AN ECONOMIC EVALUATION OF BROADSCALE TREE CLEARING IN THE DESERT UPLANDS REGION OF QUEENSLAND

J.C. Rolfe, J.W. Bennett and R.K. Blamey

Research Report No. 12
March 2000

About the authors

John Rolfe is Head of Campus for the Emerald Campus of the Central Queensland University.

Jeff Bennett is Professor of Environmental Management, National Centre for Development Studies, Asia Pacific School of Economics and Management at the Australian National University, Canberra

Russell Blamey, at the time of writing, was a Research Fellow in the Research School of Social Science, Australian National University, Canberra, ACT.
Choice Modelling Research Reports are published by the School of Economics and Management, University College, The University of New South Wales, Canberra 2600 Australia.

These reports represent the provisional findings of the research project ‘Using Choice Modelling to Estimate Non-Market Values’.

The project is being funded by the Land & Water Resources Research and Development Corporation and Environment Australia under their joint program on the conservation and management of remnant vegetation. Support for the project is also being provided by the Queensland Department of Primary Industries, the Queensland Department of Natural Resources, the New South Wales National Parks and Wildlife Service and the New South Wales Environment Protection Authority.

The views and interpretations expressed in these reports are those of the author(s) and should not be attributed to the organisations associated with the project.

Because these reports present the results of work in progress, they should not be reproduced in part or in whole without the written authorisation of the Research Project Leader, Professor Jeff Bennett.

Any comments will be gratefully received and should be directed to Professor Jeff Bennett, National Centre for Development Studies, The Australian National University, Canberra ACT 0200, telephone +61 2 6249 0154
Table of Contents

ABSTRACT i

1 INTRODUCTION 1

2 THE POLICY DEBATE 2

2.1 The Policy Debate at the State Level 3

2.2 The Policy Debate at the Commonwealth Level 4

3 THE CASE STUDY AREA 5

4 THE ECONOMICS OF TREE CLEARING 6

4.1 Net Returns at the Property Level 8

4.2 External Impacts on Land Quality 9

4.3 External Impacts on Greenhouse Gases 10

5 PUBLIC VALUES FOR PRESERVING BIODIVERSITY AND REGIONAL COMMUNITIES 11

6 DISCUSSION 16

7 CONCLUSIONS 18

8 REFERENCES 20
List of Tables and Figures

Table 1  Social Costs and Benefits of Tree Clearing  7

Table 2  Data for three case studies of land development in the Desert Uplands  9

Table 3  RCS estimated rates of return for different timbers treated  9

Figure 1  A Typical Choice Set  12

Table 4  Non-Attribute Variable Definitions  13

Table 5  Nested Logit Results  14

Table 6  Part-worths for the different attributes  14

Table 7  Profiles used for welfare estimation  15

Table 8  Additional profiles used for welfare estimation  17
Abstract

In recent years there has been substantial debate over rates of broadscale tree clearing in Queensland. State Government policy in relation to tree clearing attempts to strike a balance between the benefits of increased production and the environmental costs of vegetation loss. This is difficult to achieve because while production benefits are relatively easy to quantify, the environmental losses, the social impacts of increased controls and the value of reductions in greenhouse gas emissions are much harder to quantify. A Choice Modelling experiment has been conducted to estimate the values held by Brisbane residents for both environmental and social factors associated with tree clearing in the Desert Uplands region of central-western Queensland. In this report, estimates of these values are given for a number of different development and protection options. Some comparisons are made to the production gains and indirect costs associated with tree clearing in the region.
1 Introduction

Environmental concerns are well accepted in Australia as being important, and there have been substantial efforts made by the government and other institutions within the nation to take account of and minimise potential environmental losses. One of the most substantial ways in which this is evidenced is the establishment of procedures such as Environmental Impact Assessment to consider the environmental impact of major new developments.

Such ‘once off’ evaluation procedures are much more difficult to apply to small-scale repetitive development actions, such as tree clearing by pastoralists wishing to improve the carrying capacity of their land. In these cases, there is little capacity to bear the cost of a full environmental impact assessment for each development choice. Different approaches need to be taken to assess where the balance between environment protection and development opportunities should lie.

There is currently little consensus about where this balance lies in relation to land development in Queensland. Possible restrictions over tree clearing have been widely debated in recent years. Some of the issues of contention relate to how any controls over tree clearing will reduce the production choices of graziers, with subsequent impacts on viability levels and flow-on effects in regional communities. Other issues revolve around the environmental losses associated with tree clearing, the indirect and long-term consequences of land development, and the structure of possible regulations or incentive mechanisms.

An economic approach to these types of resource use choices typically involves comparing the benefits of production from a land development option with the environmental and other costs that might also occur. If production benefits outweigh environmental costs, then the development options offer a net benefit to society, and vice versa. However, there are a number of difficulties in applying this type of cost-benefit analysis techniques to land development options in Queensland.

The major deficiency is that little information exists to indicate what values (termed non-use values) the community holds for protecting remnant native vegetation in Queensland. Because the wider community (not just individual landholders) is likely to have some concerns about the loss of remnant native vegetation, and because those concerns are not currently registered in any market transactions, non-market valuation techniques need to be employed to estimate society’s value for protecting native vegetation. However, the complexity of land development issues and the scattered pattern of development make more traditional methods that focus on a single tradeoff difficult to apply.

For these reasons, the development of a relatively new non-market valuation technique termed Choice Modelling (CM) was trialed in relation to tree clearing issues in a particular region of Queensland known as the Desert Uplands. The progress of this project has been detailed in previous Choice Modelling Research Reports. They have helped to explain the operation of the technique (Morrison, Blamey, Bennett and Louviere 1996, Bennett 1999), outlined some of the details of the case study (Rolfe, Blamey and Bennett 1997, Blamey Rolfe and Bennett 1998), and reported on some particular issues and technical findings (Blamey, Rolfe, Bennett and Morrison 1997, Blamey, Bennett, Morrison, Louviere and Rolfe 1998, 1999).

This report is focused on relating the results of the Choice Modelling study to the case study of interest, and discussing the implications of the findings to the wider policy debate over tree clearing in Queensland. The report is structured in several sections. In the following section, the policy debate with regard to tree clearing is summarised. This is followed in section three by a description of the case study area, and an outline of an economic approach to tree clearing in section four. In section five, the CM application is described, and a discussion of the results is contained in section six. Final conclusions are drawn in section seven.
The Policy Debate

Nationally, nearly 70% of all vegetation has been removed or significantly modified, with as much lost in the past 50 years as in the previous 150 years (Industry Commission 1997). The clearing of native vegetation has been identified nationally as a major contributing factor to biodiversity decline and loss (Industry Commission 1997).

Consistent with normal commercial practice, lands with high potential productivity were cleared first in Queensland. Mechanical clearing methods (scrubpulling) were introduced to the state in the late 1950’s. This facilitated the widespread clearing of brigalow and other scrub communities in many regions, and eucalypt communities in the higher rainfall areas closer to the coast. Chemicals (particularly Tordon) have been widely used in eucalypt country, while bladeploughing to kill regrowth has become very popular since the early 1980s.

By the end of the 1970s, most of the more fertile land in the southern Brigalow region had been cleared. The lower cost of clearing and the relative profitability of both beef cattle production and dryland agriculture in the 1980s, led to increased interest in clearing the less productive vegetation types. This occurred both within the Brigalow regions where extensive clearing had already occurred, and to the north and west of that region in the semi-arid woodland country. In the 1980s and 1990s, high clearing rates have continued in Queensland, much of which has been concentrated on:

- clearing of lower quality acacia scrubs (brigalow, gidgee, mulga),
- clearing of eucalypt communities (particularly box and ironbark communities), and
- controlling regrowth in previously cleared areas,

Fairfax and Fensham (1999) report that in “the Brigalow Belt bioregion alone 85% of brigalow and gidgee lands from an original area of 107,000 km² had been cleared by 1995. In the same region about 57% of poplar box and silver-leafed ironbark lands from an original area of 83,000 km² had been cleared by 1995” (p3).

Data about rates of tree clearing have improved with the development of satellite mapping information by the Statewide Landcover and Tree Study (SLATS) within the Queensland Department of Natural Resources. This project commenced in 1996, and preliminary project findings (http://www.dnr.qld.gov.au/slats) can be summarised as:

- The average annual tree clearing rate between 1995 and 1997 was 340,000 hectares.
- 57% of all tree clearing in Queensland between 1995 and 1997 occurred within the brigalow belt biogeographic region.
- Clearing rates in the Desert Uplands and Mulga biogeographic regions in the 1995-97 period declined from levels in the 1992-95 period.
- The Balonne shire is the Local Government Area with the highest clearing rate in Queensland, accounting for 14% of the State’s clearing between 1995 and 1997. In the 1991-1995 period the Jericho shire had the highest clearing rate.
- Between 1995 and 1997, approximately 40% of clearing occurred on leasehold land, 57% on freehold land, and the remaining 3% on crown land. This is a reversal of the 1991-95 situation, when clearing rates leasehold and freehold land were 55% and 42% respectively.
- The rate of tree clearing across Queensland decreased by approximately 21% between the 1988-89 and 1991-5 time periods and then increased by 18% to the 1995-97 period.
- At least 18% of 1995-97 clearing was for regrowth, and this proportion may rise as satellite data are analysed further.
- Approximately 86% of vegetation change was for pasture production, and a further 9% of vegetation change was for cropping.

---

1 Data about rates of tree clearing have improved with the development of satellite mapping information by the Statewide Landcover and Tree Study (SLATS) within the Queensland Department of Natural Resources. This project commenced in 1996, and preliminary project findings can be viewed at (http://www.dnr.qld.gov.au/slats).
Some cases of development for pasture production in the more marginal and less fertile lands have arisen as graziers from the brigalow region acquire new land to the west and north of their original holdings and seek to replicate their past development successes. In other cases graziers have become more confident in their ability to control regrowth and wish to explore new options for improving productivity. Development has also extended into some marginal areas because the cost of machinery and development relative to income has trended downwards over time. The same influences that have substituted capital and machinery for labour in the rural sector over the past decades has also driven the search for increased, more cost-effective development.

2.1 The Policy Debate at the State level

In the mid-1990s, the main focus of the debate in Queensland in relation to broad scale tree clearing was on leasehold land, where clearing can only occur where a permit has been issued by the relevant agency of the State Government. In 1995, the State Government introduced controls over clearing on leasehold land, where previously there had been little restriction.

The Queensland Government issued the Preliminary Tree Clearing Policy (PTCP) on the 18th of December 1995 as a reference document for the development of local guidelines for broadscale tree clearing, replacing the earlier Draft State Guidelines. The local guidelines were seen as a format for landholders to have some input into the policy for their region, as well as ensuring that some flexibility would be generated within the overall policy framework.

The PTCP refers to the following three categories of vegetation type and extent:

- **Endangered and Vulnerable**: Refers to vegetation types which “have limited or very limited distribution and are at serious risk from development or other threatening processes. These categories include vegetation types with less than 5% or 10% (respectively) of the original distribution remaining intact and uncleared. Vegetation types that are, and always were, very limited in distribution (irrespective of the degree of clearing) are included here” (p.4). The policy states that these vegetation types should not be cleared.

- **Of Concern**: “Vegetation types that have been previously cleared or disturbed but which are not at risk, could be cleared provided clearing does not result in the vegetation type becoming vulnerable” (p.5). At least 20% of the ‘original extent’ of each vegetation type is to be retained on each lease.

- **Not of Concern**: “Vegetation types that are extensively disturbed and/or are widespread, could be cleared provided that clearing did not result in that vegetation type becoming ‘of concern’ ” (p.5). At least 30% of the original extent of each vegetation type is to be retained within each region, and at least 20% on each lease. As well, many communities that are not subject to a threatening process are classified within this category.

The overall thrust of the policy change was that no further clearing of ‘endangered’ or ‘vulnerable’ ecosystem types would occur on leasehold land. Further clearing of ‘of concern’ and ‘not of concern’ communities could occur within the guidelines that were set.

There was substantial opposition to these controls from the pastoral community. A review of the guidelines (Scanlon and Turner 1995) noted that some issues of resource management (such as erosion) were not primarily caused by tree clearing but related more to inappropriate grazing practices. As well, there was a significant amount of vegetation thickening occurring in the State’s uncleared grazed woodlands, which may need to be managed through clearing activities. The report also noted that tree clearing had a significant impact on biodiversity through loss of habitat, and that even under the Draft Guidelines reviewed, it was likely that biodiversity would decrease in some vegetation communities.

The effect of the introduction of the tree clearing guidelines has had little impact on the rate of tree clearing in Queensland, although it has reduced clearing in a number of vegetation communities. This is in part because:

- there are substantial woodland communities listed as ‘not of concern’ that are perceived by
landholders to have development potential. (In the Desert Uplands region, these are mostly eucalypt vegetation communities).

- there are no clearing restrictions on freehold land,
- it is possible for landholders to convert to freehold title from some lease titles, and
- a return to better seasons and market conditions have reduced the financial constraints on landholders.

In 1999, the State Government announced that it wished to extend tree clearing restrictions to freehold land. Legislation was passed to this effect in December 1999, and is likely to become effective in early 2000. The broad thrust of the legislation passed is similar to the restrictions over leasehold in that clearing of endangered or vulnerable vegetation types will be banned. There is also a stated target of preserving 30% of each ‘not of concern’ vegetation type across the state. Most regrowth will be exempt from the restrictions.

### 2.2 The Policy Debate at the Commonwealth level

There has also been substantial interest at the Commonwealth level in clearing activities in Queensland over recent years. The State of the Environment Advisory Council (SEAC) (1996) reported that vegetation clearing generally (for agriculture, urban and forestry purposes) was a major cause of biodiversity loss. The Industry Commission (1997) noted that in many areas vegetation remnants were further threatened through such problems as salinity.

The commitment of the Commonwealth Government to limiting emissions of greenhouse gases from Australia has also helped to focus some attention on tree clearing activities. In the National Inventories, a major component of Australia’s emissions have comprised of Land Use Change emissions, largely from tree clearing activities. Total net emissions from tree clearing and regrowth activities have been estimated by the Australian Greenhouse Office to be 89.7 Mt of CO₂ equivalent in 1990, and 62.9 Mt of CO₂ equivalent in 1996 (Rolfe 1998). The Queensland Government (1998) reported that approximately half of the State’s CO₂ emissions derive from Land Use Change and Forestry, although this proportion has been more recently revised to around 35%.

These estimates show that vegetation clearing has a significant impact on greenhouse gas emissions, and any controls or slowdown in the rate of clearing will automatically help Australia meet its emissions targets set under the Kyoto agreement. It is likely that the opportunity cost of meeting reduction targets by reducing land clearing will be lower than many other options based on reducing fossil fuel emissions (Rossiter and Lambert 1998). While the Australian Greenhouse Office has focused on voluntary reductions and cooperate agreements to limit growth in emissions, the policy debate about greenhouse emissions will continue to have some focus on tree clearing activities.


> “that all Australian Governments have committed themselves, through the National Heritage Trust, to reverse the long-term decline in quality and extent of Australia’s native vegetation cover by June 2001” (p.4).

The National Framework is drafted as a partnership agreement between the Commonwealth and the States to improve vegetation monitoring and management consistent with other government strategies and policies.

These developments indicate that the Commonwealth Government, through partnership agreements with the States, is likely to have more influence over tree clearing guidelines than has previously been the case.
3 The Case Study Area

Covering some 6,881,790 hectares (4% of Queensland), the Desert Uplands bioregion is an area of acacia and eucalypt woodlands. The bioregion is approximately the same size as Tasmania, and is classified in the rangelands zone of Australia. In central-western Queensland, it extends from Alpha and Barcaldine on the Capricorn Highway (west of Rockhampton) northwards to near Charters Towers and Hughenden on the Flinders Highway (west of Townsville). The region is sandwiched between the brisgalow zones to the east, and the open grasslands of the western plains.

The region is used primarily for beef cattle grazing. Some sheep are run on the western side. It is less productive for pastoral purposes than regions to the east and south because of its relatively low rainfall and poor soils, and vegetation that is reasonably unpalatable to domestic stock. One of the dominant grasses is spinifex (*Triodia spp.*), a grass common to drier areas of Australia. This one reason why the term ‘desert’ is used in association with the area. Even though the soils are mostly sandy and relatively infertile, the area is thickly vegetated.

While the region is still relatively undeveloped compared to the brisgalow regions to the east, and the integrity of most ecosystems in the region remains high, trends in management and development appear to be impacting on biodiversity (Landsberg, Ash, Shepherd and McKeon 1998, McCosker and Cox 1996). The most visible impacts are tree clearing, but overgrazing, land degradation and weed invasion are also problems in some areas.

With estimated gross cattle sales of $35 million, the Desert Uplands region accounts for approximately 2.5% of beef production by value in the state. Changes to cattle production in the Desert Uplands are occurring in three main ways (Rolfe et al 1997).

(i) Changing markets are establishing price premiums for younger, better finished cattle. This means that fattening cattle on natural pastures is becoming progressively less attractive financially. One alternative is to sell more cattle as stores, particularly into the developing markets of feeder cattle or live export trade. Another alternative is to establish better pastures so cattle can be grown and fattened more quickly.

(ii) Real rates of return generated in the pastoral industry are gradually deteriorating. This forces searches for production and cost efficiencies. The most striking changes relate to the diminished use of labour. Many properties that would have employed a number of stockmen in past years now get by with one or two. Increased capital investment (fencing, yards, roads, waters), and the use of modern technology (pumps, trucks, helicopters for mustering), offer some explanation. However, the underlying reason is that the costs of labour have increased steadily relative to production returns and the costs of capital substitution.

(iii) The industry is shifting towards breeding more suitable types of cattle. The introduction of Brahman, Brahman cross, and other breeds of cattle have improved weight gains and turnoff weights in cattle. However, this has increased stocking pressure in some areas because Brahman cattle are more resilient to dry conditions. As well, the development of supplement feeding tends to maintain cattle numbers in dry times. Previously, cattle either died or were shifted away in times of drought. Both of these changes have led to severe land degradation in parts of the upper Burdekin catchment in recent years (White 1997).

For pastoralists in the Desert Uplands, one of the key areas for improving productivity is to improve the quality and quantity of pasture. This can be done by clearing timber on the better quality country and establishing introduced grasses, mainly buffel (*Cenchrus ciliaris*). The trees are cleared mechanically with two bulldozers and a chain, stock are removed to allow grass to grow, and the country is then burnt to remove the timber and kill off young suckers from the fallen trees. New grasses are established in the ashbeds and stumpholes of the fallen trees, and with management, thicken to take over the entire pasture. Scanlan and Turner (1995) indicate that pasture production increases from two to four times when the trees

---

2 In many areas, pastures can be improved or maintained in healthy condition by conservative stocking rates and the judicial use of fire management. Effects are generally relatively long term in nature. Within the grazing industry, the term ‘pasture improvement’ is generally taken to relate to more short term measures, including the introduction of new grasses and increased moisture penetration and grass production.
are removed from eucalypt communities. The increase in production in many acacia communities is higher. However, ongoing costs may be involved to control regrowth.

Tree clearing in Queensland has tended to be associated with increased profitability and higher land values (Scanlon and Turner 1995). This is to be expected, as landholders would generally only clear trees if they expect to increase production and profitability. In many cases, the landholders who are developing country are those who are already experienced in clearing trees and establishing pastures, and who are moving further west and north in search of new development opportunities. Their expectations are that they can replicate past successes in improving productivity.

While these expectations may be widespread, they are not necessarily well defined. Graziers rarely assess pasture in any systematic way to determine quantity and quality. That makes it difficult for them to assess the benefits of tree clearing in a precise way. Instead, the benefits of tree clearing are usually expressed in terms of improved carrying capacity (of beef cattle). This generally reflects both increased numbers and improved turnoff rates. Carrying capacity though can be confounded with a number of other factors, including:

- climatic factors and seasonal variation
- improvements in cattle breeding,
- changed management practices,
- intensification (smaller paddocks and increased rotation)
- supplementary feeding

At the individual paddock or property level, graziers often attribute changes in carrying capacities to tree clearing and pasture improvement. In the first flush of production after tree clearing and burning occurs, the link between improved grass production and carrying capacity is apparent. Over the longer term though, the relationship tends to be confounded with other factors. The result is that graziers generally believe that tree clearing improves carrying capacity on their property without being able to indicate precisely the short-term or long-term relationship.

Rolfe et al (1997) report ABS data on financial returns to properties in the Desert Uplands region. The data indicates that the average property made a loss between 1988 and 1995, and that debt levels increased. They summarise the results as:

"The data paints a picture of the average enterprise relying mostly on income from beef cattle, employing very little labour, and steadily increasing debt levels in order to generate income. The average enterprise had nearly 1500 cattle but sold only 310 each year, indicating that turnoff rates are very low. Total assets held by an enterprise averaged $1,277,424 with debt levels of $207,762 indicating an average equity ratio of 84%. Capital expenditure each year was $27,600, slightly higher than the average increase in debt of $25,000. These latter figures, together with a general increase in cattle numbers, suggest that graziers are choosing to borrow money for further development in an attempt to increase productivity" (p24).

4 The Economics of Tree Clearing

Pastoralists clear trees in the expectation that the returns from increased carrying capacity outweighs the cost of clearing, pasture development and subsequent maintenance. As well, pastoralists might also factor in their personal preferences for items such as biodiversity conservation, the aesthetics of tree cover, and the risks of longer term impacts such as salinity. However, there are a range of costs and benefits that may not be considered by pastoralists, which include community values for biodiversity, indirect effects on greenhouse gas emissions, and off-farm costs of land degradation. A summary of the costs and benefits of tree clearing is presented below.
**Table 1. Social Costs and Benefits of Tree Clearing.**

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Benefits</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Property level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- direct, medium term</td>
<td>Income from improved pasture production</td>
<td>Cost of clearing trees, improving pasture, controlling regrowth</td>
</tr>
<tr>
<td>- indirect, longer term</td>
<td>Possible reduction in grazing pressure on rest of property</td>
<td>Reduced benefit of tree cover (eg shade, shelter, nutrient recycling)</td>
</tr>
<tr>
<td></td>
<td>Improved access for mustering</td>
<td>Pastoralists own value for risk of salinity, erosion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pastoralists own value for biodiversity loss</td>
</tr>
<tr>
<td><strong>External impacts</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Social value of land quality</td>
<td>Possible reduction in land degradation on some properties</td>
<td>Possible increased risk of salinity/erosion above landholder expectations and on other properties</td>
</tr>
<tr>
<td>- Cost of greenhouse gases</td>
<td>Impact of land clearing on greenhouse gas emissions</td>
<td></td>
</tr>
<tr>
<td>- Social value of biodiversity</td>
<td>Effect of tree clearing on biodiversity</td>
<td></td>
</tr>
<tr>
<td>- Indirect effects of production</td>
<td>Social value of positive effects on rural communities</td>
<td></td>
</tr>
</tbody>
</table>

(source: adapted from ABARE 1995).

In the absence of government intervention, tree clearing occurs where landholders balance up the benefits and costs at the property level and perceive that higher returns are available from pursuing clearing options. Because the markets for beef and wool give landholders few (if any) signals about the value of external impacts of tree clearing, it has commonly been left to governments to set constraints about resource use to ensure that social values are protected.

In the past, governments have emphasised the social benefits of increased production and have encouraged tree clearing through taxation mechanisms, lease conditions and other mechanisms. This has occurred in part because there has been little knowledge about some of the external and indirect costs of clearing (such as salinity, greenhouse gas emissions), and because when native vegetation was in abundance, society had little marginal value for preservation.

In recent decades, there has been a large shift in community values attached to external impacts. There is widespread knowledge now of many of the indirect effects of clearing on land quality and greenhouse gas emissions. There are increasing community values for vegetation protection, partly because of rising income and diminished levels of remnant vegetation (Hone, Edwards and Fraser 1999). There is also awareness by the community of subsequent impacts of clearing on ecosystem functioning and other biota. In general, governments have responded to these changes in information and values by promoting concepts of sustainability (eg Landcare) and engaging in direct regulation (eg the tree clearing guidelines).

These general approaches provide little indication of where tradeoffs between production and preservation should be made at a regional or property level. One way of achieving this is to apply a cost-benefit analysis framework using the impacts outlined in Table 1. At a summary level, the issue to be determined is whether the net returns from tree clearing at the property level are outweighed by the net external impacts.

Lockwood and Walpole (1999) report on a benefit cost analysis of remnant native vegetation conservation in north-east Victoria and the Murray catchment in southern NSW. The costs of conservation options were

---

3 Some clearing may also occur for other reasons, including trials of pasture development on ‘new’ country types, making country easier to muster, and in case governments impose clearing restrictions. The dominant expectation though is that clearing increases overall returns.
first assessed in terms of the economic costs to landholders such as production foregone. These were then compared to the benefits of conservation options, which included impacts on dryland salinity and greenhouse gas emissions, as well as the protection values held by the State populations. The study concluded that the benefits of conservation outweighed the opportunity costs, and that governments could spend up to $29.8 million in north-east Victoria and $40.5 million in the Murray catchment on vegetation protection to maximise community values.

Some evidence of the values in the production, land degradation and greenhouse gas emission categories for the Desert Upland is outlined below.

4.1 Net Returns at the Property Level

The evidence about net returns from tree clearing at the property level in the Desert Uplands is mixed. In part, this is because of the variety of soils and vegetation types, together with variations in development and management practices. As well, the additional pasture production resulting from tree clearing rarely remains constant. There is generally a spike in productivity increases following development where tree removal can increase pasture productivity by 2 to 7 times (Burrows 1993, quoted in ABARE 1995), followed by declines from regrowth and losses in soil fertility. In some cases, pasture yields can return to pre-clearing levels within 10 to 20 years (ABARE 1995).

ABARE (1995) reported that clearing in the Desert Uplands increased carrying capacity from 20 to 7 hectares per head of cattle, and that the change in annual gross margin (net of clearing costs) was approximately $4.30 per hectare cleared. The present value of this annual improvement in income over 30 years (at a 6% discount rate) is $59.19 per hectare. This estimate appears to be high compared to land prices in the region in 1995, and to other estimates of the value of improvements.

Scanlon and Turner (1995) reported that the annual net profit from every 10% increase in clearing rate in box country (higher quality eucalypt forest) was 20 cents per hectare. At a 100% clearing rate, this translates to $2/ha per annum. The present value of this annual improvement in income over 30 years (at a 6% discount rate) is $27.53/ha.

The Rich’s at “Castleroi”, in the southern part of the Desert Uplands, reported on their assessment of their production levels of open eucalypt forest (Desert) country in June 1995, using the Department of Primary Industries Grass Check System. The developed area produced 800 kg/ha of dry matter, some two and a half times the level in the grazed virgin area (300 kg/ha), and a third more than the level of production in the ungrazed virgin area (600 kg/ha). The annual gross value of production on the developed eucalypt country was estimated at $8.46/ha compared to $2.22/ha for the undeveloped country. For the gidgee (acacia) country, the annual gross returns were estimated at $13.2/ha for the developed country compared to $2.82/ha for the undeveloped country.

RCS (1999) used three case study properties involving different land types across the Desert Uplands to provide some estimates of development returns from clearing and other improvements. Their estimates of the increase in carrying capacity from land development are shown in Table 2 below, and are similar to those of ABARE (1995).

---

4 The high values might result from only a limited selection of production costs being included in the gross margin estimate. The additional costs and overheads would have to be considered to derive net profitability estimates.

5 The report was provided by Pat Lyons, DNR Emerald, and resulted from a visit to “Castleroi” by the Government Tree Clearing Working Party in 1995.

6 These returns will be lower when converted to gross margin estimates, but are still likely to show significant differences.
Table 2. Data for three case studies of land development in the Desert Uplands

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Land types cleared</th>
<th>Total property area (ha)</th>
<th>Estimated CC prior to clearing (head)</th>
<th>Initial stocking rate (ha/beast)</th>
<th>Total area pulled (ha)</th>
<th>Estimated increase in CC post development (head)</th>
<th>Estimated stocking rate on cleared land (ha/beast)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Silver leaf ironbark and wattle</td>
<td>21,862</td>
<td>2180</td>
<td>10</td>
<td>18,303</td>
<td>1,212</td>
<td>6.5</td>
</tr>
<tr>
<td>B</td>
<td>Gidgee and popular box</td>
<td>19,436</td>
<td>1019</td>
<td>19</td>
<td>5,012</td>
<td>351</td>
<td>8.15</td>
</tr>
<tr>
<td>C</td>
<td>Ironbark/box and gidgee</td>
<td>19,028</td>
<td>881</td>
<td>21.6</td>
<td>10,426</td>
<td>1,326</td>
<td>5.7</td>
</tr>
</tbody>
</table>

(Source: adapted from RCS 1999).

RCS (1999) concluded that the rates of return from clearing the different vegetation types (using a discount rate of 6%) could be summarised as follows:

Table 3. RCS estimated rates of return for different timbers treated

<table>
<thead>
<tr>
<th>Timber Type</th>
<th>Net Present Value ($/ha)</th>
<th>Internal rate of return (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wattle &amp; Ironbark</td>
<td>$12.34</td>
<td>11.5%</td>
</tr>
<tr>
<td>Gidgee</td>
<td>$57.61</td>
<td>17.0%</td>
</tr>
<tr>
<td>Ironbark &amp; Box</td>
<td>$28.31</td>
<td>11.6%</td>
</tr>
</tbody>
</table>

(Source: RCS 1999).

4.2 External impacts on land quality

One possible impact of tree clearing activities is on the quality of the land resource. To some extent, pastoralists may have already factored in expectations about impacts on land quality in decisions to clear. However, there is widespread evidence in Australia of land degradation issues being poorly anticipated and understood by pastoralists, scientists and policy makers. In cases such as the saline areas of Western Australia, long-term losses to society have resulted from decisions to clear vegetation for farming purposes. Here, possible land degradation issues in the Desert Uplands that may cause losses to society are reviewed briefly.

There are three broad issues of relevance to possible land degradation in the Desert Uplands, being:
- soil erosion,
- soil structure and fertility decline, and
- salinity.

Soil erosion is a major problem in Australia and White (1997) notes that some erosion rates are among the highest in the world. In the pastoral zones, erosion is generally a factor of stocking rates and management practices rather than tree clearing activities, and much soil degradation occurred as a result of high stocking rates last century. There are areas in the Desert Uplands where tree clearing and pasture establishment can arrest soil erosion problems. The classification adopted by White (1997) indicates that there is frequent erosion risk in parts of the Burdekin catchment where land is left bare from grazing, but little or no erosion risk over most of the Desert Uplands.

There is some evidence of soil structure and fertility decline, particularly in areas of the region where stocking rates exceed land capabilities in certain seasonal conditions. It is notable in the upper Burdekin catchment (particularly in the Dalrymple Shire) that the combination of harder Brahman cattle and supplementary feeding in droughts during the 1970s and 1980s dramatically increased pressure on pastures with subsequent soil degradation (White 1997). Landsberg et al (1998) documents how some landholders...
have begun to understand the fragility of land types in the region in relation to stocking rates and have changed management practices accordingly.

Land degradation is also occurring in other ways across the region, mainly through the decline in native pastures. This is associated with overgrazing and the misuse of fire (DNR 1998). Other related degradation issues are the compaction of topsoil and the introduction of woody weeds. Other evidence of declines come from vegetation thickening, a widespread phenomena across the Desert Uplands (Burrows, Anderson, Back and Hoffmann 1997).

The removal of trees is a prime cause of dryland salinity, which is a major issue in other parts of Australia. There is some evidence that pockets of the Desert Uplands may be susceptible to dryland salinity, and thus at some risk from tree clearing activities. However, the lower recharge rates in northern Australia generally means that salinity problems may be slower to emerge compared to southern Australia. One consequence is that landholders may not be fully aware of the risks of salinisation, or able to factor them into clearing decisions.

In the northern part of the Desert Uplands, Williams et al (1997) and Bui et al (1996) report that the level of salt distribution in soils and the soil/climate interaction make tree clearing problematic in the upper Burdekin catchment. Almost half the catchment can be characterised as moderate risk, and a further one-quarter characterised as high risk (Bui 1997). In the southern part, Herring (1998) reports that limited parts of the Alice River catchment are at risk, although these tended to be associated with clay soils favoured for clearing purposes.

Generally, the low levels of historical salt deposits and the low average rainfall means that most of the Desert Uplands region is not at much risk of salinisation. As a consequence, the indirect costs of clearing on land degradation can be considered low, although they may be significant in some limited areas.

4.3 External impacts on greenhouse gases

One of the impacts of tree clearing is the subsequent release of greenhouse gases, principally carbon in the form of carbon dioxide. The major form of release is likely to be from the burning and rotting of above ground vegetation once it has been cleared. Other releases are likely to come from the rotting and burning of below ground biomass (eg roots), and from changes in organic carbon levels in soils. At the same time, there may be offsetting carbon sequestration effects, largely through carbon taken up in increased pasture levels, and in some cases, improvements in soil carbon levels.

The overall loss of carbon is difficult to quantify at the case study level, for a number of reasons (Burrows et al 1997). First, the amount of biomass varies across sites according to factors such as vegetation type, soil type and climatic influences. Second, the measurement of carbon levels is imprecise because of the limited amount of data available and the early stages of scientific development of the appropriate modelling relationships. These difficulties are more pronounced for below-ground biomass and soil carbon levels compared to above ground biomass. Third, carbon releases from different sources occur at varying rates, and both release and sequestration patterns are confounded with seasonal fluxes. Fourthly, the estimation of the actual areas of each vegetation type is imprecise, making it difficult to extrapolate site data to aggregate amounts.

Given these uncertainties, some broad estimates of the amount of carbon that might be released from tree clearing can be made. Burrows et al (1997) report that for the grazed woodlands of northern Queensland, the average basal area of all woody plants was 9.62 m²/ha (±0.95). The mean above ground biomass of Eucalyptus trees (the dominant genus type in these woodlands regions) is 4,235 kgs of matter per m² of basal area, or approximately 40.74 tonnes/ha. At approximately 46% carbon, the total mass of above ground carbon is 18.7 tonnes/ha.

To this estimate for above-ground carbon must be added the below-ground stock (approximately 40% of above-ground stocks) and soil carbon levels. Burrows (pers comm) suggests that net below-ground and soil carbon stocks remain relatively unchanged after tree clearing because below-ground biomass decays tend to be balanced by pasture and soil carbon increases. If this is the case, then the net carbon loss from tree clearing can be estimated at the above-ground biomass of 18.7 tonnes per hectare. While this is a very approximate estimate, it will give some idea of the external losses associated with this factor of tree clearing.
Trade in carbon offsets is an emerging market, with many initial trades occurring in the region of around $10US/tonne of carbon. Rolfe (1998) summarises a number of international forestry carbon offset programs as costing between $1.50 and $12.50 Australian. Within that range, the indirect losses associated with greenhouse gas emissions from tree clearing in woodlands regions appears to lie between $28 and $233 per hectare. Lockwood and Walpole (1999) selected $10/tonne of carbon dioxide as an appropriate benchmark, which converts to approximately $2.70/tonne of carbon. At this value, carbon sequestration is approximately $50.50/ha.

If a further 10% of the Desert Uplands region were protected from clearing, the value of reduced greenhouse gas emissions at $50.50/ha is approximately $34.7 million. If a further 30% of the region is protected, the value is approximately $104 million. If the lower value of $28/ha is adopted, these estimates fall to $19.3 million and $57.8 million respectively.

5 Public values for preserving biodiversity and regional communities

In the previous section information has been summarised about the size of production benefits that are available from tree clearing in the Desert Uplands, together with information about the possible indirect impacts on land degradation and greenhouse gas emissions. To complete the full assessment of costs and benefits as outlined in Table 1, information also needs to be gathered about the community values that might exist for preserving both biodiversity and regional communities. This presents special challenges, for these are non-use values, and thus cannot be estimated from market information. It is for this specific purpose that the Choice Modelling application has been developed.

There is general evidence that values for biodiversity protection are important within the Australian community. The growth in awareness of environmental issues have been paralleled by developments in legislative and regulatory frameworks in Australia that protect environmental assets. Among the changes have been increased restrictions on tree clearing in most Australian states. Although research is limited in many areas, it appears likely that tree clearing in Queensland does not only reduce the quantity of native vegetation, but may impact more severely on the conservation status of some species (DEST 1995). Scanlon and Turner (1995) reported that some further biodiversity loss was still likely to occur from tree clearing in Queensland even after the more restrictive guidelines over leasehold land had been introduced. Fairfax and Fensham (1999) note that in many central Queensland vegetation communities it is the introduction and spread of buffel grass following clearing that has the most significant impact on biodiversity. The dominance of buffel grass reduces the diversity of native plants.

At the same time, Australian communities also hold strong concerns about viability issues and adjustment processes in rural communities. Some evidence of this concern comes from the maintenance of many essential services in smaller communities, and direct support payments to rural businesses through the Rural Adjustment Schemes. In Queensland, the latter programs have delivered approximately $85.6 million in support to the beef and beef/wool sectors between 1994/5 and 1998/9 (Rolfe and Donaghy 2000). As well, concerns about rural viability and restructuring pressures in the Desert Uplands region have led to the establishment and funding of the Desert Uplands Community Scheme by the Queensland Rural Adjustment Authority.

Different values are held for woodland areas by different groups within a population. For example, people in control of the resource (eg pastoralists, miners) usually derive the benefits from directly using it, while a wider group of people in the local or regional area might enjoy some indirect benefits (eg catchment protection). In contrast, non-use benefits tend to be spread much more widely, where for example, people from a state or even national basis might derive some benefit from knowing that a particular species or ecosystem continues to exist. In the same way, different groups may also have different values for supporting rural communities.

---

7 Prices for carbon offsets are likely to fall further as new opportunities for offsets are found and the markets continue to develop.
Because these values are distributed unevenly across the population, problems of “missing” markets arise. For example, graziers in rangelands areas respond to the demands from the wider population for meat and wool, but receive no corresponding demand signals from the wider population for biodiversity protection. A market for biodiversity protection does not spontaneously exist. As a consequence, the use values for rangelands areas tend to dominate the decisions of individual graziers. To correct for “missing” markets, governments are usually expected to take the values of the wider community into account when making resource allocation decisions.

The difficulty for decision makers wishing to assess the public good aspects of resource allocation choices (the non-use and some indirect use values) is that they cannot be inferred from direct observation of behaviour. This is because there is little or no incentive to provide these services through market mechanisms. Specialist valuation techniques have been developed to estimate these non-marketed values.

One such technique, Choice Modelling (CM) has been used to estimate the value of remnant vegetation in the context of potential changes to broad scale tree clearing regulations in the Desert Uplands (Blamey et al 1999). Lockwood and Walpole (1999) report a similar application in north-eastern Victoria and the Murray catchment in southern NSW. The aggregate benefit of preserving remnant native vegetation in the former region was estimated at $60.7 million, and at $75.6 million in the latter region. The area of the two regions combined is 25% lower than the area of the Desert Uplands region.

In the Desert Uplands project, the main task was to estimate how the public might value the protection of both biodiversity assets and human assets (in the form of regional communities). To apply the CM technique, the implication of changes to tree clearing regulations were described in terms of six attributes, being:

- Number of endangered species lost to the Desert Uplands region
- Reduction in population size of the non-threatened species
- Loss in area of unique ecosystems.
- Income lost to the Desert Uplands region ($ million)
- Jobs lost to the Desert Uplands region
- Payment by society for changes (Levy on income taxes)

An experimental process was used to give a random selection of people in Brisbane choices between different conservation and development alternatives for the Desert Uplands regions. An example of a choice set presented to respondents is presented in Figure 1.

**Figure 1: A Typical Choice Set**

<table>
<thead>
<tr>
<th>Implications</th>
<th>Option A Current Guidelines</th>
<th>Option B</th>
<th>Option C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levy on your income tax</td>
<td>none</td>
<td>$60</td>
<td>$20</td>
</tr>
<tr>
<td>Income lost to the region ($ million)</td>
<td>none</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Jobs lost in region</td>
<td>none</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>Number of endangered species lost to region</td>
<td>18</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Reduction in population size of non-threatened species</td>
<td>80%</td>
<td>75%</td>
<td>45%</td>
</tr>
<tr>
<td>Loss in area of unique ecosystems</td>
<td>40%</td>
<td>15%</td>
<td>28%</td>
</tr>
</tbody>
</table>
This shows that respondents were presented with a status quo option (Option A) and two options for increased preservation (Options B and C). While the same status quo option was included in all choice sets for all respondents, the attributes of options B and C varied according to the experimental design.

The description for Option A, together with the background material presented, made it clear that some standards of preservation were already being met under the current tree clearing guidelines.

The final version of the questionnaire was administered in the form of a B5 booklet with a colour insert containing photos and an attribute glossary, and included a number of background, attitude and respondent characteristic questions as well as the series of eight choices. The questionnaires were administered in a door knock drop-off/pick-up format to 480 Brisbane households in November 1997.

The most accurate models of choice were generated using a nested logit model, where respondents were initially seen to choose between ‘doing something’ and ‘doing nothing’. The status quo option (Option A) was the ‘do nothing’ alternative. If the ‘doing something’ branch of the ‘nest’ was chosen, respondents could choose between the two improvement options (B and C). Some of the attitudes of respondents were found to be very significant indicators of whether they chose to support a ‘do something’ or ‘do nothing’ alternative. Once respondents had made the choice to ‘do something’, their subsequent choice between Options B and C was based on the levels of the six attributes used to describe the options.

The variables describing respondents’ attitudes are defined in Table 4, and the results of the nested logit analysis are presented in Table 5. The “branch choice equations” indicate the relative utility of ‘doing something’ versus ‘doing nothing’. Respondents with a pro-environment orientation (envatt=1) were more likely to choose one of the environmental improvement options than respondents with a pro-development perspective (envatt=0). Those who report being confused by the choices presented in the questionnaire (confuse=1) were more likely to choose the status quo, as are those who have problems with the notion of a tree levy (object=1). The results suggest that despite the best efforts to minimise confusion and protest through questionnaire design, a significant degree of confusion and protest remained. This appears to have generated a degree of bias toward the status-quo, potentially similar to that reported by Adamowicz et al (1988).

The choice between Options B and C is modelled as shown under the heading ‘Utility functions’ in Table 5. The attributes in the utility function are all signed as expected and are highly significant. The negative coefficient on \( \text{Levy} \) indicates that respondents are less likely to choose options with increasing payment amounts. The negative signs on the other coefficients mean that increasing amounts of the other attributes (eg more job losses, more endangered species losses) are negatively correlated with choice\(^8\).

### Table 4. Non-Attribute Variable Definitions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>Alternative-specific constant taking on a value of 1 for options 2 and 3 in the choice sets, and 0 for the base option.</td>
</tr>
<tr>
<td>const1</td>
<td>Alternative-specific constant taking on a value of 1 for option 2 in the choice sets, and 0 for the base option.</td>
</tr>
<tr>
<td>envatt</td>
<td>Dummy variable taking on a value of 1 for respondents indicating that, over the years, when they have heard about proposed conflicts between development and the environment, they have tended to “More frequently favour preservation of the environment”. 0 otherwise.</td>
</tr>
<tr>
<td>confuse</td>
<td>Five point likert scale response indicating extent of disagreement with the statement “I found questions 3 to 10 [the choice set questions] confusing”.</td>
</tr>
<tr>
<td>object</td>
<td>Five point likert scale response indicating extent of disagreement with the statement “A tree levy is a good idea”.</td>
</tr>
</tbody>
</table>

\(^8\) These results are explained in some detail in Blamey et al (1998).
Table 5. Nested Logit Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>coeff.</th>
<th>s. error</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Utility Functions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>const</td>
<td>0.1644</td>
<td>0.0663</td>
</tr>
<tr>
<td>levy on income tax</td>
<td>-0.0107*</td>
<td>0.0011</td>
</tr>
<tr>
<td>Jobs</td>
<td>-0.0324*</td>
<td>0.0053</td>
</tr>
<tr>
<td>Regional income</td>
<td>-0.0597*</td>
<td>0.0138</td>
</tr>
<tr>
<td>number of endangered species</td>
<td>-0.1214*</td>
<td>0.0111</td>
</tr>
<tr>
<td>Population of non-threatened species</td>
<td>-0.0180*</td>
<td>0.0029</td>
</tr>
<tr>
<td>area of unique ecosystems</td>
<td>-0.0392*</td>
<td>0.0065</td>
</tr>
<tr>
<td><strong>Branch Choice Equations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>const</td>
<td>-1.9738*</td>
<td>0.5913</td>
</tr>
<tr>
<td>const*envatt</td>
<td>1.1344*</td>
<td>0.1105</td>
</tr>
<tr>
<td>const*object</td>
<td>-0.5750*</td>
<td>0.0501</td>
</tr>
<tr>
<td>const*confuse</td>
<td>-0.1550*</td>
<td>0.0477</td>
</tr>
<tr>
<td><strong>Inclusive Value Parameters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>do something</td>
<td>0.1904#</td>
<td>0.0795</td>
</tr>
<tr>
<td>do nothing</td>
<td>1.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td><strong>Model Statistics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n (choice sets)</td>
<td>5769</td>
<td>5784</td>
</tr>
<tr>
<td>Log L</td>
<td>-1685.564</td>
<td>-1547.388</td>
</tr>
<tr>
<td>adj rho-square (%)</td>
<td>20.1</td>
<td>26.7</td>
</tr>
</tbody>
</table>

NB: + denotes significance at the 10 per cent significance level, # denotes significance at the 5 per cent level, * denotes significance at the 1 per cent level.

The application enabled the estimation of ‘implicit prices’ for the different attributes. An implicit price is the amount a representative respondent is willing to pay to see a one unit improvement in the attribute under consideration. These are calculated on a ‘ceteris paribus’ basis (everything else being held constant), and are reported in Table 6. The implicit prices for all the attributes are positive, implying that Brisbane residents have positive values for increases in each attribute.

For the environmental attributes, the willingness to pay (WTP) to maintain endangered species in the region is $11.39 per species, the WTP to avoid each 1% loss in non-threatened species is $1.69, and the WTP to avoid each 1% loss in the area of unique ecosystems is $3.68. For the social attributes, the WTP for job preservation is $3.04 per job, while the WTP to maintain each million dollars of regional income is $5.60. These part-worth estimates may be multiplied by the number of households within Brisbane (approximately 300,000) to give an idea of the total value of a change in each of these items.9

Table 6. Part-worths for the different attributes.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Part-worth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jobs</td>
<td>3.04</td>
</tr>
<tr>
<td>Regional Income</td>
<td>5.60</td>
</tr>
<tr>
<td>Endangered Species</td>
<td>11.39</td>
</tr>
<tr>
<td>Population of non-Threatened species</td>
<td>1.69</td>
</tr>
<tr>
<td>Unique Ecosystems</td>
<td>3.68</td>
</tr>
</tbody>
</table>

9 Estimates of value held by interstate and other Queensland communities have not yet been assessed. Assuming that average household size is 2.8 people, there are an additional 500,000 households in the south-east corner of Queensland (encompassing Gold and Sunshine Coasts and Brisbane surrounds, and a further 400,000 households across the rest of Queensland.
These results illustrate the type of information that can be generated for resource managers and policy makers from a CM application. The part-worth values show that there is significant support for preserving both social and environmental factors. In relation to the social factors, there appears to be more support for preserving a single job rather than $1 million in regional income.

In a similar way, it appears that support for endangered species and unique ecosystems is substantially higher than support for non-threatened species at an individual site level. If proposals to clear at specific sites have direct impacts on endangered species or unique ecosystems, then the protection values are likely to be high. However, the protection values for non-threatened species are also not trivial, being approximately $1.69 for each 1% loss of vegetation across the Desert Uplands.

A further way of using the CM results is through the comparison of estimates for changes in community well-being for different scenarios of tree clearing restrictions. Because there is substantial support for protection options (reflected in the parameters for the nested logit model in Table 5), the part-worths cannot simply be added together to find values for different options. Instead, values for a particular scenario (X regional income, Y jobs, Z endangered species, etc) have to be calculated, and then compared to values for other scenarios.

This exercise has been performed for a number of strategies. The results are reported in Table 7. For example, the value of a policy to restrict tree clearing that would give rise to a scenario described by option A gives improvements in well-being of approximately $87 per household in Brisbane. This scenario may be unrealistic because of the possibility of losses in jobs and regional income. When some of these social costs are added in (as in option B), the willingness to pay estimate for the environmental protection falls to $76 per household.

If the exercise is repeated for greater levels of environmental protection, then similar results occur. Option C involves further protection of the environment over current measures (eg 10 species will be protected from being lost to the region, a further 45% of non-threatened species eg trees will be preserved, and an additional 20% of unique ecosystems will be preserved). The willingness to pay for this scenario is estimated at $117 per household. When some offsetting social costs are added to the scenario (as in Option D), the willingness to pay estimate falls to $88 per household.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Change from current trends</th>
<th>Change from current trends</th>
<th>Change from current trends</th>
<th>Change from current trends</th>
<th>Change from current trends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jobs lost in the region</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Regional income lost</td>
<td>0</td>
<td>$5 million</td>
<td>0</td>
<td>$10 million</td>
<td>0</td>
</tr>
<tr>
<td>Additional species preserved in area</td>
<td>2</td>
<td>2</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Additional % of non-threatened species preserved</td>
<td>30%</td>
<td>30%</td>
<td>45%</td>
<td>45%</td>
<td>30%</td>
</tr>
<tr>
<td>Additional area of unique ecosystems preserved</td>
<td>10%</td>
<td>10%</td>
<td>20%</td>
<td>20%</td>
<td>10%</td>
</tr>
<tr>
<td>Willingness to pay</td>
<td>$87</td>
<td>$76</td>
<td>$117</td>
<td>$88</td>
<td>$83</td>
</tr>
</tbody>
</table>

These value estimates are not primarily driven by concerns about endangered species. To check if this was the case, Option E was introduced which differs only from option B in terms of there being no change in the number of additional species being preserved in the region. The difference in overall preservation values is only $4 lower.
6 Discussion

Some indications about where the balance between protection and development is appropriate can be gained from the data available. For example, Option B from Table 7 gives an estimate of $76 per household for the protection values attached to perhaps protecting an additional 30% of vegetation on each property\textsuperscript{10}. Across the 300,000 households in Brisbane, the total value for this protection option is approximately $22.8 million\textsuperscript{11}. The opportunity costs of not developing 30% of the Desert Uplands region imply that an additional 2,064,000 hectares are protected. If the opportunity costs are valued at $27.53/ha (the Scanlon and Turner (1995) estimate), the total opportunity cost is $56.7 million, meaning that production values outweigh preservation values held by the Brisbane population.

This protection estimate may not take enough account of social impacts. If the social impacts attached to Option B in Table 7 are increased to 50 job losses and $10 million lost in regional income, the WTP of the Brisbane community for the option falls to $47 per household. This translates to a total value for this option of $14.1 million. If the potential production losses of this option are valued at $12.34 per hectare (the ironbark/wattle option in RCS (1999)), the total opportunity cost is $25.5 million. If the production losses are valued at $28.31/ha hectare (the ironbark/box option in RCS (1999)), the total opportunity cost is higher at $58.4 million\textsuperscript{12}.

Even if all Queensland households had the same willingness to pay for the protection option, the latter production loss of $58.4 million would still be higher than the total implied preservation value of $56.4 million. However, when the values of greenhouse gas emissions from land clearing are also factored in, it appears that many tree clearing options are not in society’s best interest.

These scenarios involve a relatively large increase in native vegetation protection in the Desert Uplands. The same type of exercise can be repeated for smaller increases in protection levels. For example, the controls proposed for tree clearing on freehold land will tend to restrict the overall amount of clearing in the region, but will be particularly focused on ecosystems that are ‘Of Concern’, ‘Vulnerable’, or ‘Endangered’. Because the controls will affect some remaining pockets of high quality land that remain uncleared, potential production losses may be higher than if only eucalypt woodland were affected.

Table 8 below presents the values for profiles that involve only a 10% increase in overall clearing restrictions across the region, but greater impacts on preserving unique ecosystems and endangered species.

\textsuperscript{10} Note that there may be other ways of achieving that profile outcome.
\textsuperscript{11} If similar protection values are held by the other 500,000 households in south-east Queensland, the value of the protection option increases to $60.8 million.
\textsuperscript{12} These opportunity costs are likely to be slightly overstated because they are based on gross margins rather than net profitability. As well, they have been estimated as if the loss in potential production was immediate. In reality, land development is incremental, so that only a proportion of the opportunity costs would be incurred in each of the next 20 to 30 years.
Table 8. Additional profiles used for welfare estimation.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Change from current trends</th>
<th>Change from current trends</th>
<th>Change from current trends</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OPTION F</td>
<td>OPTION G</td>
<td>OPTION H</td>
</tr>
<tr>
<td>Jobs lost in the region</td>
<td>50</td>
<td>50</td>
<td>180</td>
</tr>
<tr>
<td>Regional income Lost</td>
<td>$5 million</td>
<td>$10 million</td>
<td>$10 million</td>
</tr>
<tr>
<td>Additional species preserved in area</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Additional % of non-threatened species preserved</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Additional area of unique ecosystems preserved</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>Willingness to pay</td>
<td>$80</td>
<td>$74.50</td>
<td>$0</td>
</tr>
</tbody>
</table>

It is notable that Option F, which allows some relatively high social impacts from an increase in protection rates of 10%, still has a substantial household willingness to pay estimate of $80. Even if the impact on regional income is doubled to $10 million (as in Option G), the willingness to pay only falls to $74.50. Job losses would need to rise to 180 (Option H) before the willingness to pay of the Brisbane population fell to zero.

If a further 10% of the Desert Uplands was protected from tree clearing, the potential production losses range from $8.5 million (at $12.34/ha for ironbark/wattle country) up to $19.5 million (the $28.31/ha for box/ironbark country). In contrast, the values held by the Brisbane population for preservation options F and G in Table 8 above sum to $24 million and $22.4 million respectively. As well, additional protection values are likely to be held by the other residents of Queensland. This suggests that there is a strong case to be made for an increase in protection levels that will give extra protection to endangered species and unique ecosystems, so long as the social impacts on jobs and regional income are limited.

The results of the CM exercise highlight that the wider community has preservation values for the ‘not of concern’ ecosystem classes, and do not only value endangered species or unique ecosystems. Biodiversity values held by the wider population are non-trivial, even for natural vegetation types that are not threatened or not of concern. There are three broad conclusions that can be drawn from this analysis of community values.

The first is that additional clearing for very marginal production benefits is unlikely to be economic from the viewpoint of the society as a whole once the resultant losses of preservation benefits are factored in. This indicates that there is an argument to restrict clearing activities on the very marginal land types in rangelands areas where there are limited production benefits (few jobs or income consequences). Evidence for this comes from the existing regional leasehold guidelines, where clearing of some vegetation types and in areas of skeletal soils is restricted because of the limited returns available.

The second is that clearing of endangered vegetation or unique ecosystem types is also unlikely to be socially desirable in grazing woodland areas when lost preservation values are factored in. This is partly because protection values are high, and because these ecological communities are a small fraction of the total land mass. Hence, not clearing these would cause only small losses of income and employment. The creation of national parks and nature conservation areas, and the ban on clearing endangered vegetation types on leasehold land provide examples where this tradeoff is already being recognised.
It is unlikely that tree clearing will be socially desirable in these two cases of firstly small potential production gains and secondly where clearing involves endangered vegetation or unique ecosystems. Many choices about tree clearing in the Desert Uplands do not fit within these two classifications. The evidence reviewed earlier indicates that there are some substantial production gains available from tree clearing, and that for much of the Desert Uplands, clearing involves non-threatened species, suggesting that biodiversity preservation values will be limited.

The third conclusion to be drawn then is that outside of the two extremes noted above, the broad range of clearing opportunities will have to be evaluated according to the range of environmental and social consequences. Many policy settings for tree clearing will have a range of environmental and social consequences that may be offsetting, and these will have to be evaluated in each instance to determine the appropriate outcome.

The examples provided earlier suggest that there is a general case for increased protection for vegetation in the Desert Uplands region. At the same time, there may still be many instances where the benefits of tree clearing and further development outweigh any protection losses. There may be a number of ways of improving protection outcomes that meet with society expectations.

One option is for landholders to nominate sections of their land that may be protected under some form of covenant, or set-aside from grazing for rehabilitation purposes. Incentive payments could be made by government or other community groups to encourage this behaviour. Landholders might compete for covenant funds by nominating remnant vegetation stands that would be protected against clearing and the amount of compensation required.

Another option is for landholders to be given access to carbon offset opportunities. Under this scenario, landholders might guarantee to protect areas of vegetation and be able to sell the carbon content of the trees in the form of an offset. It is likely that it will be cheaper to supply carbon offsets in the form of reduced tree clearing in the pastoral sector than through technology changes in the industrial sector (Rossiter and Lamberg 1998). The associated benefit of this proposal is that increased protection of biodiversity would also result.

**7 Conclusions**

In this report, some of the economic consequences of broadscale tree clearing in the Desert Uplands bioregion have been examined. A major emphasis of the report has been on the results of a Choice Modelling study of the protection values that society holds for biodiversity and regional communities.

The evidence from the study indicates that Brisbane households hold substantial protection values for native vegetation in the Desert Uplands. However, incorporating these values into a benefit cost analysis of remnant vegetation options does not automatically make clearing activities socially undesirable. In some cases environmental benefits may be still outweighed by production and social factors. This means that policy makers must search for ways of restricting clearing activities that still allow commercial opportunities to be pursued.

The values that have been reported in this study must be qualified to some extent with the observation that research in this field is very new. It is currently unclear how other communities in Australia value environment protection in areas such as the Desert Uplands, and how values for environment protection in that area compares to, and relates to, values in regions such as the Brigalow and Mulga lands. Further research into these issues will develop a more accurate picture of community values for environment protection.

However, the results provide some indication that the general community does have substantial values for protecting native vegetation communities. The evidence from this study suggests that there are still significant community net benefits to be gained in increasing the protection of vegetated areas, even in relatively uncleared regions such as the Desert Uplands. While the highest protection values are concentrated on endangered species and unique ecosystems, there is also significant value in preserving non-threatened species.
The protection values calculated from this study are very sensitive to social impacts in the form of losses in jobs and regional income. Protection options that limit these impacts will be favoured by the wider community. However, the profiles available from the CM application suggest that consideration of social impacts are unlikely to be substantial enough to negate completely any environmental protection values.

The key focus for the Queensland government and the relevant stakeholders should be on a pastoral industry that has a sustainable resource base but still has the flexibility to pursue new economic opportunities. To achieve this in the context of the tree clearing debate, a range of flexible mechanisms that help to limit clearing activities by giving pastoralists other incentives should be pursued.

There appears to be a strong case for further restricting clearing activities in two particular circumstances. The first is where there are very limited production benefits available. In these cases, the preservation values appear to outweigh substantially the potential production benefits. The second case is where clearing impacts on endangered species or unique ecosystems (or increases the risk that they move to that stage). In this case the preservation values of society appear to dominate any production benefits.

Between these two cases lies a large range of clearing activities that has to be judged on a case by case basis. Generally clearing activities seem to have been conducted with limited regard for longer term indirect impacts or losses in biodiversity, suggesting there is a case for at least slowing clearing rates. Some of the most promising opportunities for changing behaviour appear to be linked to greenhouse gas emissions. The development of carbon offsets for trading to industry might provide important incentives to landholders for vegetation retention.
8. References


Department of Natural Resources (DNR) 1998 *The Desert Uplands*, Land fact sheet L17, Brisbane.

DNR Statewide Landcover and Trees Study (SLATS) (1999), Interim Report, Brisbane.


Previous Research Reports in this Series


