourage free-riding.

The Auction process involves respondents bidding for the provision of a public good in an iterative sequence. Payment of bids is required, and the incentive for respondents to under-state preferences or 'free-ride' is negated by the threat of exclusion from provision for the whole society or group involved, if the costs of provision are not met by the total group bid.

3.3.2 Bohm's method of estimating demand for public goods

Bohm (1972) uses six different approaches to estimate demand for a public good. Revelation of individual preferences would produce important guidelines for output decisions and distribution policy. The main importance would seem to be that it provides an experimental approach to tackle the problem of selecting a practicable method for estimating demand for public goods. Bohm's six different approaches to determine the aggregate maximum willingness-to-pay for a given increase in the output of a public good are briefly given below. The first five state that the given increase will be made, if the aggregate stated maximum willingness to pay exceeds costs. If so, each individual will have to pay;

(i) according to his maximum willingness-to-pay as stated,

(ii) the same fraction of the maximum stated, the fraction being equal to costs divided by the stated aggregate maximum willingness-to-pay,

(iii) according to one of several alternatives, the choice not yet being made,

(iv) a given amount, the same for all individuals, and

(v) nothing.

(vi) With this last approach it amounts to asking what the individual thinks the increased volume of the public good would at most be worth to him, not mentioning the conditions under which it would be produced nor what it would cost him if produced.

The main results of the test were that none of the first five approaches gave an average maximum willingness to pay that significantly deviated from that of any other of the approaches. In particular, an approach which provided no incentives for overstatements, but possibly the opposite, did not produce an estimate significantly different from that obtained from another approach which provided no incentives for understatements.

Another result, 'which confirms' preconceived ideas in this area was that the estimate from the sixth and completely different approach, aiming at the calculation of a hypothetical willingness to pay, significantly exceeded the estimate obtained from one of the above mentioned approaches.

The main importance of Bohm's study would seem to be that it provides an experimental approach to tackle the problem of selecting a practicable method for estimating demand for public goods. Bohm (p. 112) concludes that people subjected to his test reacted in a way which is promising for experiments of this nature. Bohm's success lends optimism to the use of a direct question method in this study. Thus, direct question methods should be explored further for further empirical evidence.

3.3.3 Johnston's willingness-to-pay surveys

Johnston (1982), carried out a survey to ascertain the general nuisance value of the bushfly, which affects a variety of outdoor activities. Also, he tried to estimate (a) the value of the fear that bushflies are transmitters of human and animal diseases, and (b) the unfavourable-impression-value that bushflies make on overseas tourists.

He tested Bohm's hypothesis that free-riding is insignificant. He also noted that Bohm's conclusions suffered from two major defects. The first was the laboratory context of the survey which allowed the respondents willingness-to-pay bids (WTP) to be actually collected. The essence of the public good problem in large-number situations is the inability to actually collect individual bids. So the laboratory context casts some doubt on the validity of Bohms conclusion that free-riding is unimportant in actual empirical situations. Secondly, Bohm alerted respondents to the opportunities for free-riding and

provided an incentive to answer honestly. This feature may have caused biased results.

The willingness-to-pay (WTP) survey, reported in Johnston (1982), attempts to overcome these two shortcomings. Willingness to pay bids are obtained in a realistic public choice setting and respondents were not alerted (or discouraged) to provide strategic responses.

The essence of Johnston's study is relating willingness to pay for public goods to willingness to pay for private goods. This should provide explicit information on the accuracy of sample surveys as a means of estimating the demand for public goods. In order to provide some check on the accuracy of respondents WTP bids for the public good (ibid p. 219), an attempt was made to relate these bids to their actual expenditures on an alternative private means of 'controlling' bushflies - namely through the use of personal insect repellents. As it happened, expenditures on insect repellents proved to be an unsatisfactory measure of the communities WTP for public control. As a matter of interest, results indicate the vast majority favoured it because it reduced dependency on repellents.

The exploration of the use of bidding games to elicit more accurate WTP bids is a unique feature of the above study. Bennett (1984), measuring the costs of bushfires to national park users, relies on direct questioning. He comments that direct questioning is superior mainly because of some theoretical inadequacies inherent in other alternatives of using available data on park usage and recreation demand elasticities. The above work thus justifies the use of direct question method with bidding games to value preservation benefits in this study.

3.3.4 Hardie and Strand's method

Hardie and Strand (1979) in their American Journal of Agricultural Economics article adapted a standard budget allocation method to estimate benefits for potential public goods. They then measured the benefits from these goods by estimating demand curve changes and consumer's surplus values.

Their estimation of the underlying demand curve was the standard supply-price technique. The approach in the present study is an extension of their method by an increase in the number of price sets and the number of goods, as illustrated in the questionnaire (question 2, schedule I) of Appendix 10.

The Hardie and Strand formulation is consistent with the multi-equation approach used in recent recreational demand studies (Gum and Martin, Cheshire and Stabler in Hardie and Strand p. 315). Following their work, the choice of goods is accomplished through substituting an agency budget into the individual's choice problem and asking the individual to allocate this budget according to his preferences. The costs of goods are set at a magnitude equal to the entire marginal cost of providing the good. Following Hardie and Strand, in this study the preservation problem is stated so that each individual is allocating the agency's budget to provide maximum utility to the individual. With a fixed agency budget, and a fixed column vector of alternative costs of providing a given quantity of each the problem of choice of preservation alternative becomes a constrained utility maximization problem for the subset of public goods, which the government agency is authorised to produce.

The solutions from the questionnaire for different and given budgets and costs generate points on the individual's demand curve for a potential quantity of preserved species. Representative demand curves are then obtained by weighting and pooling individual observations and employing an econometric technique to estimate systems of equations [Cicchetti, Fisher and Smith (1976)].

3.4 The Methodology of the Present Study

The use of bidding games in this study to elicit willingness-to-pay bids can be partly justified by the fact that the many recent studies on preservation have relied on the method, including Brookshire et al. (1982), Johnston (1982) and Bennett (1984). The direct-question approach establishes hypothetical markets (contingent markets) in the minds of the respondents before they value the goods.

In the present study the bidding games are used in questionnaire question 2; schedules I and II (Appendix 10). This and other willingness-to-pay questions were used in a direct question method for the elicitation of bids and willingness-to-pay, on a random cross section of the Armidale population (Appendix 1, the basis of selecting the required sample size).

The study area of Armidale, contained a wide variety of landscapes and, most importantly, it contained some of the worst areas of dieback in the region. As envisaged in chapter 1, the emphasis of selecting Armidale as the centre of this research is the importance of the collection of information pertaining to the preferences of it's off-farm inhabitants for woodland preservation.

Therefore, it may be useful to make available the sample information on social values for policy implication purposes. Hopefully, these sample values could be extrapolated to place a societal value on eucalypt woodland. It will enable to obtain an Australia-wide social value (X million dollars) placed on eucalypt woodland by it's population.

Chapter 4

METHODS OF ANALYSIS

4.1 Introduction

In this chapter, the methods of analysis will be discussed, and the main regression problems identified. The dieback problem concerns both producers (mainly graziers), and those members of the public who care for the environment. The preservation problem is presented to members of the public in the form of a survey questionnaire. It generates information pertaining to preferences and choices of the social group.

The setting for the study and regression analyses emanate from the main problem of, which goods are preferred and which of the characteristics are important to the kinds of utility an individual is trying to value. The nature of recreation value, it's relative importance against existence and option values are the other problems.

4.2 The Setting

The study includes the following analyses.

(a) The initial survey question concerns the relative importance of different attributes and characteristics of the dieback problem.

(b) The main survey questions are simulations of the allocation of government funds in bidding games using the Hardie and Strand (1979) approach. The particular interest is the preferences of the sample population for competing public goods, in the first case the outcomes of alternative strategies for coping with dieback, and in the second case the biological and landscape characteristics of different types of eucalypt woodland.

(i) The first simulation is the allocation of funds between the eight alternatives listed in Appendix 10, p128. Of these alternatives, numbers 1,2,5,6,7 and 8 are alternative ways of coping with dieback, the objective is to obtain estimates of the preferences of the respondents for the consequences of the use of these ways of coping.-

- Alternatives number 3 and 4 relate to research and extension and are intended to elicit respondents preferences for investment in the creation and dissemination of knowledge of the problem compared with merely coping with it in the ways nominated.

(b) The second simulation concerns the biological and landscape characteristics of different types of eucalypt woodland. The budget allocation procedure is again used to seek preferences. Purchase and preservation of existing woodland is a major possible policy measure. The alternative goods are substantially 'the same' as they are but different types of eucalypt woodland. Subjects will be asked to select quantities of nine alternative types of eucalypt woodland, which will vary in their characteristics.

(c) The other questions concern the benefit values of recreation, existence and option values. Standard demand functions will be used to value these benefits from willingness-to-pay bids.

Consumer characteristics such as the number of children in the household, and income (except in given budget situations), will be used as appropriate in all models to test their influence in determining preferences. In addition, variables that are possible socio-economic determinants of preferences, such as experience of living in the bush, and frequency of reading about nature appear in the models. The basis for selecting these explanatory variables was the evidence and beliefs about their relationship with the dependent variables. To ascertain whether the selected variables are significantly correlated, a correlation coefficient test was carried out using all 19 socio-economic variables. This indicates the statistical validity of the variables as the problem of multi-colinearity does not exist between them and dependent variables.

4.3 Specification of the Analytical Models

A general form of a demand function is used and the specification is as follows.

$$Q_i = f(P_i, P_n, I, S_n),$$

where Q_i is the quantity of good i demanded, and a function of its price (P_i), the prices of other goods (P_n), I(income) and other socio-economic characteristics (S_n).

Income in this function is represented by a budget in the bidding games and actual income elsewhere.

4.3.1 Application to choice between alternative policies

Many potential control measures have been suggested to counter the 'eucalypt dieback' problem, including steps to preserve healthy woodland and fence livestock out of young regeneration. Biological research on the required measure is continuing. But it seems of interest to attempt to investigate preferences of the community for the more important measures particularly since the local concern seems to rest on perceived external costs of dieback on the non-farm population. Such costs could include loss of heritage due to death of native woodland, loss of aesthetic benefits as trees die and deterioration of ecological condition of the region. Objective, quantitative evidence on these costs does not exist as yet.

4.3.2 The budget allocation game and free-rider difficulty

One problem with public goods is the free-rider problem, and it's associated problem of preference revelation. However, from the extensive literature on this problem, it is possible to determine three ways to obtain revealed preferences. One is an experimental technique which include ingenious devices that penalise the experimental subject for attempts to engage in strategic behaviour. Smith (1979) claims that his 'auction mechanism' produces approximately pareto-optimal quantities of a public good, because it provides explicit incentives to discourage free-riding. Another method has been to observe the market for private goods which are complementary to public goods.

The Dreze-Poussin (1971) and Malinvaud (1971) process involves consumers reporting their preferences as marginal rates of substitution between public good and private good. This is simply the trade-off of the amount of public goods to be given up in order to get an additional amount of private good. This, in fact, is the choice of quantities to be purchased.

The essence of their model in terms of empirical application, is to ask relevant individuals to allocate a given budget between public goods that a government agency is about to provide. The goods are described, priced and the individuals are asked to choose the combination of goods that best meets their preferences and just exhausts the budget. Prices are varied and further sets of preferred quantities are collected. They investigated preferences for five goods (lakes, nature parks, camping parks, resort complexes and day-use facilities) amongst over 500 people. The subjects simulated the allocation of the capital budget of the Maryland State Park Service of the United States. Preferences were analysed through estimation of separate demand functions for each good. As Hardie and Strand used it (the budget allocation process) in their study, this agency is assumed to want to spend this budget as the population sees fit. Since control/management of resources directly influences the people, the agency would like to seek out their preferences. As Hardie and Strand saw willingness-to-pay is the correct approach to this problem and the methodology of this study also employs the allocation process to seek out preferences between different consumption goods. Use of a fixed agency budget and requesting interviewees to imagine themselves as responsible for allocating this fixed budget on behalf of the agency is simply a technique for removing the interviewee from the narrowness of his personal income, i.e. overcoming the free-rider problem. Therefore, this problem is one of preferences for consumption of public goods. Interpretation of the problem involves choice between different public goods resulting from outcomes of coping with dieback through different control measures, i.e. a range of public goods.

Hardie and Strand developed their allocation procedure in order to provide such information on preferences. This study concerns the preservation problem of eucalypt woodland. The problem of dieback confronts the respondent's mind. The direct question method used in the study in the first instance elicits purchases of quantities and these preferences are for public goods. These public goods are the consequences of alternative strategies to cope with the dieback problem. In the second instance the responses show the choice between the characteristics of different types of the same public good.

In this study, the individuals were asked to allocate $ 100,000 between eight possible goods or control measures (alternative strategies of coping with the dieback problem, schedule I of the questionnaire). The sum had recently been collected locally and allocated between similar control measures. The appeal, collection, and use of the funds had received considerable publicity. Individuals were given a price for each good, and asked to allocate the budget and select the goods to exhaust the budget as closely as possible, and to maximise their expected benefit from their choices.

4.3.3 Nature of regression analysis

The neo-classical theory of choice assumes that households maximise a utility function,

$$1. \qquad U = U(Q_1, \ldots P_1)$$

subject to an income constraint,

$$2. \qquad I = P_1Q_1 + \ldots + P_nQ_n \ .$$

The term U represents utility, and Q_n the quantities of each good purchased at prices P_n from a given income I.

The solution to the utility maximisation problem gives the general demand function for the ith good as

$$3. \qquad Q_i = f(P_1, \ldots P_i, \ldots P_n) \ .$$

There were altogether six sets of prices used in the game. The first set of prices were representative prices for each good. The other five sets of prices were used to give a range between likely minimum and maximumum prices. Thus, for each good the current minimum, representative and maximum prices were identified, and three more were selected randomly between the extremes. The prices in set 1 were the representative prices, but the other five price sets were again randomised. All prices in the six different price sets were tested for multicollinearity problem and between them there were only one correlation above 0.70 (Appendix 2).

Further, variables which should a priori influence Q_i are sometimes included. They are often socio-economic characteristics (S) of person j and to symbolise these, the equation can be rewritten as;

$$4. \qquad Q_i = f(P_1, \ldots P_i, \ldots P_n, S_j)$$

This conventional single equation specification should be modified, or rather expanded, where individuals clearly spend their given budget amongst competing goods. This gives a system of demand equations which may be specified as follows.

$$5a. \qquad Q_i = a + \beta P + u$$

where

(5b) $$Q_i = \begin{bmatrix} Q_1 \\ \vdots \\ Q_n \end{bmatrix}$$

there are n competing goods,

$$\beta = \begin{bmatrix} \beta_1 \\ \vdots \\ \beta_n \end{bmatrix}$$

for each of the prices, and

(5c) $$P = \begin{bmatrix} P_{11} & \cdots & P_{n1} \\ \vdots & & \vdots \\ P_{1m} & & P_{nn} \end{bmatrix} .$$

u is the vector of disturbance terms (e's). In a symmetrical model the influence of each price would be estimated on each good, and the matrix in 5c be symmetrical m=n. Therefore, the system of demand equations can be written as follows.

(6) $$\begin{aligned} Q_1 &= a_1 + b_{11}P_1 + b_{12}P_2 + \cdots + b_{18}P_8 + S_n + e_1 \\ &\vdots \\ Q_8 &= a_8 + b_{81}P_1 + b_{82}P_2 + \cdots + b_{88}P_8 + S_n + e_8 \end{aligned}$$

Hardie and Strand (1979) estimated a single demand equation for three of the five goods under consideration, but as they reported, they were unable to explain a substantial proportion of the variation in individual choices so they argued for further exploration of the approach i.e. joint estimation of a system of demand equations.

Ciccheti, Fisher and Smith (1976), used a similar method to measure the consumer surplus associated with a natural resource development project. Burt and Brewer (1971), used a system of demand equations to estimate net social benefits from outdoor recreation. Their results of the application suggest that investments in outdoor recreation can be evaluated under objective economic decision criteria.

Zellner (1962) proposed the seemingly unrelated regression (SUR) approach for situations where at least two equations are being estimated and where cross-equation correlation should be present. According to Judge et al (1982 p. 321), the efficiency gain tends to be high when the errors among different equations are highly correlated.

The budget allocation device was used to generate responses of different individuals to a particular budget constraint, and was applied to eight different goods which suited the SUR method in a system of equations. This is a result of including competing goods in the allocation game and relying on the responsibility of individuals to utilise the given budget in the same way as government funds are allocated.

Theory also invites joint estimation. It is possible to test for the symmetry of the cross-price terms in the equations and also to restrict this if necessary. Economic theory suggests that the demand functions must satisfy certain restrictions. First they must satisfy the budget constraint. Secondly homogeneity, then the Slutsky conditions, and finally the aggregation conditions (Intriligator, 1978 pp. 212-15). The third set of conditions are the Slutsky conditions, which are based on the static effects of changing prices and income, and determine the resulting changes in demand. Here the concern is not on the first of Slutsky conditions i.e. the negativity conditions, but on the second, the symmetry condition. According to Henderson and Quandt (1980, p. 30) the Slutsky conditions can be extended to account for changes in the demand for one commodity resulting from changes in the price of the other. These cross-price effects in essence are symmetric determinants emanating from the imposed Slutsky symmetry conditions.

In this study the concern was on the price coefficients, and the imposition of the Slutsky symmetry conditions to observe the cross-price effects. This would enable to identify the substitutes and complements among plausible but competing dieback control measures. Another important aspect of this study was the given budget situation that would account for the strategic type behaviours. Hence it would be imparative to seek evidence for the income effects in the cross equations. These can be interpreted logically as follows.

With the symmetry conditions applicable to both a changing price and income situation, and with imposed restrictions the equation should take the following form.

$$(7) \qquad \frac{\partial x_1}{\partial p_2} + \frac{\partial x}{\partial I} x_2 = \frac{\partial x_2}{\partial p_1} + \frac{\partial x_2}{\partial I} x_1$$

where p's are the prices and I's income levels. But with a given budget the income effect will not be reflected in the equation once the restrictions are imposed.[1] Therefore the symmetry condition applicable to that situation could be written as:

$$(8) \qquad \frac{\partial x}{\partial p_2} x_2 = \frac{\partial x_2}{\partial p_1} x_1 \ .$$

Thus the above symmetry condition should be sufficient to facilitate the following intended inquiry to find out substitutes and complements among plausible control measures.

Complementarity-substitutability between different goods is indicated by positive and negative cross-price coefficients respectively. Thus a negative coefficient on a cross-price variable would imply complementarity between two goods. A positive sign would indicate that the two goods are substitutes. The level of significance on the variable indicates the strength of the relationship. For example an insignificant cross-price variable with a negative sign shows that the indicated complementarity is infact unlikely to exist.

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[1] This is also the view of Ass.Prof.Bill Griffiths, of the Department of Econometrics.

4.3.4 Estimation of the system

A variety of complete systems of demand equations have been used in the literature. For example, Parks (1969) reviews three functional forms to model expenditure patterns in the Swedish economy. The Rotterdam Differential model uses logarithmic transformations of quantities of goods, prices and expenditures. The Indirect Addilog model rests on an indirect additive utility function. However this function implies restrictions about demand elasticities which seem inappropriate for the present study.

The Linear Demand model rests on a direct, utility function:

$$U = u(x_1, x_2, x_3, \ldots . x_n) = f[(u_1(x_1), \ldots . u_n(x_n)]$$

when the individual utilities are scaled or weighted from zero to one, the function can be specified as the additive form (Anderson, Hardaker and Dillon, 1977),

$$u(x_1 \ldots \ldots x_n) = \sum_{i=1}^{n} ut_i \ [U_i(x_i)]$$

All three demand-equation systems are homogeneous in degree zero in prices and income; they satisfy the adding-up criterion; and they satisfy the Slutsky symmetry condition. The second order conditions will be satisfied if $m - \sum_{j=1}^{n} yjpj > 0$ and $0 < \beta_j < 1$ hold for all j. These conditions further limit the parameters and can be used to check the validity of the estimates. Some results (Houthakker, in Parks p. 632), indicate that the additive form of the utility function restricts the form of elasticities. Park observes that since β_j cannot be negative then, clearly it cannot treat inferior commodities.

All three models are based on utility maximization subject to a budget constraint. They also satisfy the adding up, homogeneity, and the Slutsky symmetry conditions. Since the three models, the Rotterdam differential demand model, the indirect addilog demand model, and the linear demand model differ in their computational problems and in their empirical performance, the most flexibile model has been selected for this study.

methods
Linear equations are convenient/but as Burt and Brewer argue, are almost a necessity in the imposition of constraints for restrictions. The demand equations from the additive model were summarised as equation 5a and the system was specified as equation 6 previously.

The quantity of each demanded is chosen in the budget allocation game. These quantities became the dependant variables in regressions estimated as functions of eleven exogenous variables, comprising eight prices and three other variables (socio-economics variables). The basis for selecting these explanatory variables rests on evidence and beliefs about their relationship with the independant variables. The analysis will be based on restricted and unrestricted, seemingly unrelated regressions. The imposition of restrictions will be tested for validity (i.e. if the restrictions hold) by using values of F-tests.

4.3.5 Application to the choice between alternative woodland types

The second major objective of the study is to compare preferences for different types of eucalypt woodland assuming that purchase and/or preservation of existing woodland is a major possible policy measure. The necessary preference data have been collected by a budget allocation game in the survey (schedule II of the questionnaire). Subjects are asked to select quantities of 8 alternative types of eucalypt woodland which vary in their characteristics.

The characteristics under investigation include health of the species, rarity of the species, visibility of the woodland types, and ecological fragility of the site (whether bad or good).

They are asked to choose quantities so as to maximise their own utility from the choice and meet a budget constraint. Accordingly study
to/the objectives of discovering which woodland types are most preferred and how choices vary with price, woodland characteristics and socio-economic characteristics, a suitable analytical model should be a single equation, estimated by ordinary least squares.

$$Q_{ij} = f(P_i, K_{il}, \ldots, K_{in}, S_j)$$

where Q_{ij} is the quantity of woodland type i demanded by person j, P_i is the price of Q_i, K_{in} is the level of the n^{th} characteristic of the woodland type i, and S_j are the socio-economic characteristics of the person j.

4.4 Extension of the direct method to benefit valuation

The direct method of determining extra market benefits, applied to this study, simply involves asking respondents "what would you be willing to pay for a permanent pass as a once only donation to preserve and maintain healthy woodland for recreation?" Similarly, willingness-to-pay for knowledge that this healthy woodland would continue to exist, and for retention of such options for future use can be questioned by this approach. In the case of an individual confronted by distance (travel), he can be asked to reveal his willingness-to-pay for recreation and then these results can be regressed in the following form.

$$WTP_r = f(\text{Income, Distance, } S_n)$$

where willingness to pay for recreation (WTP_r) is a function of income, distance from the household to the site, and socio-economic characteristics (S_n). The same model encapsulate the willingness-to-pay for knowledge. The model only slightly differs for option values. Willingness-to-pay for options (WTP_0) that should be retained for future use is written (as follows) as a function of the probability that a visit will take place, the income, and the socio-economic characteristics.

$$WTP_0 = f\ (\text{Probability, Income, } S_n).$$

Thus the regression equations for each of these willingness-to-pay are used to estimate demand for each concept. The main assumptions in this approach are as follows.

(a) That respondents can assign an accurate value to the recreation form being discussed.

(b) That this value can be elicited from them by the use of a questionnaire.

Therefore the expectation is that the willingness-to-pay method reveals a true preference for the measurement variable. It is believed that WTP is the best indicator of ones recreation quality and, in that belief, it is thought to be reliable for other measurements as well (existence and option values).

The questions were designed in order to ascertain the relative importance of recreation value compared to existence and option values (Appendix 10: Q3, 4 and 7). The sequence was that the amount over and above recreation value (question 3, willingness-to-pay bids) was the existence value (or amount quoted in Q4)less the amount quoted in Q3). Any amount above that (Q7) was the option value. Thus each question provided with a net value of each measure (i.e. Q3 = RV, Q4-Q3 = EV, Q7 = OV). These net values in aggregate became the Total Value of preservation. The questions 5 and 6 were specifically designed to seek the willingness-to-pay information on extra benefits over the amount willing-to-pay for knowledge (Question 4).

4.5 Socio-Economic Characteristics

All questions relating to the household information are listed in Appendix 10 (question 9 to 25). Based on a correlation analysis, the ones that showed the least significance among the socio-economic variables were selected to be included as explanatory variables in the demand functions except income. These same variables were represented in every demand function of the study. The chosen variables were tested again to see if they have high correlations with the price variables.

Initially the following five variables were apparent to be chosen for the study.

Question number	Units	Variables
9	Years	Number of years spent in the bush (BUSH)
11	1-5	Relationship of the profession to the bush
12	1-5	Frequency of reading about nature (NATURED)
20	Years	Education of the household head
22	Persons	Number of children in the household (NCHILDREN)

These variables within them did not show a very high correlation and neither did they with price variables (Appendix 3). Still the variables on the relationship of the profession to the bush (S_{11}) and education of the household head (S_{20}) were left out as those two variables had the highest correlations ($>.50$) with other variables. On the other hand number of years spent in the bush (S_9) showed low correlations among the variables hence the inclusion of that variable would explain what significance it has with the dependent variables under investigation. As education (S_{20}) had a high correlation with reading about nature (S_{12}), it was apparent from a subsequent correlation coefficient analysis (Appendix 4) that it should be left out. On that basis the following variables were selected for the study.

(9) Number of years spent in the bush
(BUSH)

(12) Frequency of reading about nature
(NATURED)

(22) Number of children in the household
(NCHILDREN)

The question 24 of the questionnaire was on the annual income of the household. This was expected to be an influential determinant of ones willingness-to-pay, hence it was included in the functions as appropriate.

Chapter 5

ESTIMATION OF RECREATION, EXISTENCE AND OPTION VALUES

5.1 Introduction

As noted in Chapter 1, tree decline in the rural landscapes has been a problem across Australia, and environmental awareness of this problem has been given prominence from time to time in both the local and national media.

So far, most research has concentrated on biological work and on-farm studies. The present study may be the first to identify and report on the preferences of a particular population for dieback control and for other characteristics of the problem, and the first of these results are now reported.

In this chapter, the data on the respondents' preferences for different attributes of the dieback problem are reported and analysed. The results indicate whether the particular population is more concerned with the changing wood products, ecological, recreational, aesthetic or other characteristics of the eucalypt woodland.

The associated concern is with how the population values those different characteristics and uses. Thus, the chapter moves to the question of estimating some relevant values. A willingness-to-pay survey determined the relative values (or benefits) of the particular benefit concepts that were investigated. The whole 136 people were sampled for these values. The concepts of benefit that are explicitly valued are the recreation value (RV), existence value (EV) and option value (OV).

5.2 Attitudes to Characteristics of Dieback Problem

An initial objective of the research was to seek opinions on each of the many effects of the dieback problem. This analysis provides an introduction to the rest of the research.

Table 5.1

Attitudes to Characteristics of Dieback of Eucalypt Woodland

Variable number	Characteristic	Mean Score	Standard Error	Maximum	Minimum	Ranking in an order of importance[a]
V_1	Aesthetic degradation of the overall landscape	3.78	0.04	5	1	5
V_2	Aesthetic degradation of local landscapes	4.10	0.08	5	2	4
V_3	Further to travel to recreation sites with healthy woodland	3.51	0.09	5	1	10
V_4	Long-term degrese in firewood availability	3.15	0.10	5	1	11
V_5	Loss of heritage through loss of native woodland	4.24	0.06	5	2	2
V_6	Increased erosion of soil	3.71	0.07	5	1	6
V_7	Reduced quality of run-off water	3.54	0.07	5	2	8
V_8	Loss of stock shelter	3.54	0.10	5	1	8
V_9	Loss of woodland with rare eucalypt species	4.26	0.06	5	2	1
V_{10}	Loss of habitat for predators of leaft-eating insects	4.18	0.07	5	2	3
V_{11}	Loss of habitat for poisonous snakes	2.80	0.09	5	1	12
V_{12}	Loss of habitat for pretty birds	3.71	0.08	5	1	6

[a] Criterion 1 = highest mean value, the highest five ranked characteristics are underlined.

The basic data were collected as responses to a simple question, "which of the following aspects of dieback concern you?" Responses were scored from 1 to 5 as follows.

	Very unconcerned	Unconcerned	Neutral	Concerned	Very Concerned
V1	1	2	3	4	5
"					
"					
V12					

The 12 characteristics (V1 to V12) are shown in Table 5.1. Each person had to score each variable (V1 to V12) with a particular tick for his response. The aggregated data are presented in Table 5.1, with mean scores and standard errors per characteristic.

Variables V2, V5, V9, and V10 had the highest mean score. The aesthetic value of local landscapes (V2) scored higher than the aesthetic value of the overall landscape (V1). Hollis (1983) found that the rarity status of the species influenced individual's willingness-to-pay and extremely rare species were preferred to just endangered ones. The relevancy of her findings to the present study is that people appear to conform to this preference pattern when they rank their preferences over a number of alternatives. The supporting evidence is that respondents' attitudes towards rarity of eucalypt species (V9) had the highest ranking among the characteristics. Further the heritage characteristic (V5) was the second highest ranked characteristic.

Reduced quality of run-off water (V7) showed the same mean value as the loss of stock shelter (V8). Loss of habitat for pretty birds (V12) was of the same importance as the increased erosion of soils (V6).

The loss of habitat for predators of leaf eating insects (V10) and loss of habitat for pretty birds (V12) had a much higher ranking than the poisonous-snakes characteristic (V11), the latter being the least preferred. This re-affirms the results of Wellham (1982), and Hollis (1983), that people may be responding somewhat emotionally

to the more favourable term 'pretty birds' rather than the term 'poisonous snakes'. It is possible, too, that people prefer poisonous snakes least of all.

It is evident from the maximum scores that all twelve variables had their 'natural' maximum of 5, whereas only five of the twelve variables showed a minimum of 2. The remaining seven had the 'natural' minimum of 1. The ones with 2 as minima were ranked highly (the first five highest ranking mean values) among the rest of the variables. This indicates a possible consistency in the way the respondents behaved.

5.3 The Recreation Values

The recreation values of eucalypt woodland were measured by the use of a direct-question method, with question 3. This question was phrased as follows. "How much are you willing to pay to buy a large eucalypt woodland for a recreation site?" This kind of method, (termed a contingent valuation method,) is approved by the U.S. Water Resources Council (1979). The recreational consumer surplus was elicited for a given kind of recreation in a given kind of woodland, which might be located at three possible distances from the household.

5.3.1 The values in aggregate

Table 5.2 summarises the recreation values as averages, with their standard errors. From these data it appears that the respondents behaved rationally to the nominated distances of the recreation site. The highest bid (being $38.6) was for a site of closest proximity and the lowest donation ($21.5) was offered for the most distant location of 25 km from home.

Travel time is an inseparable part of the recreation trip. But it can be a pleasure or a cost, depending on the scenery, the road and so on. In the usual economic sense, travel time and the recreation experience itself are a package of commodities. According to Burt and Brewer (1971, p. 826) and Walsh et al (1984), the consumer may have few alternatives other than the particular package of recreational sites presented to him, due to his spatial location. Therefore, consumers will react to time cost and travel cost in recreational

Table 5.2

Recreation and Existence Values ($ mean per household)[a]

Recreation Values (RV)			Existence Values (EV)		Total WTP (RV + EV)
38.6	(3.9)	at 5 Km distance	13.9	(4.9)	52.5
29.4	(3.1)	at 15 Km distance	14.0	(4.1)	43.4
21.5	(2.6)	at 25 Km distance	11.1	(3.5)	32.6
29.8		Average over all distances	13.0		42.8

Figures in parentheses refer to standard errors.

[a] As willigness-to-pay for benefits for (recreation and existence) a given woodland at X Km distance from household.

choices. The present results support the above argument about the decisive nature of distance in recreation choice and valuation, and imply that travel between 5 and 25 Km impose net costs.

5.3.2 Disaggregated explanatory models

The variation in recreation value was explored using full disaggregated data. The aim of conducting this regression analysis for individuals is to ascertain the facts of what determined the variations. The regression was in the form;

5.1 $$RV_j = f(D, I, BUSH, NATURED, NCHILDREN)$$

where recreation value of j^{th} individual was tested as a function of D(distance), I(income), BUSH (number of years spent in the bush), NATURED (his reading about nature) and NCHILDREN (number of children in the household).

The regression results for these disaggregated data are as follows.

5.2 $$RV = 16.972 - \underset{(4.023***)}{0.835}\ DISTANCE + \underset{(8.376***)}{1.536}\ INCOME - \underset{(0.617)}{0.082}\ BUSH + \underset{(0.616)}{0.896}\ NATURED - \underset{(3.466***)}{4.744}\ NCHILDREN$$

$\bar{R}^2$ 0.18 (5 d.f.)

F 19.95

N 408

For this regression the number of observations was 408 as there were three observations for each person (136 persons in all).

The signs were as expected for these data and were consistent. DISTANCE, INCOME and NCHILDREN were all significant at 0.025 level. The socio-economic variables BUSH and NATURED were insignificant for these data. The null hypothesis of no dependence on the explantory variables is rejected at 1 per cent level of significance. Therefore the model has some explanatory power.

For a fuller analysis of variation in recreation value, the sample was categorised on the rationality of their behaviour. For instance, an individual is considered rational if his recreation value decreases with distance. Therefore, the whole sample was divided into the following four groups.

(a) The completely rational (CR) group, in which the recreation value continuously decreases with increasing distance, had 51 people.

(b) The somewhat rational group A (SRA), in which the recreation value was constant for the first two distances (5 and 15 Km) and then decreased, had 28 people.

(c) The somewhat rational group B (SRB), in which the recreation value was the same for all distances, had 43 people.

(d) The apparently irrational group (AIR), in which recreation value increased with increasing distance and/or second or third donation highest other too low, had 14 people.

Among the somewhat rational group B (SRB), 10 said $0 for all distances. Yet, they were included in this group as this could still be considered a somewhat rational response. The behaviour of these 10 persons (or 7 per cent of the entire sample) is explained fully in the next section when existence value is discussed.

The regression model for each rational group was in the form:

$$5.3 \qquad RV_{jr} = f(D, I, BUSH, NATURED, NCHILDREN)$$

where recreation value of j^{th} individual of the particular rational group r was tested as a function of D(distance), I(income), BUSH(number of years spent in the bush), NATURED (his reading about nature) and NCHILDREN (number of children in the household).

Overall, the model for the completely rational group showed a better explanatory power (Table 5.3, $\bar{R}^2$ of 0.34) than the model for the whole sample (an $\bar{R}^2$ of 0.18). The signs of the coefficients

Table 5.3

Recreation Value of Individuals

Explanatory Variables	Completely Rational	Somewhat Rational A	Somewhat Rational B
DISTANCE	-1.766	-0.679	-0.081
	(5.84)***	(2.349)**	(0.73)
INCOME	1.877	0.811	1.462
	(6.54)***	(2.364)**	(4.02)***
BUSH	-0.417	-0.119	0.149
	(1.931)*	(0.665)	(0.528)
NATURED	4.122	0.587	-1.230
	(1.95)*	(0.72)	(0.36)
NCHILDREN	-4.142	-4.585	-9.176
	(1.82)*	(2.47)**	(3.001)***
CONSTANT	28.087	20.551	9.466
Number of observations	153	84	129
Number of people	51	28	43
$\bar{R}^2$	0.34	0.18	0.13
F-value	16.96	4.67	4.82
Degrees of freedom	5	5	5

[a] Figures in parentheses refer to t-values.

in Table 5.3 were consistent in the case of BUSH and NATURED in the model for somewhat rational B, but here the variables were insignificant. INCOME was the most significant explanatory variable in all the models. NCHILDREN was the next most significant explanatory variable, being significant in all three models. DISTANCE showed the same significance as INCOME for completely rationals (at 0.025 level of significance), and for somewhat rationals A (at 0.05 level). But it was not found to be significant (at any level) for somewhat rationals B. The explanatory variables BUSH and NATURED were found to be significant (at 0.10 level) only in the completely rational model.

In the F-tests the model for the completely rational group showed significance at 1 per cent level, but the models for the somewhat rational groups showed significance only at 5 per cent level.

5.3.3 Aggregated model

To continue to explore variations in recreation value, and in continued search for consistency, a further analysis was carried out using aggregated data. This analysis followed that of Brookshire, Randall and Stoll (1980) and, would attempt to reduce the influence of individual household differences in the relationship with income. Each willingness-to-pay (WTP) bid was entered into an income group (there were six groups) for the three distances. Therefore, the number of observations is 18(6 x 3) for this analysis.

The general form of the model is RV = f(distance income).

The regression result for the aggregated data is as follows.

5.4 $$RV = 9.047 - 0.747\ DISTANCE + 1.559\ INCOME$$
$$(6.9158***) \qquad (17.114***)$$
$$\bar{R}^2\ 0.94\ (2\ d\ f)$$
$$F\ value\ 170.36$$
$$N\ 18.$$

The t-values are shown in parentheses. INCOME is very significant and its sign is as anticipated. DISTANCE, appearing with its expected (negative) sign, indicates that distance "is" an opportunity cost through its influence of travel time. The high $\bar{R}^2$ value gives an

indication of the explanatory power of this model which was the best so far for recreation values, and this is further substantiated as F* > F at 1 per cent level of significance.

5.4 Existence Value (EV)

Another often-measurable benefit of preserving land uses is existence value. According to Bishop (1978), existence value reflects the utility that people receive from simply knowing that something exists. Walsh et al. (1984), extended this concept to include the satisfaction derived from knowing that something, like eucalypt woodland, exists in its natural state.

Table 5.2 has summarised the existence value data from all 136 households. The data were collected through Question 4 to give values as benefits over and above the recreation value at each of the different distances. The values represent the individual's willingness-to-pay (WTP) in return for the knowledge that the healthy woodland would continue to exist.

Whereas recreation value showed an average willingness to pay of $29.8 over all distances, the average existence value was only $13.0. The results of Table 5.2 also show that existence value does not vary consistently with distance. The total willingness-to-pay (RV + EV) over all distances was $42.8 and approximately 70 per cent of this was recreation value. The existence value of the average person was 30 per cent of his total willingness-to-pay, or $13.00.

5.4.1 Disaggregated explanatory models

In order to find out what determines an individual's willingness-to-pay for knowledge, and to test for consistency in his behaviour, the following model was estimated.

$$5.5 \qquad EV_j = f(D, I, BUSH, NATURED, NCHILDREN),$$

where, existence value of the j^{th} individual was tested as a function of D(DISTANCE), I(INCOME), BUSH(number of years spent in the bush),

---

The observed F* variance ratio is compared with the theoretical value of F. If F* > F the null hypothesis is rejected, i.e. accept that the difference between the mean is significant. The inference was that the populations from which the samples were drawn do differ.

NATURED (his reading about nature), and NCHILDREN (number of children in the household). The regression as conducted for recreation value was completed using the whole sample. This test, carried out irrespective of their rationality, sought to observe the patterns and consistency of all the individual decisions. The results for this disaggregated model are as follows.

5.6 EV = 5.608 - 0.151 DISTANCE + 0.554 INCOME + 0.095 BUSH -
(1.547*) (6.442***) (1.521*)
0.559 NATURED - 0.639 NCHILDREN
(0.819) (0.995)

$\bar{R}^2$	0.09 (5 d f)
F	8.95
N	408.

The signs were as expected and were consistent with the previous results. INCOME was the most significant explanatory variable (significant at 0.025 level), and DISTANCE and BUSH were again significant at 0.10 per cent level of significance. For a fuller analysis of variation in existence value, the sample was categorised on the rationality of the respondents behaviour in the same manner as was done in recreation value. Table 5.4 summarises the existence values. It also indicates the number of observations in each group. The regression model was the same as for the previous analysis, and was in the following form:

5.7 EV_{jr} = f(DISTANCE, INCOME, BUSH, NATURED, NCHILDREN),

where the existence value of the j^{th} individual of a particular rational group is tested as a function of four (usual) socio-economic variables and distance.

The adjusted coefficient of determination for the completely rational individuals (CR) indicates that up to 43 per cent of the total variation in willingness-to-pay was explained by the variables included in the functions. However for somewhat rational individuals (SRA) and SRB, only 18 per cent of the variation was

Table 5.4

Existence Value of Individuals

Explanatory Variables	Completely Rational	Somewhat Rational A	Somewhat Rational B
DISTANCE	-0.392	-0.579	DNC
	(2.178)**	(2.244)**	
INCOME	0.833	1.116	0.552
	(0.755)	(4.014)***	(6.202)***
BUSH	-0.533	0.447	0.101
	(0.917)	(1.619)*	(1.485)*
NATURED	3.189	2.134	1.233
	(0.530)	(1.22)	(1.341)
NCHILDREN	5.544	0.599	-0.637
	(0.826)	(0.354)	(0.854)
CONSTANT	6.736	5.444	1.097
Number of observations	18	105	183
Number of people	6	35	61
$\bar{R}^2$	0.43	0.18	0.18
F-value	3.59	5.49	11.27
Degrees of freedom	5	5	5

DNC: The computer programme did not compute statistics.

Note: The irrational group (14 people) has been excluded from the analysis due to their inconsistency in WTP bids.

explained by the equations. The F-values would allow an acceptance of the hypothesis that the difference between the mean is significant. Only the equation for somewhat rational individuals (SRB) qualified at the required significance level (1 per cent).

DISTANCE was significant in the model (at 0.05 per cent level) for the completely rational individuals (CR), and for the somewhat rational individuals A. In the latter model for somewhat rational A, BUSH (number of years spent in the bush) was also a significant variable (at the 0.10 level of significance). In the somewhat rational B model, INCOME was the most significant variable (at the 0.025 level of significance) and BUSH was again significant at the 0.10 level of significance.

Strangely, INCOME did not become significant for the completely rational model.

So far, the disaggregated model for the whole sample showed significance at the 5 per cent level in the F-test and the same significance was observed for the F-value of the somewhat rational A. Although the F-value for the somewhat rational B became significant at the 1 per cent level, the model for the completely rationals did not become significant at the 5 per cent level.

5.4.2 Aggregated model

An aggregate analysis similar to that carried out for recreation value was conducted to find out how well variations in distance and income are related to aggregated variations in existence value. A search for consistency was the other objective behind this exercise.

The regression results are as follows.

5.8 $$EV = 2.088 - 0.130\ DISTANCE + 0.594\ INCOME$$
$$(1.829) \qquad (9.904***)$$
$$\bar{R}^2\ 0.82\ (2\ d\ f)$$
$$F\ 50.71$$
$$N\ 18.$$

These results show that variations in existence value are not significantly related to variations in distance, whereas income is highly related in this way. Therefore, as was the case with recreation value, income was the most significant and decisive variable in measuring aggregated value for the existence of eucalypt woodland. The F-value, being significant at the 5 per cent level, and the increase in the $\bar{R}^2$ value (the highest among the models for existence value), shows the explanatory power of the model.

It was found in the somewhat rational B sample there were 28 people who were not willing to pay for this 'knowledge'. Out of these, 10 people had neither a recreation nor an existence value. So these appear to have a consistent pattern in their behaviour.

From Table 5.5, it is evident that a very high correlation exists between each of the existence values. However recreation and existence values are each far less correlated with the relevant socio-economic variables. This implies a closer relationship between recreation habits and the knowledge that there is a place for recreation.

Income is included for its importance in utility function, choice and in order to determine its relationship with other variables. Of the socio-economic variables, income was the most highly related to recreation and existence values with it's correlations between 0.368 and 0.411. Interestingly, these correlations (income with recreation value and income with existence value) rise consistently with distance.

A similar analysis as conducted for recreation and existence values using disaggregated data was carried out to analyse variations in total values. The total value consists of total willingness-to-pay for recreation and knowledge.

5.5 Total Value

The regression results of the disaggregated analysis (for all 136 people) of total value (RV + EV) are now presented.

Table 5.5

Correlation Coefficients Among Measurement Variables and Socio-Economic Variables

Variable	Recreation Value at			Existence Value at			No of Years Spent in the	'Reading about	Children under
	5km	15km	25km	5km	15km	25km	'Bush'	Nature	18 years
RV 15 km	0.918								
RV 25 km	0.797	0.942							
EV 5 km	0.956	0.908	0.792						
EV 15 km	0.885	0.953	0.889	0.947					
EV 25 km	0.802	0.919	0.955	0.858	0.940				
BUSH	-0.102	-0.089	-0.067	-0.065	-0.059	-0.024			
READING	0.133	0.118	0.099	0.108	0.113	0.109	0.031		
CHILDREN	-0.050	-0.087	-0.104	-0.033	-0.082	-0.069	0.091	0.090	
INCOME	0.368	0.374	0.382	0.389	0.391	0.411	-0.095	0.237	0.151

5.9 TV = 22.906 - 0.986 DISTANCE + 2.092 INCOME +
(3.649***) (8.767***)
0.005 BUSH + 0.189 NATURED -
(0.346) (0.996)
5.297 NCHILDREN
(2.974***)

$\bar{R}^2$ 0.18 (5 d f)
F 19.56
N 408.

The most significant explanatory variable was INCOME, then came distance followed by NCHILDREN, all of which were significant at the 0.025 per cent level. The sizes and signs were quite similar to those of recreation value, but the sizes of the coefficients here were larger than those of the disaggregated model of existence value. The significance of F-value (at the 1 per cent level) indicates the difference between the mean of the sample populations.

An aggregated analysis was carried out for total value following similar analyses for recreation and existence values. This was conducted to check the consistency and report what determines total value. The regression results are presented below.

5.10 TV = 11.10 - 0.881 DISTANCE + 2.157 INCOME
(5.403***) (15.681***)

$\bar{R}^2$ 0.93 (2 d f)
F 137.54
N 18.

Again it was found that income was the key determinant in aggregate total value (RV + EV). The results are similar to that of aggregated recreation value as regards the significant variables. The high $\bar{R}^2$ (0.93), together with significance of F-value at 1 per cent level, suggests the explanatory power of this aggregated model. This was a consistent pattern for all the aggregated models.

5.6 Option Value

This attempt to estimate option values by a willingness-to-pay survey appears to be consistent with recent studies. In particular, Freeman (1984) notes that option value could be a significant component of total willingness-to-pay (TWTP). Several authors, such as Schmalensee (1972 in Freeman), suggest that assumptions as to whether demand is certain or uncertain will influence the sign of option value.

The data for this part of the investigation come from those 67 people who were posed the questions concerning the option that trees will remain healthy (Q7 and Q8). Question 7, in essence, asked how much extra an individual was willing to pay to increase the probability from 10 per cent to X per cent that the trees will remain healthy. The size of X varied between 25 and 90, and individuals responded according to whether their demand for visits to the area were certain or uncertain. Question 8 asked whether, in fact, they were certain users or uncertain users. The following table (5.6) lists the mean value bids for each of the options and standard errors.

Considering the individual mean bids for the decreasing probability levels, both certain and uncertain visitors donated less money as probability decreased. Further, certain donations exceeded the uncertain donations except at 25 per cent probability. In this case, the difference was only 39 cents (and the mean uncertain bid exceeded the mean certain bid). It appears from these means that respondents behaved rationally to the probability levels. The highest bid ($19.64) was for the 90 per cent probability that all trees would remain healthy and visits be certain. The lowest donation ($10.73) was offered for the 25 per cent probability level.

5.6.1 Disaggregated model

The relationships of option value with relevant explanatory variables were examined through a regression of:

5.11 $$OB_j = f(\text{Probability, DUMMY, BUSH, NATURED, NCHILDREN and INCOME})$$

Table 5.6

The Option Values

(as mean bids in $ per individual)

Probability that all trees will remain healthy (per cent)	If chances of visiting the area are	
	Certain	Uncertain
90	19.64 (2.6)	16.42 (2.6)[a]
70	16.63 (2.3)	15.19 (2.5)
50	13.91 (2.1)	13.02 (2.3)
25	10.73 (2.2)	11.12 (1.8)
AVERAGE	15.23	13.94

[a] The figures in parentheses refer to standard errors.

for all 67 individuals. There were 8 option values per individual (one for each of certain and uncertain use), giving 536 sets of observations. The estimated model is shown in Table 5.7 [regression number (1)]. The dummy variable indicates either a person is a certain visitor (1) or not (0). Although 90 per cent of the relationship is unexplained through the model, all explanatory variables except BUSH became significant at the 0.025 level. BUSH (number of years spent in the bush) became significant at the 0.05 level. Probability, as expected, was positive and so was INCOME. Out of the other socio-economic variables only NATURED (reading about nature) had a positive sign. In contrast BUSH and NCHILDREN had negative signs in their coefficients. The coefficient for the DUMMY was positive and significant for an individual indicating the influence of the variable.

In an effort to understand further the bid-behaviour, and in recognition of the relatively low $\bar{R}^2$ of 0.10, the total set of observations was disaggregated into two groups. One group of observations included all 67 people and their values for a certain visit, and the other all 67 people and their values for an uncertain visit. This classification recognises that willingness-to-pay to preserve an option should vary within and between groups. The relevant model is the same as for 536 observations. The null hypothesis that is tested here is; that the mean values are the same for the certain and uncertain visitors.

The regression results of option value for 'a certain visit' (regression number 2), and an 'uncertain visit' (regression number 3) are presented in Table 5.7. The signs of the coefficients were consistent except of the DUMMY that appeared with a negative sign. This dummy variable was not significant in determining the option value of an uncertain visitor, moreover the coefficient appeared very low and negative in this case. Strangely BUSH, NATURED, and NCHILDREN did not significantly influence the option value of a certain visit. But they were all highly significant in the values of an uncertain visitor and in the option value (1). $\bar{R}^2$ values were 0.13 for certain, and 0.12 for an uncertain visit slightly better than the $\bar{R}^2$ for the option value (1).

Table 5.7

Estimated Option Values

Dependent Variable (Regression number)	Intercept	ESTIMATED COEFFICIENTS (t-values) Probability (P)	DUMMY	BUSH	NATURED	NCHILDREN	INCOME	Mean Value ($) (Standard errors)	$\bar{R}^2$ (F-Values)	Number of observations (df)
Option Value p	2.74	0.11	5.24	-0.10	1.52	-2.09	0.40	14.58	0.10	536
		(3.41)***	(3.14)***	(2.04)**	(2.45)***	(3.45)***	(4.59)***	(18.02)	(11.27)	(6)
Option Value of a	6.85	0.14	10.75	-0.07	0.29	-0.66	0.40	15.23	0.13	268
Certain Visit p		(3.06)**	(4.65)***	(0.93)	(0.34)	(0.78)	(3.25)***	(17.6)	(8.04)	(6)
Option Value of an	1.37	0.08	-0.27	-0.14	2.75	-3.53	0.41	13.94	0.12	268
Uncertain Visit p		(1.87)*	(0.11)	(2.03)**	(3.20)***	(4.19)***	(3.37)***	(17.68)	(7.41)	(6)

The F-tests carried out for all of these models indicated that the 'values' were significant at the 1 per cent level.

The data were again disaggregated into the rationality groups. A behavioural pattern is evident in the results for the disaggregated data (Table 5.8). Of the certain visitors, only 9 (4 observations per person) behaved in a completely rational manner (CERCOMS donation decreases with decreasing probability). Of the rest, 34 behaved somewhat rationally their first two scores being even and, 3rd, 4th decreasing and/or first value highest other three even (SOMECERTSA group 3). 11 donated equally to each thing (SOMECERTSB - somewhat rational type 2), and five donated nothing. There were eight completely-irrational persons among certain visitors to the area. Donations fell then rose as probability decreased.

Among uncertain visitors there were two who were completely rational (UNCERCOMS - group 2), 21 who were somewhat rational (SOMUNCERTS - group 5). 28 persons made equal donations for all probabilities (SOMUNCERTSB - group 6), 8 made no donation and were regarded as completely irrational.

Regressions were estimated only for the rationals and the somewhat rationals who had some option value. No regressions were estimated for irrationals or for those with zero donations for both certain and uncertain visitor. The regression results indicate that for all groups (except equal donations for certain and uncertain visitors, that is categories 5 and 6) the coefficient of (P) had negative signs.

The importance of the probability variable is indicated by those statistics. Probability levels did not matter for the individuals who had an equal donation for everything. INCOME was significant on three occasions with somewhat rational type 2 for both certain (group 4) and uncertain visitors (group 6). A negative sign appeared in the coefficient of explanatory variable NCHILDREN in all cases except in the certain completely rational group. $\bar{R}^2$ values for the different equations were between 0.08 (group 6) and 0.82 (group 2).

Table 5.8

Option Values of Different Groups

Dependent Variable (Category)	Constant	ESTIMATED COEFFICIENTS (t-values)					Mean Value $ (Standard errors)	$\bar{R}^2$ (F-Values)	Number of Subjects[a] Number of Observations (d f)
		Probability (P)	BUSH	NATURED	NCHILDREN	INCOME			
1. CERCOMS									9
Option Value of a certain (completely rational) visitor p	19.35	0.44 (3.90)***	-0.49 (1.43)	-12.51 (2.30)**	9.33 (1.42)	-0.33 (0.62)	22.17 (16.33)	0.37 (6.19)	36 (5)
2. UNCERCOMS									2
Option Value of an uncertain (completely) rational) visitor p	0.54	0.26 (4.43)***	-0.83 (3.74)***	omitted[b]	omitted	omitted	omitted	0.82	8 (5)
3. SOMECERTSA									34
Option Value of a certain (somewhat rational type 1) visitor p	9.65	0.24 (4.07)***	-0.08 (0.87)	2.43 (1.88)*	-1.36 (0.99)	0.33 (1.84)*	13.86 (16.75)	0.13 (5.29)	136 (5)
4. SOMECERTSB									11
Option Value of a certain (somewhat rational type 2) visitor p	0.98	0.000 (0.000)[c]	0.32 (1.49)*	-0.19 (0.09)	-1.13 (0.73)	0.80 (4.13)***	18.36 (14.18)	0.22 (3.91)	44 (5)
5. SOMUNCERTSA									21
Option Value of an uncertain (somewhat rational type 1) visitor p	20.42	0.30 (3.10)**	-0.22 (1.34)	8.37 (3.78)***	-3.37 (1.42)	0.32 (1.14)	16.43 (21.30)	0.22 (6.19)	84 (5)
6. SOMUNCERTSB									28
Option Value of an uncertain (somewhat rational type 2) visitor p	5.15	0.000 (0.000)	0.07 (0.65)	0.86 (0.89)	-1.06 (1.09)	0.49 (3.17)***	15.39 (12.01)	0.08 (3.11)	112 (5)

[a] The number of subjects adds upto 67.

[b] These variables were omitted by the computer programme due to high correlations with other predictor variables.

[c] The coefficients and t-values zero as the regression is same for the variable P.

The sign of the estimated coefficient of probability (P) is consistently positive throughout, the size fell between 0.24 and 0.44, and the coefficient was always significant. The socio-economic variable BUSH (number of years spent in the bush) appeared with a negative sign in all equations except in SOMECERTSB (certain somewhat rational, group 4) and SOMUNCERTSB (uncertain somewhat rational, group 6) but here the coefficient was not significant. BUSH was found significant only in UNCERCOMBS (uncertain completely rationals) and just significant in SOMECERTSB (certain somewhat rational or group 4), thus indicating no consistency in its relationship with the option value. Although the appearance of the sign of the explanatory variable NATURED (reading about nature) was not consistent, it seemed to have more influence than BUSH, being significant in three equations (twice at two or more significant levels). NCHILDREN (number of children in the household) had a negative sign in all equations except in CERCOMS (certain, completely rational group 1). However it had no significant influence in any of the equations. INCOME had a positive sign wherever its coefficient was significant. This followed expectations.

According to the Tables 5.7 and 5.8, the null hypothesis cannot be rejected as the mean values are not the same for certain and uncertain visitors. Lack of significance was evident in cases other than CERCOMS, UNCERCOMS and SOMEUNCERTS-A, where they became significant at the 5 per cent level.

5.6.2 Aggregated model

In the search for consistency, and more detailed analysis, further regressions were estimated using aggregated data. The aggregation was based on the four probability levels and on six income groups as for recreation and existence values. The results appear in Table 5.9.

The $\bar{R}^2$ values became appreciably higher than the $\bar{R}^2$ values for the disaggregated (Table 5.7) data, but were only slightly better than the group-wise disaggregated results (Table 5.8). Yet, these $\bar{R}^2$ values were comparatively lower than the aggregated

results of recreation and existence values. This relatively lower aggregated $\bar{R}^2$ value could be attributed to the following factors.

(a) For the aggregated recreation and existence values 136 people were sampled. In this aggregation the required sample size was 67. The lesser number of observations might have led to the low $\bar{R}^2$ for the option value.

(b) Recreation value is always closer to natural thinking, whereas option value asserts retention of something for future use. Thus, in valuing recreation benefits people may have been more straight forward than they were in valuing the lesser explained options.

A consistent pattern was observed in the aggregated option value determination and disaggregated results (Table 5.9). For individuals, the significance of probability and income were again significant determinants of option value for the whole sample. The signs and sizes of coefficients were consistent in both certain and uncertain option values. Not only was the $\bar{R}^2$ value (0.36) of certain visitors relatively high, but the explanatory variables were significant at the 5 per cent level compared to only 10 per cent level for uncertain visitors with their $\bar{R}^2$ of 0.31. Therefore, the high significance of explanatory variables in option value of certain visitors indicate a better model with a high $\bar{R}^2$ value.

For these models F-values become insignificant at the 5 per cent level.

5.7 Extensions to Existence Values

Willingness-to-pay for preservation benefits could vary with the individual's perception of the way in which the fund might be spent to achieve existence-benefit goals. Similarly, it might vary with the kind of preservation benefit that might be realised. Accordingly, one half of the sample (the 69 who were not asked about option values) were asked the following questions.

Table 5.9

Aggregated Option Values

Dependent Variable	Intercept	ESTIMATED COEFFICIENTS (t-values)		Mean Value $ (Standard errors)	$\bar{R}^2$ (F-values)	Number of Observations (d f)
		Probability	Income			
Option values for certain visits	2.06	0.17 (3.03)**	0.39 (2.82)**	14.99 (6.61)	0.36 (8.57)	24 (2)
Option values for uncertain visits	0.61	0.12 (2.56)*	0.33 (2.75)*	13.81 (5.68)	0.31 (7.08)	24 (2)

(5) How much extra would you be willing to pay, over and above recreation and existence donations, if you knew that this woodland management would:

(a) give knowledge to help to prevent dieback in general throughout Australia? _____

(b) provide a study area to help education today in local schools? _____

(c) possibly provide health benefits in 25 years through discovery of more medicinal compounds from the eucalypts? _____

(d) provide 5 more jobs per year in Armidale? _____

(6) Suppose that the fund were to be used for other purposes, also related to dieback control. How much would you be willing to donate, if the fund were used to:

(a) buy eucalypt woodland to preserve _____

(b) buy land and plant eucalypts _____

(c) buy land and plant pines _____

(d) help research into the dieback problem _____

(e) finance extension _____

The results are summarised in Table 5.10.

The first four benefits as extra values were donations over and above the previous total values (RV + EV). The highest bid came for GENERAL DIEBACK CONTROL (give knowledge to help to prevent dieback in general throughout Australia) a mean value of $12.37, and the next nearest value ($6.32) was for JOBS (provide 5 more jobs per year in Armidale). According to the respondent's perception, EDUCATION and HEALTH BENEFITS did not count as important extra benefits.

These extra benefits can be interpreted as follows. This sample population is not particularly interested in further benefits from employment to locals, educational or medicinal discoveries. In contrast, they are much more interested in the knowledge that dieback in general throughout Australia would be reduced.

Table 5.10

Valuation of Extra Benefits

	Benefits	Mean	Standard Error
GENERAL DIEBACK CONTROL	give knowledge to help to prevent dieback in general throughout Australia?	13.37	2.15
EDUCATION	provide a study area to help education today in local schools?	4.81	0.92
HEALTH	possibly provide health benefits in 25 years through discovery of more medicinal compounds from the eucalypts?	3.68	0.73
JOBS	provide 5 more jobs per year in Armidale?	6.32	1.61
WOODLAND	buy eucalypt woodland to preserve	17.28	3.79
PLANT	buy land and plant eucalypts	6.39	1.72
PINES	by land and plant pines	2.64	1.02
RESEARCH	help research into the dieback problem	23.36	3.48
EXTENSION	finance extension	6.28	1.85

Results concerning changes to benefits due to changes in kinds of expenditure indicate that RESEARCH (help research into the dieback problem) is the most preferred measure (mean value $23.36). Buying eucalypt woodland to preserve (WOODLAND) was valued next to RESEARCH, and was given a mean value of $17.28. The EXTENSION and PLANTing of eucalypts were not as much preferred, and were given a lower but more even value (at $6.28 and $6.39). PINES were the lowest extra value, and recorded only 2.64.

5.8 Conclusions and Policy Implications

The findings of this study indicate that households are most concerned that dieback will lead to further loss of rare eucalypt species and that their heritage will be lost through the loss of native woodland. They also indicate a preference for the aesthetics of local landscapes. The considerable amount of money actually donated, and the high willingness-to-pay in the survey, suggest that this particular sample is very concerned to improve the state of the surrounding woodland.

This the 'community' thinks should be done by extra management, not merely to preserve healthy woodland, but to provide more 'good' recreational opportunities in eucalypt woodland. Furthermore, the respondents were not particularly interested in further benefits from extra employment in the locality, education or medicinal discoveries. They were much more interested in the knowledge that dieback in general throughout Australia would be reduced.

Results concerning changes to benefits due to changes in kinds of expenditure indicate that aid to research into the dieback problem is the most preferred. This, and buying eucalypt woodland to preserve, was thought to contribute more to the 'cause' than planting pines could do.

Recreation values are higher than existence values. However recreation values decline rapidly with distance. Existence values, too, appear to decline significantly with distance for rational groups. Income proved to be the most decisive factor in determining recreation and existence values.

Walsh et al. (1984) also analysed the relationships between recreation and existence values. In their study of preferences for wilderness, they found that existence values accounted for about 43 per cent of recreation values. This result is close to that of the present study where existence values accounted for 44 per cent of recreation values, on average.

BUSH (number of years spent in the bush) was an important explanatory variable for a completely rational individual in his recreation value, and the value for knowledge with somewhat rationals. It was also a key determinant to an individual in his willingness-to-pay for knowledge. NCHILDREN (number of children in the household) was a key variable that determined an individual's recreation value, but it seems to be less important in determining ones value for knowledge.

The option value of respondents tends to decrease with the decreasing probability that woodland will remain healthy. This was common for both certain and uncertain visitors. Average bids for certain visits tend to exceed bids for uncertain visits. In determining option value for individuals, the socio-economic variable NATURED (reading about nature) dominated the socio-economic variable BUSH, although the latter was also a key determinant. This is in contrast to what was found with individual preferences for recreation and knowledge, where BUSH was the key determinant and NATURED significant.

It was also evident that a certain bid for an individual visit to a site was never influenced by anything other than his income. But in contrast a bid for an uncertain visit to the same site was determined by his experience of living in the bush, reading about nature, and the number of children in the household as well as his income. This was also true for whose option value irrespective of the certainty of his visitation to 'the site'.

In terms of $\bar{R}^2$ values alone, the best explained were always the aggregated models for recreation and existence values. Although not flourishing, the aggregated models for option value also showed far better $\bar{R}^2$ values than the disaggregated models. The disaggregated

rationally-grouped models showed a better explanatory power than just disaggregated models. Some best examples were; the completely rational models for recreation and existence ($\bar{R}^2$ 0.34 and 0.43 respectively) values, and completely rational uncertain group of option value ($\bar{R}^2$ 0.82).

In all the cases the failure to reject the null hypothesis, that the mean values were the same for the certain and uncertain visitors is consistent with the results of Brookshire et al. (1984). Other consistencies with their findings were: the positive relationship of probability with the option values under certain and uncertain demand; and the significance of income. As an extension to their study, an attempt was made to investigate what other factors influence option value of individuals other than their age. BUSH (number of years spent in the bush), NATURED (reading about nature) and NCHILDREN (number of children in the household) were found to be important determinants of option value of an uncertain visit. However, for a certain user not these but income was the important determinant. This implies that income determines, to a large extent the probability of a certain visit. Not surprisingly, an uncertain visit is also affected by income, but status of reading about nature, experience of living in the bush, and the number of children in the household were all significant determinants.

5.9 Possible Directions for Further Studies

The models used in this chapter to describe individual explanations to variations in disaggregated data did not bring in entertaining results as regards $\bar{R}^2$ values. On the other hand an aggregated model explained up to 94 per cent of variation in recreation value. Nonetheless, a model in aggregation did explain up to 36 per cent of total variation in option values for certain visits and showed lack of significance in f-tests. The diversity of these results suggests the following.

(a) The disaggregated models should exercise adequacy in their capacity to explain individual variations, therefore they should be flexible and their data should supplement such efforts.

(b) It was evident in measuring recreation values in particular, that respondents had a tendency to respond swiftly because of their willingness-to-pay and their sense of benefit from recreation. This was also true with existence value as explanatory power was still high for the aggregated equation for willingness-to-pay for knowledge. But the situation changed when option values were measured. The $\bar{R}^2$ were comparatively low for the aggregated option value models. There must be a better explanation for the variations in option values. This is an area for future exploration, as was confirmed by the lack of significance in the F-tests of the inexplicability of the aggregated models for option values.

(c) Further evidence might also suggest the possibility of there being improvements to research findings on the behaviour of individual rationality. These group-wise regressions did not provide encouraging statistics as regards $\bar{R}^2$ values, although all of them showed better results than their whole sample counterparts.