**Can Cover Cover Costs:
Approaches to the Economic Assessment of Native Vegetation Management**

H. Smith and P. Pagan

Economic Services Unit, NSW Agriculture[1]

Native vegetation management has become an issue of increasing community concern. Various initiatives have been established to address regional and state wide land degradation issues thus placing increasing pressure on land managers to develop sustainable native vegetation management solutions.

A great deal of literature has been produced identifying various aspects of the economics of native vegetation management. In spite of this however, it has been suggested that land managers are still not making socially optimal decisions in regards to the management of native vegetation.

This paper identifies the economic issues behind native vegetation management, provides a literature review of existing methodologies, and discusses some deficiencies with existing approaches in providing land managers with better information on which to base decisions. The paper then discusses some of the policy implications consequent to these deficiencies and proposes a general approach which attempts to overcome some of these problems.

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[1] The views expressed in this paper are those of the authors, rather than those of NSW Agriculture or the NSW Government.

1. Introduction

Large tracts of Australia's agricultural zone are degraded due to soil erosion, land salinisation and acidification. Rising saline watertables threaten over five million hectares of NSW (Bradd and Gates 1995, Walker *et al.* 1998,). Knowledge of the biophysical linkages between native vegetation clearing and (natural) decline and the exacerbation of these other land degradation problems is rapidly improving (Miles 1998).

It is believed that the clearing of native vegetation on a broad scale is one of the main causes of environmental problems currently facing Australia. Some of the identified impacts of clearing include dryland salinity, the invasion of weeds, soil erosion, soil structural decline, the loss of animal habitats and the subsequent loss of plant and animal species. "The clearance of native vegetation has significantly impacted on Australian agriculture in both physical and economic terms. In 1995 the Department of Environment Sport and Territories estimated that lost agricultural production owing to land degradation was $1.15 billion annually" (Miles et al. 1998a, p1).

In addition, the loss of native vegetation is a continuing threat to the loss of species and unique ecosystems. About 25 per cent of native mammal species present in NSW in 1788 are now extinct (NSW State of the Environment Report 1997). Over 700 of the 5300 native plant taxa in NSW are listed as either threatened or rare (Briggs and Leigh 1995).

Consequently, there is growing interest in the conservation and management of native vegetation in Australia because of its long-term value for agricultural production and its importance for the conservation of native species and their habitats (Benson 1999).

1.1 Government policy responses

The commitment of governments to improve the management of native vegetation is evident in the increasing level of policy support in the form of legislation, land use agreements, research, education and other initiatives.

Australia is a signatory to the *World Biodiversity Convention* (1992), and successive State and Commonwealth governments have embraced ecologically sustainable land management objectives since the *National Strategy for Ecologically Sustainable Development* was adopted in 1992. In 1998, the Australian and New Zealand Environment Conservation Council (ANZECC) resolved that native vegetation clearance and decline is a major threat to the conservation of Australia's biological diversity and was an issue of national importance (NVAC 1999). Major initiatives such as Landcare and the Natural Heritage Trust include improved native vegetation management as core activities.

At a NSW level, recent legislative responses include the *Threatened Species Conservation Act* (1995) and the *Native Vegetation Conservation Act* (1997). In addition, strategies such as the *NSW Policy for Sustainable Agriculture* (1998*), NSW Biodiversity Strategy* (1999) and *NSW Salinity Strategy* (2000) all include strong linkages to vegetation management, and include significant programs of research, education and incentive initiatives associated with their implementation.

1.2 Objectives of the paper

The fact that native vegetation management is so closely linked to a large number of land management and biodiversity conservation issues makes it an important focus of economic analysis. The basic problem is one that is fundamental to the discipline of economics, as articulated by Gillespie (2000). At any one time, the resources available, such as land with native vegetation on it, are in limited supply or are scarce relative to the competing demands they are called on to satisfy. Competing demands for land may include agricultural production, urban development, conservation of biodiversity, and control of land degradation such as salinity. Therefore choices need to be made about what goods and services to provide with the scarce available resources.

It has been suggested, however, that the "market" has not been making these allocation choices in a way which is optimal for society. These alleged inefficient market outcomes can largely be explained by market failure problems produced by information failure, externalities, the public good nature of many of the benefits of the retention of native vegetation, and government failure. Market failures are known to distort the appropriate pricing of resources.

The development of appropriate policy responses requires careful consideration of potential causes of non-optimal vegetation management outcomes, and the identification of the most significant market failures. There is an expanding body of analysis of vegetation management issues and the first objective of this paper is to review the range of approaches that have been adopted in Australian economic studies of native vegetation management.

These approaches are then analysed in regard to their ability to contribute to vegetation management decisions being faced by individuals and groups at a range of levels (for example farm, region, state, nation). Finally, the paper considers some of the consequent policy implications and discusses a general analytical approach which may be useful in clarifying the vegetation management decision problems faced by land managers and policy makers in a range of circumstances.

1.3 Outline of the paper

The structure of the remainder of the paper is as follows. Section 2 provides a brief overview of the history of native vegetation management in Australia. Section 3 outlines an economic perspective to the issues involved in native vegetation management. The range of approaches that have been adopted in the economic analysis of native vegetation management, and the state of the valuation literature are reviewed in Section 4. Section 5 contains an evaluation of the capacity of these approaches to contribute to vegetation management decisions and policy reforms. Finally, Section 6 includes a discussion of the policy implications of, and considers a generic approach that accommodates many of the limitations identified in the previous section. This section also includes concluding comments on the various issues raised within the paper.

2. Background of Native Vegetation Management in Australia

Since the time of first European contact, Australia has witnessed a substantial loss of native vegetation. In some areas, the amount of vegetation removed has been as much

as 93 per cent. Records indicate that in 1788 forests covered almost 9 per cent of the continent. However by the 1980's approximately 175,000 square kilometres of these forests had been thinned to woodland or open woodland, and a further 140,000 square kilometres of forest had been cleared mainly for grazing, leaving only about 5 per cent of Australia forested (Miles, *et al*, 1998b).

Over this time, the area of native woodland also decreased, from 21 per cent to 14 per cent. 75 per cent of Australia's rainforests, 60 per cent of coastal wetlands and more than 99 per cent of temperate lowland grasslands in south-eastern Australia have been lost (Miles, *et al*, 1998b). "The Industry Commission (1997) reported that the area of native vegetation cleared in the last 50 years has been as much as in the previous 150 years" (Miles, *et al*, 1998b). This level of clearing has contributed to Australia being recognised as the country with the highest level of forest and vegetation clearance in the western world, and the eighth highest rate of any country (DLWC 2000).

In more recent years the rate of vegetation clearing in Australia has slowed due to the declining availability of suitable agricultural land previously uncleared, pressure from environmental groups to reduce clearing, and increasing recognition of the negative consequences of clearing. Even despite this reduction, however, Government estimations suggest that over 500,000 ha of Australia's native vegetation has been cleared annually since 1985 (Miles, *et al*, 1998b).

These national clearing trends have also been reflected within NSW. Prior to the introduction of government reform programs, particularly *the Native Vegetation Conservation Act (1997)*, vegetation clearance in New South Wales was deemed to be occurring at unsustainable levels. "On average, it has been reported that approximately 150,000 hectares of native vegetation were being cleared every year across NSW" (DLWC 2000).

3. Economic Issues in Native Vegetation Management

The physical evidence outlined above has led many to believe that the management of native vegetation continues to result in outcomes which are not ecologically sustainable. However, as Kirby and Blyth (1987) point out, the existence of land degradation does not itself prove that intervention is necessary. From an economic perspective, the issue is one of determining whether the rate of land degradation is optimal or not.

In many cases, the management of native vegetation does not appear to be in the interests of maximising current or future community welfare. From an economic perspective, these outcomes can to a large extent be explained by the pervasive presence of market failure and government failure issues in the management of native vegetation.

3.1 Market Failure

Market failure, where market practices result in price and output distortions and a misallocation of resources, is proposed to occur in the management of native vegetation in three main forms: the presence of externalities; information failure problems; and the provision of public goods.

3.1.1 Externalities

Native vegetation has been most often cleared from private property in an attempt by the landholder to expand production. The increased availability of arable land provided additional farm income, usually through cropping or grazing. The implications of clearing, however, often expand beyond the immediate financial costs and benefits to landholders.

In a spatial context, when the impacts from land management actions are confined only to the land in question, the landholder bears all the costs and realises all of the net benefits. While ever all of the impacts remain private, it is in the best interest for the landholder to ensure that the land is not cleared beyond the point where it's long term agricultural viability is threatened. However, due to the complex biophysical interactions associated with native vegetation, the impacts of clearing rarely do remain private, and externalities occur. These externalities are the impacts which flow on to affect surrounding properties or the public in general.

Externalities can exist in both a spatial and temporal context. For example, the conservation and or planting of native vegetation may result in long term improvements in dryland salinity at discharge sites in another part of the catchment. This has a spatial dimension in that the benefits accrue to another landholder and a temporal dimension in that these benefits may not be realised for some period of time.

3.1.2 Information Failure

Landholders clear with the expectation that it is in their own long term interest. The costs involved in clearing the land are perceived to be outweighed by the income gained from expanding the farm enterprise. However, clearing has been linked to the contribution of many environmental problems eventually resulting in either direct or indirect costs to landholders as well as society more generally. This situation suggests that land managers in some circumstances are basing vegetation management decisions on poor, incorrect or incomplete information. In this case, information failure could result in decisions being made that are neither in the interest of the landholder or the community.

In addition to inefficient decisions being made which effect the welfare of the current land manager, information deficiencies can also have important temporal dimensions. The removal of some areas of native vegetation can have irreversible effects. The physical characteristics of natural capital can make them non-substitutable in the market. Therefore, intergenerational uncertainties can compound the information failure problems experienced in short term native vegetation management decisions.

3.1.3 Public Goods

Market failure also occurs in relation to native vegetation management due to the public good attributes of many ecological services. These public good attributes are also displayed in some recreational, non-use, and research and education functions.

Public goods exhibit characteristics of non-rivalry and non-excludability in consumption. As such, there are no incentives for individuals to bear the cost of initial provision of public goods. Once they are initially provided however, there is a zero marginal cost associated with providing them to additional people. Consequently,

there is a strong argument for government involvement in ensuring the provision of public goods (Perkins, 1994).

3.2 Government Failure

Government failure may arise from the past ideals of government. In the recent past governments provided incentives to encourage clearing. In the light of recent research and understanding of the consequences of these policies, it is clear that these incentives were inappropriate, and could be described as a form of government failure.

Even with the presence of market failure it can only be considered justifiable for the government to intervene if it can be shown that the benefits of this intervention outweigh the costs of doing so. Consequently, the evaluation of alternative management and policy options related to improving native vegetation management is necessary not only for making choices between new proposals but also to justify government intervention at all.

4. Review of Economic Approaches

The economic implications of native vegetation management are shared between both market and non-market impacts. That is, those for which a market exists (such as clearing land for increased crop production) and those for which no market exists (such as impacting the intrinsic values of natural habitats and ecosystems). The majority of all of the *market based* impacts are usually internalised by the *private* landholders decision making and are realised as *private* costs and benefits. These *market based* impacts are usually easier to identify and quantify.

The *non-market* impacts accrue primarily as *public* costs and benefits, however there are many non-market impacts that also accrue to the *private* landholder and help to influence the landholders decision making. However, these *non-market* impacts are often very hard to quantify and thus are usually not given their due consideration in land management decisions. It is often for this reason that negative impacts are borne by the *public* through the actions of *private* landuse management.

There has been a significant amount of literature dedicated to the study of the economics of native vegetation management issues. The current economic literature could be grouped in the following way:

- literature that links biophysical attributes to the economic significance in a general way without actually quantifying the relationship;

- literature that identifies the non-market economic impacts of native vegetation, that accrue to both the public and to private landholders; and

- literature that identifies the market economic impacts that accrue primarily to the private landholders.

A summary of the approaches and findings of a broad cross-section of the Australian native vegetation management economics literature is presented below, under this categorisation.

4.1 Unquantified Values of Native Vegetation

The majority of literature on native vegetation conservation deals with management issues and best practice conservation, without actually attempting to identify or quantify social or economic aspects of the issue. Examples of this include reports such as ABARE (1994), Brandsema (1994), DEST (1992), DLWC (1995b), Loomis (1993) and Wilson (1994).

Similarly, when assessing the impacts of clearing native vegetation many authors offer a history of clearing rates in NSW and the inferred effects that this is having on land degradation and species decline. Assessments are usually limited to estimating the links between native vegetation decline and its associated environmental effects, without considering social and economic effects (eg., DEST 1995 a&b, DLWC 1995, BRS 1999, Gill 1995, Howling 1997 and Sivertsen 1994).

The Mid Lachlan Regional Vegetation Management Plan (DLWC 1999), does not attempt to quantify economic values, but offers some valuable insights into the ecological, economic and social benefits derived from native vegetation conservation. Managing vegetation communities will have major benefits in terms of property protection, land degradation impacts and habitat enhancement.

These reports do offer insight to society's perceived value of native vegetation. However, they do so without offering the landholder objective quantitative economic information that may be useful in decision making.

4.2 Non-market

Papers such as Brennan 1999, Walpole 1998 and Lockwood 1998, offer some explanation for the non-market social and economic impacts of remnant native vegetation clearing through the use of landholder survey techniques. Their results, however, are confined to the landholder's perception of the economic impact, and are not always given a monetary value. Contingent valuation and choice modelling techniques are used in Lockwood 1998, which suggests state-wide willingness to pay values for the preservation of native vegetation on private property. However, such a willingness to pay value is unlikely to feature in the decision criteria of landholders in the absence of a market mechanism.

A choice modelling study was undertaken by Blamey *et al* (2000), for the Desert Uplands region of Central Queensland, to provide estimates of the benefits of retaining remnant vegetation that are appropriate for inclusion in a cost benefit analysis of tighter clearing restrictions. Attributes included in the choice model were reductions in the population size of non-threatened species, the number of endangered species lost to the region, and changes in regional income and employment. The estimated benefits are reported for several tree clearing policy regimes that are more stringent than those currently applied.

Clough, et al, (1999) also considers the economics of certain non-market based conservation options using marginal value. The paper suggests the establishment of an overall willingness to pay for conservation outcomes, to then select projects and units for funding according to cost effectiveness in contributing to a particular conservation goal.

Of the more comprehensive studies reviewed, Brennan (1995) considered non-market landowner issues arising from State Environment Planning Policy (SEPP) 14, competition of natural resources, custodian taxation and conservation valuation criteria. However, the economic analysis is not extensive and offers only the theoretical method of assessment without producing numerical results.

Walpole *et al* (1992) explored the non-market effects of land clearing and its implications for agricultural output, through valuing the opportunity cost to the agricultural community and society. The net benefit of conservation was calculated as the increase in the value of agricultural production plus the reduction in off-site costs less the implied costs of conservation. For areas in the wheat/sheep zone in NSW, the study found that 30 local government areas had benefit-cost ratios above 1.0, indicating that the treatment of gully erosion in those regions could be justified on an economic basis. This result has implications for the preservation of native vegetation as a preventative measure against gully erosion.

CSIRO (1998) evaluates the use of tree lots on farms for addressing non-market land degradation issues caused by clearing at a catchment scale. From this analysis, conclusions can be made about the usefulness of retaining the native vegetation. Many situations may require at least 30 per cent of the catchment to be tree covered to stabilise or ameliorate degradation, in some cases the whole catchment would require plantings. The impact of tree planting at the catchment scale is linked with the biophysical attributes of the catchment. The results appear to be catchment specific.

Miles, et al (1998a), takes a more direct approach to assessing the on-farm non-market economic values of remnant native vegetation on private property. The methodology is based on survey questions which refer to the perceived costs and benefits of remnant native vegetation and also its impact on property values. With specific regard to vegetation conservation, the direct costs such as weed control, pest control and fencing have been listed. However, the indirect opportunity costs have also been considered. Miles, has adopted a 40 year time horizon to allow for the possibility of establishing hardwood plantations.

Of particular significance to this paper, Miles undertakes a Cost Benefit analysis of the economics of native vegetation on private property using a Base Case and 5 conservation scenarios. The conservation scenarios include variations of: restrictions on clearing; fencing native vegetation; limited grazing of native vegetation; restricting the collection of firewood; and the introduction of horticultural opportunity cost.

The conclusions about the impacts of native vegetation in the NSW Riverina, Miles states that "The most important economic benefits from RNV under current management regimes are productivity effects associated with prevention of land degradation, firewood production, and for the NSW study area, stock and crop shelter. The most significant cost is for weed management" (Miles, et al, 1998a, p28).

For this same case study area, however, Miles concluded that "this study demonstrates that a large proportion of participants cannot expect a positive return from investing in any of the five suggested RNV management scenarios. The direct and opportunity costs clearly outweigh the benefits. Any policy approach to achieve conservation objectives for RNV clearly requires significant financial incentives for landholders to undertake conservation activities" (Miles, et al, 1998a, p30).

The use of economic analysis to investigate non-market issues in native vegetation management has been the subject of considerable recent attention. The studies noted above rely on a range of techniques involving the direct valuation of the non-market attributes, and other methods to determine non-market values by implication. They also act to highlight the time, effort and resources that are required in providing effective assessments of some non-market aspects of native vegetation management.

4.3 Market Based

A significant portion of the literature limits its focus to the market impacts that accrue to the public and to private landholders. Miles, et al, (1998b) undertakes a theoretical approach to investigating the economics of incentive policies, by outlining the role for governments in RNV conservation. The methodology considers the economic theory behind when it is worthwhile for a landholder to clear and when to conserve. This however, does not consider the actual costs and benefits.

Continuing on the role and impact of government policy, Scott (1999) investigates the impact that clearing restrictions have on a landholders gross margins. Scott concludes that when considering the opportunity cost of land in terms of next best use, clearing restrictions in general act to reduce gross margins.

Adamson (1988) investigated the relationship between areas of undisturbed vegetation and stock and crop productivity. The results of the research suggest that maintaining areas of natural shelter on farms could significantly increase the survival rate of lambs, and the productivity of stock activities. These findings are supported by a number of other studies, such as McLaughlin *et al.* (1970), Thompson and Taylor (1976), Lynch and Alexander (1977), Morrison (1979), Wilson (1980), Ralph (1981) and Bird *et al.* (1984). Wilson (1980) estimated an average reduction in lamb losses associated with increased shelter of 15 per cent per year.

The Victorian Department of Conservation and Natural Resources (now the Department of Natural Resources and Environment) has published extension material indicating benefits to livestock and cropping activities associated with maintenance of wildlife habitats (DCNR 1992). These include 35 per cent higher wool cuts and six kilograms per head more liveweight from sheep on sheltered plots at Armidale. Cold stress is claimed to depress wool growth by 25 per cent and live weight gain in sheep by 12 per cent and cattle by 31 per cent. It is further suggested that shelterbelts can increase average crop yields by up to 20 per cent.

Adamson (1988) also reported that natural vegetation cover not only aids in preventing stress in stock from environmental extremes, but also provides benefits to adjoining cropping activities. For example, Brandle *et al.* (1984) reported a 15 year trial in the USA which showed that the average net yield per annum increased by 15 per cent with shelter. This included a realistic discount rate for costs of establishing and maintaining the shelter belt. Sturroch (1981) found a 35 per cent increase in grain yields in one artificial windbreak experiment in New Zealand, and Vora *et al.* (1982) showed an increase in wheat and mustard yields with shelter in a semi-arid environment in India.

Similarly Mullins (1998) makes observations as to the optimal level of tree cover for grazing enterprise in the Gunedah region. Mullins "..investigated at what level tree cover detracts from productive grazing capacity. It was found that the gross value of pasture input was at its highest level when the proportion of tree area is at 34 per cent".

Rolfe (1999) emphasises that, in relation to the rangelands of central western Queensland, "clearing only provides limited production gains because of the low rainfall and infertile soils..". This would be typical also of NSW, in that much of the choice agricultural land has been cleared already. Attempts to clear further land would then most likely be on more marginal agricultural land, which would not be expected to achieve the same levels of agricultural productivity as the existing farming land.

Patton (1998) undertakes an economic analysis from the landholders viewpoint of establishing planning guidelines for cropping and dedicated conservation areas in the Southern Mallee. Within this report, clearing native vegetation for agricultural purposes is addressed and benefit-cost techniques are applied to development budgets for alternative land uses.

Patton (1998) undertakes an extensive investigation into the present value of costs and benefits for clearing and establishment of a cropping enterprise. This includes both 11 & 12 year rotations, with climate risk factored in. Monte Carlo simulation was used for price and yield risk, and historical data simulated for price. Yield is then correlated to historical rainfall data. A level of risk aversion was assumed, that research suggests typifies Australian farmers, and the conclusion reached was that grazing offers benefits sooner and with less variability than cropping.

These reports attempt to identify some of the more straightforward impacts of native vegetation management, especially in respect to the impact that may be incurred on productivity and gross margins. As many of the decisions made by landholders are a reflection of the potential impact on farm profits, it adds support for the need to accurately assess the market based impacts of vegetation management.

5. Deficiencies in existing approaches to the economic analysis of native vegetation management

The range of approaches that have been taken to the economic analysis of native vegetation management options outlined in Section 4 indicates that there is a large amount of research and analytical effort being expended on native vegetation management issues. The analytical effort in this area appears to cover the range of market failure and government failure issues discussed in Section 3.

These analyses have assisted in clarifying the broad need for management to move towards enhanced conservation of Australia's native vegetation resources. The extent to which economic analysis has been responsible for policy change at this broad level may be questionable. However, this general acceptance for the need for change in the management of vegetation has led to a range of regulatory and other actions by the Commonwealth and State Governments around Australia.

These policies and new directions however, generally need to be implemented at a more localised scale. The reforms involve making changes (often tradeoffs) at

catchment, district and individual farm scales. At this implementation level, economic analysis can play an important role in supporting the specific circumstances that each catchment committee, landcare group, or individual etc is faced with in improving the management of native vegetation.

Critically, economic analysis can assist in ensuring that mechanisms are designed and implemented that are effective in addressing the particular issues that are leading to inefficient native vegetation management outcomes at the implementation scale. In different places, these poor native vegetation outcomes are likely to be driven by different combinations of the economic issues discussed in Section 3. For example, understanding that there are key information failure problems in the way individuals are managing native vegetation obviously has implications for designing information sharing and educative programs. But if the poor outcomes are largely being driven by strong public good attributes of the benefits of management changes made by individuals, then educative programs are not likely to be a good use of resources in facilitating change.

While economic analysis is being provided at this implementation scale, its effectiveness in many instances has been quite low. There still appears to be programs introduced and decisions being made that are not the most appropriate for particular circumstances. There are also continuing calls for information and analytical support by groups responsible for pursuing the vegetation management goals articulated by governments.

This paper focuses on the input of economists in assisting decision makers determine a more appropriate path to ensuring the efficient and sustainable use of native vegetation resources in specific instances. It is proposed that there are a number of factors which appear to constrain the influence of economic evaluations on the decision processes of land managers. These include the ability to accurately value non-market attributes, the non-transferability of valuations, and problems incorporating the analysed values into a form that assists with decision making. Each of these factors is discussed below.

5.1 Valuation of non-market attributes

In order to simplify the decision process economists often attempt to achieve a common numerical basis on which to make comparisons. Only some effects can be valued by observing their transaction directly in markets. However, the use of a range of techniques to elicit values through surrogate markets (eg. hedonic pricing) and simulated markets (eg. contingent valuation) increases substantially the capacity to estimate monetary values for a wide range of effects.

Unfortunately, there are both contentious theoretical and practical issues involved in applying the simulated market techniques. Some of the problems include:

- The hypothetical nature of simulated market techniques. This may result in respondents acting strategically to try and influence the outcome of the survey. This can include respondents trying to dishonestly benefit themselves, or simply because the hypothetical nature encourages them to act as "citizens" rather than "consumers". For example, studies by the Resource Assessment Commission (1991), and Walsh et al. (1984) failed to find a positive correlation between income and stated willingness to pay, indicating that the studies were unlikely to

be accurately measuring consumer surplus. Sagoff (1988) proposed that simulated market responses often reflect the desire to acquire moral satisfaction rather than a reflection of genuine willingness to pay. This was confirmed in studies by Kahneman and Knetsch (1992);

- Survey design issues. A major issue is the embedding effect, where large differences can occur in the valuation of a good depending on whether offered on its own or as part of a package (Kahneman and Knetsch, 1992, Kemp and Maxwell 1992). Other problems include bias effects from the design of questions due to the level of starting bids, and non-response, and the time and expense of undertaking these studies;

- The types of issues that they tend to be applied to. As these techniques are applicable to circumstances where there are no direct or related markets, the techniques are often used in the valuation of the more difficult attributes such as non-use values (existence, bequest, option and quasi-option values). The different techniques all try to estimate the value of impacts to the relevant individual or group in terms of welfare or utility, regardless of whether the impact results in actual financial transactions. While most economists have little problem recognising the legitimate contribution to total welfare that these non-use values provide, many decision makers will discount the importance of some of these values. This issue is further discussed in Section 5.3 below.

Moran (1991) provides a poignant example of the consequences of some of the problems with simulated market approaches discussed above. The use of Contingent Valuation by the Resource Assessment Commission in relation to the Kakadu Conservation Zone resulted in the calculation of an annual rental value of $130,000 per hectare for the area.

The Environmental Valuation Working Group (1999), a group established by the South Australian Government, considered the appropriateness of a range of market, surrogate market and simulated market techniques in the valuation of environmental effects (resource degradation, pollution, recreation, natural amenity, and non-use benefits). In regard to the simulated market techniques, the Working Group classified only Contingent Valuation as "highly relevant", and then only for analysing non-use benefits. A range of market and surrogate market techniques were considered "highly relevant" for analysing the other classes of environmental effects. A key reason cited for their conclusions was that market based approaches rely on direct and observable data, while other approaches generate their own estimates of value, and therefore the approach adopted in each study has the potential to significantly influence the value of the results obtained.

5.2 Transferability of valuations

Undertaking evaluations is regularly both time and resource intensive. This is particularly the case for attributes where market value approaches can not be used. Consequently, benefit transfer is a technique regularly used. This involves making use of models and/or values generated in one circumstance for the estimation of values in different but similar circumstances. In NSW the Environment Protection Authority (EPA) maintains an internet based database (ENVALUE) for this purpose, and encourages the use of benefit transfer as a means of providing indicative quantitative

estimates of a range of environmental values in circumstances where time and resources would otherwise not allow any quantitative valuation.

The transfer of values derived for a particular study, to another study would appear, however, to be of dubious worth. Bergstrom (1996) undertook a study of benefits transfer applications in the United States. These applications included fixed value transfer, expert judgement, and value estimator model methods[2].

The review included the empirical testing of the feasibility of benefits transfer through the use of convergent validity tests and value surface tests. Bergstrom concluded that value estimator models appear to represent the most promising benefits transfer technique in terms of accuracy and reliability, though even these methods could not be strongly supported. In the case of natural resource services, final economic values at a particular location and time are dependent on complex linkages between biophysical functions, economic services and economic values. Differences in any of these linkages across the study and policy sites could result in large measurement error.

The implications of these findings is that while benefits transfer is regularly proposed as a means of overcoming information, time and resource constraints in evaluating policy alternatives, they are generally of very low reliability. This is particularly so where fixed value transfer methods are employed.

5.3 Decision making

The investigation of the technical relationships underlying specific benefits and costs, and the consequent valuation of these individual impacts is a critical component of developing appropriate management responses to native vegetation management issues. However, unless the appropriate management response hinges on the outcome of the evaluation of a single specific impact, it will be necessary to incorporate the results of the individual evaluations into a format that allows decision makers to choose the most appropriate management response (for example cost-benefit analysis, a partial budget, or multi-criteria analysis).

For any particular management option, a thorough evaluation may include the incorporation of a range of: financial values that can be observed in actual markets; ecological service values; opportunity costs; as well as more esoteric use and non-use values (such as those arising from altered aesthetics, cultural values, bequest and option values).

The market, related market and simulated market techniques identified above enable economists to articulate the value of most impacts in a common denomination (money). While all values are equally relevant in contributing to the overall welfare of the individual or group concerned, decision makers are likely to differentiate between

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[2] *Fixed value transfer* methods are where total benefits at the policy site are estimated by aggregating existing standard values per unit derived from the study site data. *Expert judgement* methods are where the total benefits at the policy site are estimated by aggregating values per unit derived from an expert opinion process. For example, total benefits at the policy site may be estimated as the product of an expert opinion adjusted value per fishing day for the study site and total fishing days at the policy site. *Value estimator model* methods are where estimator models derived from study site data are used with explanatory variable data collected at the policy site to estimate both value per unit and total units at the policy site.

the various types of effects (regardless of the fact that they have been presented using a common monetary measure). Commonly, decision makers place greater emphasis on values that are reflected in monetary transactions or which can be shown to have a demonstrable role in the economy. Values which vary dramatically between people, which accrue to an undefined group (spatially and temporally), and for which individuals do not have to directly "pay" for in some way are often seen as unsubstantiated, and consequently treated with suspicion.

The South Australian Environmental Valuation Working Group (1999) claim that while there are significant conceptual and methodological issues associated with carrying out reputable environmental valuations, there is a real need to better present and communicate the results to the public, policy advisers and decision makers. Their assessment is that, historically, the environmental valuation that has been undertaken does not appear to have had a significant influence on decisions.

The World Conservation Union (IUCN) has also recognised the incorporation of environmental valuations into decision making as a significant problem (IUCN 1996). Surprisingly, IUCN has recommended that economic assessments of conservation issues should focus on measuring the impacts of options simply in terms of how they affect the economy, rather than on how the total welfare of society is affected. Their argument is that many conservation issues can be supported on the basis of the value of conservation to the economy, and that the inclusion of non-use values (such as bequest, option, cultural, and intrinsic ecological values) only undermines the analyses in terms of acceptability to decision makers. This due to scepticism by decision makers over the valuations placed on these types of impacts.

6. Policy Implications and Conclusions

Economic analysis can play a key role in implementation of vegetation reform. It can be of particular use when considering management options that require a choice between options for the use of particular resources, and in the design of policy instruments to facilitate change. A number of issues, however, have been identified above which act to inhibit the ability of economic analysis in fulfilling these roles in relation to catchment and localised scale vegetation reform implementation.

The development of good native vegetation management related decisions and policy requires that all of the effects of management options be considered. However, the nature of the problems identified above (valuation of non-market attributes, the poor transferability of valuations, and problems incorporating some values into a decision framework) would seem to indicate the desirability of ensuring that all effects are considered without necessarily undertaking formal valuation of each effect. Adopting the IUCN approach (noted above) and supplementing it with qualitative data on impacts that are not explicitly valued would allow the problems discussed in Section 5 to be largely overcome. Threshold analysis is a technique which can substantially fulfil these requirements.

6.1 Threshold Analysis

ABARE (1999) provides the following summary of the concept and application of Threshold Analysis. It is a form of partial benefit cost analysis, which presents estimates of the quantifiable net benefits in conjunction with information on the

nature of the non-quantifiable (non-market) benefit or costs. The application of threshold analysis in decision making is summarised in Box 1.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Non-quantifiable (non-market) effects</td></tr>
<tr><td>Positive</td><td>Negative</td></tr>
<tr><td rowspan="2">Quantifiable net benefits</td><td>Positive</td><td>I. Support proposed action</td><td>II. Weigh up tradeoffs before proceeding</td></tr>
<tr><td>Negative</td><td>III. Weigh up tradeoffs before proceeding</td><td>IV. Reject proposed action</td></tr>
</table>

Box 1: Use of threshold analysis in decision making

Where the quantifiable benefits and costs of a proposed course of action are, on balance, positive and the non-quantifiable effects are also thought to be positive (quadrant I in figure 1) then decision makers can confidently conclude the proposal will lead to an improvement in social welfare. The preferred course of action would be to support the proposal. Conversely, where the quantifiable and non-quantifiable net benefits are both negative (quadrant IV) then the proposal should be rejected.

However, in other cases the decision maker will need to trade off one set of benefits against another set of costs to decide on the preferred option. In the situation depicted in quadrant III the non-quantifiable benefits would have to be sufficiently important to outweigh the net costs associated with the quantifiable outcomes of the project for it to lead to an improvement in social welfare. If this were thought to be the case, the project should be supported. Conversely, in quadrant II the non-quantifiable costs would have to be considered to be less than the quantified net benefits for the proposal to gain the support of the decision maker.

A key advantage of threshold analysis is that the simplicity and cost effectiveness of the technique will in many cases come with few costs to the accuracy of the decision processes which the information supports. Valuations for individual aspects are not provided in the way that other valuation techniques can be applied to particular attributes. However, the technique has the ability to provide a clear structure and outline of the choices faced in relation to an issue, (such as native vegetation management), which may otherwise appear to be a highly complex scenario of different impacts. This enhanced structure for considering the quantitative and qualitative attributes can often be more useful in supporting decision making, than focusing on eliciting specific values for some of the impacts.

Threshold analysis is applicable across a range of scales, such as an individual farm, location, region, catchment or state. For example, at a farm scale, a landholder may be faced with the choice of implementing strategic replanting of native vegetation in recharge areas to act as a preventative measure against dryland salinity and productivity losses, or the choice of clearing further areas of native vegetation to expand production. In applying threshold analysis, the quantifiable market based impacts would be assessed, providing a 'threshold' against which the non-market impacts are assessed.

The application of threshold analysis in circumstances that appear to be purely about private issues (such as above) can also reveal valuable information about landholders attitudes and values that they place on non-use attributes. These can be of particular

interest to policy makers in relation to the development of incentives and cost sharing arrangements.

Similarly, threshold analysis is applicable at broader scales such as district, catchment or state. Analyses at these levels will include public benefits and costs, and the decision issue becomes one of which option is in the greatest interest of the whole group of stakeholders or citizens covered by the analysis. The proportion and range of non-quantified values that must be considered in aggregate against the threshold will increase as the scope of the evaluated issue increases spatially and temporally. Consequently, the complexity of the decision problem faced by the decision maker will also increase, but is still likely to be significantly better informed than without the use of threshold analysis.

The simplicity of the approach however also brings limitations. These include:

- The technique does not provide any actual information (relative or otherwise) on the importance of individual non-quantified effects.

- Using the technique transfers the limitations encountered in assessing effects with simulated market valuation techniques to the decision maker (who must make judgements on the balance of quantified and non-quantified factors).

6.2 Concluding Remarks

Economic evaluation of native vegetation management is important to improve the allocation of these scarce resources. This paper has reviewed a significant proportion of contemporary native vegetation economic analyses. It has been concluded that issues concerning the accurate valuation of non-market attributes, transferability of valuations, and articulation of results to decision makers are important in explaining the perceived lack of availability of economic information useful in determining efficient new directions in vegetation management.

Consequently, it has been proposed that that an approach such as threshold analysis should not be seen as a poor quality alternative to more complex valuation methods. The simplicity of threshold analysis can have significant advantages through its greater acceptability by decision makers, and ability to structure decision problems.

The implications of such an approach is that it increases the importance of developing accurate and comprehensive means of qualitatively describing the variables which have not been quantified. It is critical that the importance of these non-quantified values is not demoted due to the fact they are not quantified. It should be stressed that whether an attribute is quantified or not is simply a reflection on the ability to value, rather than the worthiness of the attribute for valuation. In addition, the quantified analysis provides a threshold value that decision makers consider the value of all unquantified factors against. It is therefore essential that these non-quantified values are clearly described in order to support reasoned judgements.

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