Assessment of the on-farm economic values of remnant native vegetation

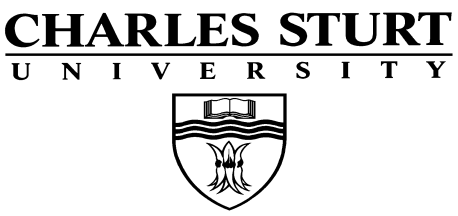
Sandra Walpole, Carla Miles & Michael Lockwood
Johnstone Centre, Charles Sturt University, Albury, Australia

Paper presented at the 43rd Annual AARES Conference and the 6th Annual NZARES Conference
Christchurch Convention Centre, Christchurch, New Zealand
20 - 22 January 1999

Abstract

The widespread clearance of native vegetation has been identified as one of the major environmental issues facing Australia. Impacts of clearing include dryland salinity, weed invasion, soil erosion, soil structural decline and the loss of species. Development of effective polices to deal with remnant native vegetation (RNV) decline has been hampered by lack of detailed data on the economic benefits and costs of RNV conservation. This study measured the on-farm benefits and costs associated with RNV in the two study areas, the northeast Victorian catchment and the Murray catchment of NSW. Data were collected using landholder surveys. The most important economic benefits from RNV under current management regimes in the Victorian study area were productivity effects associated with prevention of land degradation, firewood production, and for the NSW study area, stock and crop shelter. The most significant cost in both study areas was weed management.

A proposed conservation management scenario that included fencing of the RNV, and limitations on grazing and firewood and post removal would negatively effect most of the survey participants. The differences between the net present value (NPV) of the current management regime maintained over a 40 year period, and the NPV of the proposed scenario were large and negative. For Victorian participants, the marginal effect of the conservation proposal was - $2 million, and for NSW participants -$15 million. In both study areas, the incremental economic costs of the scenario outweighed the incremental economic benefits for at least 89% of participants. This study confirmed that one of the major barriers to protecting RNV is the economic costs associated with conservation management. A large proportion of participants cannot expect a positive return from investing in RNV conservation. Any policy approach to achieve conservation objectives for RNV requires significant financial incentives for landholders to undertake conservation activities.



1. Introduction

The widespread clearance of native vegetation has been identified as one of the major environmental issues facing Australia. Impacts of clearing include dryland salinity, weed invasion, soil erosion, soil structural decline and the loss of species (Nadolny *et al.* 1991, ABS 1992). 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 (Walpole 1996).

Remnant native vegetation (RNV) is the term used in this study to describe those patches of bushland which remain on private property following the widespread clearance of native vegetation. While there are numerous benefits of conserving RNV, there are also significant costs involved with the management of these areas. The goal of this study is to weigh up the market benefits and costs of RNV to private landholders so that this information can be considered in policy development. Currently our knowledge of market and non-market economic values of RNV is minimal. This deficiency is impeding development of rational policies which are both acceptable to landholders and adequately address community demands for the public good benefits afforded by RNV.

Remnant native vegetation can contribute to on-farm productivity through provision of unimproved grazing, timber products and stock shelter. It can impose an opportunity cost if the forested land could otherwise be cleared and used as improved pasture, pine plantation, or some other enterprise. This paper details the results of the work on these on-farm costs and benefits of RNV conservation for two study areas - northeast Victoria and the Murray Catchment Management Area (CMA) in southern NSW (Figure 1). Details of the study areas are given in Lockwood *et al*. (1997a, 1997b).

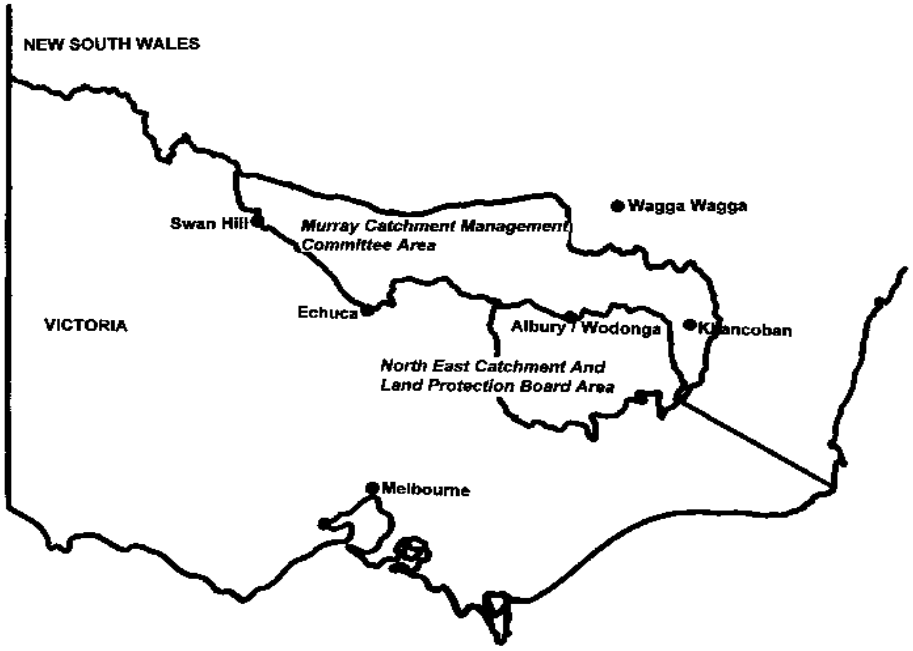
2. Method

2.1 Survey development

Data on the economic benefits and costs associated with RNV in the two study areas were collected using landholder surveys. Early drafts of the survey instrument were refined with the assistance of a focus group of northeast Victorian landholders, members of the steering committee for the wider project, and a pre-test among other northeast Victorian landholders. Details of the process used to develop the surveys are given in Miles (1998).

A focus group of eight landholders from around northeast Victoria were invited to attend a meeting held on the 25th August 1997. The main issues explored in the focus group included: the comprehension of draft questions; the difficulty of the tasks required; the suitability of language; the sufficiency of content for the desired results; and the appropriate method for delivery. Focus group members generally felt that the draft survey was well developed and relevant information was being gathered for the purpose of the study. Minor changes to wording resulted and many practical comments were used to alter the structure and comprehensibility of the survey. In addition, general issues on RNV conservation were also raised.

Figure 1 Study areas



Benefits of RNV were easily identified by focus group members. However, they all commented that quantifying these benefits was an extremely difficult task. As a result, the final survey hence provided participants with the option to comment on benefits and to quantify these only where possible.

The steering committee overseeing the research project also had input into the survey format and content. The major issues related to the clarification of the definition of RNV and the purpose of the survey - for example: 'it must be clear that the survey isn't being done for regulations, but rather incentives'. Other changes included justification for demographic information and adding a question regarding landholder perceptions of RNV quality.

A pre-test of the survey instrument was conducted using 12 landholders within northeast Victoria. The purpose of the pre-test was to ensure comprehension and clarity of the survey instrument, so that any necessary changes could be made before final implementation. It provided an opportunity to note: length of interview; whether there were differences in conducting the survey in person or on the telephone; evidence of the participant finding any questions difficult or misleading; and any difficulties experienced by the interviewer in delivering the survey questions. There were no complications with the delivery or comprehension of questions. There were no major changes required of the survey format and content, hence interviews completed in the pre-test were included in the final data set.

2.2 Survey content

The survey instrument was developed for both the purpose of deriving information relating to the on-farm benefits and costs for this study, as well as information relating to land values. The survey was divided into three sections. Parts A and B concerned on-farm costs and benefits, and Part C addressed the impact RNV may have on property values. Results from Part C of the survey are reported in (Walpole *et al*. 1998).

Part A included seven questions related to general background information about participants' property and remnants. Questions relating to RNV included the size, number of individual patches, and quality of RNV (Table 1).

Table 1. Quality descriptions of RNV

Quality rating	*Description/definition*
Degraded	Regular grazing, no tree hollows, no fallen timber, no overstorey regeneration, much tree dieback present, no understorey shrubs.
Modified	Lightly grazed, a few tree hollows present, a little fallen timber present, a little overstorey regeneration present, some tree dieback present, some understorey shrubs.
Intact	Not grazed/rarely grazed, some/many tree hollows present, some/a lot of fallen timber present, some/a lot of overstorey regeneration present, none/little tree dieback present, some/much understorey shrubs.

Part B was divided into three sub-sections: (i) on-farm costs and benefits of RNV management; (ii) incentives for RNV management; and (iii) information about the participants and their households. The following brief descriptions indicate the purpose of some of the major questions in Part B.

On-farm costs and benefits of RNV management

Q. 8 asked participants if any areas of RNV were fenced off on their property, and if so the area fenced and cost of construction. This information was required to determine whether the fencing component of the proposed management scenarios would or would not be a cost to the landholder. Q. 9 asked how many stock grazed in the remnants and for what period of time (weeks/year). This information was essential to calculate the benefit derived from stock shelter and shade and also the economic effect of restricting stock access to the RNV. Q. 10 and Q. 11 asked participants to describe how their remnants were used (apart from grazing). This enabled an analysis of the dominant uses of RNV across the study area, and introduced the likely benefits associated with RNV.

Q. 12 listed possible benefits of RNV. Participants were asked to imagine the hypothetical situation where their remnant/s were cleared and sold, and as a result the possible benefits lost. This hypothetical approach was taken because of the difficulty for participants in estimating the benefits of RNV, having never been without them. Participants were asked to indicate the benefits (or disbenefits) of having RNV on their

property, and to quantify these in terms of benefits per year, for example an increase in stocking rate owing to shelter and shade. However, participants were reassured that this was a difficult task, and that comments would be satisfactory where figures could not be provided. Those responses which were quantifiable, were converted into dollar values.

Q. 13 asked participants whether there was any chance that they would clear their RNV in the next ten years. Responses to this question enabled determination of any forgone benefits (opportunity costs) which could result from the conservation of RNV. The area of proposed clearing and the likelihood of clearing for different purposes were also ascertained. Q. 14 and Q. 15 asked if any areas of RNV had been cleared in the last ten years, and if so, for what purpose.

Q. 16 related to direct costs involved with the ongoing management of RNV. These included costs such as fencing (expenditure on materials and labour, the latter taking into account landholders' time) and pest plant/animal control.

Incentives for RNV management

Q. 17 - Q. 19 asked participants whether they wanted incentives to conserve their RNV and if so, what sort of incentives they would prefer. Q. 20 asked for suggestions of other incentives, not already listed in Q. 19. Participants were then asked to indicate whether they would be prepared to undertake a number of management options provided incentives were available, including: fencing off their RNV (if so for what purpose: strictly no use, or grazing permitted), ceasing clearing, establishing and implementing a management plan, and attending information workshops.

Information about the participants and their household

Demographic questions asked were age; level of education; income; length of time on the property; length of time in farming; membership of rural organisations/voluntary groups; and intentions for future management.

2.3 Selection of participants

Participants were selected on the basis of having any areas of RNV on their property greater than one hectare in size. This threshold of one hectare was adopted both because smaller areas were difficult to locate using available satellite imagery, and it is unlikely that smaller areas would support significant nature conservation and production values in the long-term. The population of participants with more than 1ha of RNV were identified based on the RNV distribution maps (Lockwood *et al.* 1997a, 1997b), and shire property maps.

To obtain a cross-section of properties, participants were purposively selected from throughout the geographic ranges of each study area. A superior method would have been to first stratify the study areas based on various key attributes, and to ensure that surveys were conducted in each of the major strata. Unfortunately, information required to generate the strata were available too late for them to be used to assist with the sampling design. However, as described below, they were used after completion of the surveys to both assess the adequacy of the sampling, and to extrapolate economic values from the individual property level up to the entire area of RNV present in the respective study areas.

The study areas were stratified according to broad vegetation type (BVT), landform, climate and land use (Table 2). Each stratum was given a code that indicated the corresponding BVT, landform, climate and land use. For example, the code 7**G6G** indicates the BVT as dry foothill, the landform as gentle to moderate hill, climate as >700 mm temperate, and land use as sheep or cattle grazing.

Table 2. Characteristics used to define strata

Land characteristic	*Code*	*Description*
Broad Vegetation Type	1	Mallee
	2	Plains grassy woodland
	3	Riverine grassy woodland
	4	Box ironbark
	5	Inland slopes woodland
	6	Valley grassy forest
	7	Dry foothill forest
	8	Moist foothill forest
	9	Subalpine Woodland
Landform	F	Present floodplain
	P	Plain above flood level
	G	Gentle to moderate hill
	S	Steep mountain and hill
Climate	1	300-400 mm
	2	400-500 mm
	3	500-600 mm
	4	600-700 mm
	5	>700 mm; temperate
	6	>700 mm; montane
Land use	G	Grazing (sheep or cattle)
	E	Extensive cropping and crop pasture
	I	Intensive cropping
	H	Horticulture

For the Victorian study area, the combination of all four land characteristics resulted in a total of 55 strata that contained RNV. Given available resources, it would not have been possible to survey all these strata, and those containing 500 ha or less RNV would have been a suitable cut-off point. Of the 55 strata, 26 had less than 100 ha of RNV, and a further 13 had less than 500 ha of RNV. In Victoria, four strata with RNV areas between 1117 and 1606 ha were not surveyed. One stratum with an RNV area less than 500 ha was surveyed. The proportions of surveys in each stratum did not match the proportions of RNV. However, despite these limitations, a reasonable coverage of interviews across the strata was obtained.

For the NSW study area, the combination of all four land characteristics resulted in a total of 79 strata that contained RNV. Again, limiting the surveys to strata containing 500 ha or more RNV would have been a suitable design. Of the 79 strata, 26 had less than less than 100 ha of RNV, and a further 16 had less than 500 ha of RNV. Four strata with more than 500 ha RNV were not surveyed. In one case, surveys were done for the

corresponding stratum in the NSW study area. Four strata with less than 500 ha RNV were surveyed. As for northeast Victoria, the proportions of surveys in each stratum did not match the proportions of RNV. However, despite these limitations, a useful coverage of interviews across the strata was obtained.

2.4 Interview procedure

Participants were given the option of undertaking the interview either in person (face-to-face) or over the telephone. This provided participants with a choice most convenient for them, allowing a greater number of interviews to be made, while reducing costs involved in carrying out the total number of interviews in person (reduced travel costs). A hard copy questionnaire and scripts for telephone conversations were developed to standardise the interviews.

The mixed strategy of face-to-face and telephone interviews had the potential to result in varied responses between the two different methods. The likelihood of such differences were investigated following the pre-test of the survey. There were no differences at this stage, so a mixed approach continued for the remainder of the interviews. Chi-square tests were done on several key questions to test for any significant differences between the telephone and face-to-face responses. Questions tested were the likelihood of clearing RNV in the future, and the NPV values for the various scenarios (Section 3.6). In all cases, there were no significant differences between responses gathered using the two methods.

Owners of properties containing RNV were identified using the RNV maps (Lockwood *et al*. 1997a, 1997b) and cadastral maps. Potential participants were contacted using telephone numbers identified from the Telstra white pages. The initial telephone call introduced the project and asked the participant whether they had any RNV blocks greater than one hectare. This was done to confirm the presence of RNV. If landholders responded positively to this question, they were then asked whether they would be interested in participating in the survey. If the landholder was interested, a letter of introduction explaining the purpose of the survey, and a summary of the survey questions were sent. In particular, questions with five or ten point scales were sent in the summary so that participants understood the context of the questions and could view these if the interview was on the telephone. This approach addressed concerns of Beed & Stimson (1985) who found evidence that people tend to handle five-point scales differently on the telephone than in a face-to-face interview. A consent form to participate in the survey was also sent to landholders as required by the University Committee for Ethics in Human Research.

To confirm that landholders were interested in conducting the survey, they were telephoned again, following the arrival of the information in the mail. If they agreed to undertake the interview, appointments were organised to conduct the survey, either on the telephone or in person. In Victorian almost half of the surveys were completed in person and just over half were completed by telephone. In NSW, the majority of surveys were conducted over by telephone (Table 3). Many of the NSW landholders

Table 3. Percentage of surveys completed by face-to-face and by telephone

Interview method	*Victoria*	*NSW*
	% of surveys completed	*% of surveys completed*

Face-to-face	46	14
Telephone	54	86

were planting crops during the survey period, which made daytime face-to-face interviews difficult. In addition, most NSW participants were aware that the interviewers would, in many cases, have had to travel a considerable distance to conduct the interview. Interviews were conducted both during the day and evening. Many of the telephone interviews were conducted in the evening, as it was generally more convenient for landholders. There were four interviewers responsible for conducting the interviews. Consistency was maintained, both in the initial stages of contacting landholders and during the interview, by scripts which were read on both occasions.

During the interview, each question was read from the questionnaire by the interviewer to the interviewee. All responses were recorded by the interviewer as the interview progressed. Some of the closed-ended and partially closed-ended questions involved reading the response options to the participant while others required the participant to describe their answer. In the latter case, likely answers were pre-coded for ease of recording, but were not read to the participant. Most of the questions were partially closed-ended, so that any responses that were not predetermined in the development phase of the survey could be recorded under '*other (please specify)* _____', and categorised after the completion of surveys.

3. Results

Generally interviews took between 30-45 minutes to complete, depending on the number of questions participants answered. In the Victorian sample, a total of 130 landholders were contacted to request their involvement in the survey. Thirty landholders refused to participate in the survey, 21 of these refusals being at the time of the initial telephone call, and nine on the follow up telephone call. Reasons for refusal were usually that they were not interested or did not have time. It is also possible that landholders may have declined to participate since they knew the survey was about RNV and feared that their involvement may lead to restrictions on future management options. A total of 100 participants were interviewed between November 1997 and February 1998 - a response rate of 77%.

In the NSW sample, a total of 251 landholders were contacted to request their involvement in the survey. The refusal rate was much higher than Victoria, with 129 landholders not wishing to participate in the survey, 70 of these refusals being at the time of the initial telephone call, and 59 on the follow up telephone call. As with the Victorian sample, reasons for refusal were usually that they were not interested or did not have time. There also appeared to be a greater tendency for NSW landholders to fear that their involvement may lead to restrictions on future management options. A total of 122 participants were interviewed between February 1998 and June 1998 - a response rate of 49%.

3.1 Profile of participants

Information about the participants and their households was requested in order to develop a profile of the participants in the study area, and to compare the sample against

the Australian Bureau of Statistics (ABS) records for the study areas. The average demographic characteristics of participants, together with the equivalent data for the populations of the two study areas, are given in Table 4.

Table 4. Demographic characteristics

	Victorian participants	*Ovens Murray SD*[2]	*NSW participants*	*Upper and Central Murray SSDs*[3]
Sex (% male/female farm managers)[1]	75/25	70/30[4]	82/18	71/29[4]
Average age (years)	48.1	45.5[5]	49.1	48.7[5]
Average education (years)	12.1	12.4[5]	12.1	12.0[5]
Average before tax gross income ($)	64,195	35,073[5]	102,501	32,211[5]
Percentage of on-farm income	49%	-	82%	-
Average time farming (years)	22	-	30	-

[1]Surveys answered by male/female partners were counted towards both the male and female percentages

[2]The Ovens Murray Statistical Division closely matches the boundaries of the northeast Victoria study area

[3]The combined Upper and Central Murray Statistical Subdivisions encompass most of the NSW study area

[4]Data obtained from CLIB91 (1994)

[5]Data obtained from CLIB96 (1997)

In Victoria, the demographic characteristics of participants closely match those of the population, with the exception of household income. The average household gross income (before taxes) of participants, in the 1996/1997 financial year, was $64,195 for Victorian participants, compared with a population average in 1990/91 of $35,073. This is to be expected, given that the population includes wage and salary earners as well as self employed people. Gross income of self employed people, including farmers and graziers, would be considerably higher than average, given that they also have to cover the running costs of their businesses. On average, net income for landholders may well be less than that of wage and salary earners.

The difference in average income is even more marked for the NSW study area. This probably reflects the greater reliance of NSW participants on income from their properties. There is also some bias in the NSW sample towards male farm managers.

On average, just over half of the household income for the Victorian sample was derived from off-farm activities. Twenty-nine per cent of the Victorian participants relied totally on on-farm income, and 14% of the participants relied totally on off-farm income. In contrast, a much higher proportion of NSW participants' income (82%) was derived from the properties they manage. In Victoria, there was a strong positive correlation between the size of the property and the proportion of on-farm income (Spearman's rank correlation = 0.71, $p < 0.001$). A weaker, but significant positive relationship was also found for the NSW sample (Spearman's rank correlation = 0.25, $p = 0.012$).

Participants were questioned about their membership in rural organisations and voluntary groups (Table 5). Most participants were members of local fire services, Landcare and farmer organisations. The higher membership of farmer organisations among NSW participants probably reflects the relative importance of the farming enterprise as a source of income compared with the Victorian sample.

Table 5. Membership of rural organisations

	Victoria (% of participants[1])	*NSW (% of participants[1])*
Local Fire Service	72	89
Landcare	55	47
Farmers Federation or other farmer organisation	51	94
Greening Australia or other conservation organisation	5	12

[1]More than one alternative could be selected by each participant

3.2 Profile of properties

In northeast Victoria, a total of 26,058 ha of land was being managed by the participants, of which 6,659 ha (25%) was RNV. The average size of each property surveyed was 260 ha, with an average RNV area of 66 ha on individual properties (ranging from one hectare to 810 ha). The average number of RNV patches greater than or equal to one hectare on individual properties was 2.4. The highest number of patches recorded for one property was ten. Participants were also asked to indicate the size of their largest patch of RNV. On average this was 45.5 ha, almost three quarters (68%) of the total area of RNV on each property. When asked to rate the quality of RNV, the majority of participants indicated that their remnants were either modified (55%) or intact (40%). These findings are consistent with the inventory of RNV in northeast Victoria undertaken by Lockwood *et al.* (1997a).

In the Murray catchment, a total of 195,571 ha of land was being managed by the participants, of which 18,542 ha (9%) was RNV. The average size of each property surveyed was 1603 ha, with the average RNV area of 154 ha (ranging from one hectare to 2000 ha). There were, on average, 6.2 RNV patches greater than or equal to one hectare on each property. The size of the largest patch of RNV was on average 91.5 ha, or 60% of the total area of RNV on each property. When asked to rate the quality of RNV, the majority of participants indicated that their remnants were either modified (60%) or intact (19%), but a higher proportion of remnants were considered degraded (21%) compared with the Victorian study area (5%). This is a higher proportion of degraded RNV than identified in Lockwood *et al*. (1997b), where surveys of 203 RNV blocks found 10% to be of low quality.

Questions regarding farming enterprises were recorded in a pre-coded answer format by the interviewer. However, the question was open-ended, in that participants simply described their main farming enterprise without seeing the predetermined answers. Responses are summarised in Table 6. The most common farming enterprise undertaken on Victorian properties was the grazing of beef cattle, followed by the

grazing of sheep for wool, and dairying. In the NSW study area, the most common enterprise was cropping, followed by cattle grazing, sheep for wool and sheep for mutton.

Table 6. Main farming enterprises undertaken by participants

Enterprise	*Victoria (% of participants[1])*	*NSW (% of participants[1])*
Cattle	67	65
Sheep (wool)	18	60
Dairying	11	4
No farming enterprise	7	1
Sheep (mutton)	6	43
Horticulture	6	1
Tourism	5	0
Goats	3	1
Hobby farm	3	0
Cropping	2	69
Sawmill	2	1
Farm forestry	1	1
Fish farm	1	0
Deer	1	0
Irrigation	0	25
Pigs	0	1
Eucalypt oil	0	1

[1]More than one alternative could be selected by each participant

3.3 Uses of RNV

Participants were asked to describe how they used their remnants as part of their farming practices (Table 7). This question was open-ended, although likely responses were pre-coded on the questionnaire. For the Victorian participants, the major use of RNV was household firewood, followed by stock shelter and shade, domestic grazing and fence posts. A similar use pattern was evident in NSW, with fence posts being less important, while honey production and commercial firewood extraction were more significant. The 'other' category comprised a number of different responses such as protecting water quality; regeneration; education; furniture; windbreak; mulch; foliage; and a dump for dead cattle.

Table 7. Uses of RNV

Use of RNV	*Victoria (% of participants[1])*	*NSW (% of participants[1])*
Household firewood extraction	85	62
Stock shelter and shade	73	84
Grazing	71	75
Fence posts	49	21
Honey production	22	30

Timber extraction	16	9
Seed collection	15	13
Other	7	12
Commercial firewood extraction	3	10

[1]More than one alternative could be selected by each participant

3.4 Costs of RNV

Direct costs

Direct costs are the time and money specifically spent on RNV management. Table 8 indicates the average annual amount spent on the ongoing management of RNV per property taking into account landholders' labour costs which were valued at $15 per hour. The total costs for all participants as well as the average costs per hectare of RNV are also provided. On average, participants were spending an annual amount of $3,098 in Victoria and $2,400 in NSW on the direct management of their remnants. Weed control was the highest cost associated with the ongoing management of the RNV in both Victoria and NSW. Thirty per cent of Victorian and 44% of NSW participants had some RNV fenced off, with an average of $582 per year spent on maintaining fencing in Victoria and $426 in NSW. NSW participants spent more money on pest animal management than Victorian participants.

Table 8. Direct management costs associated with RNV

Management		*Average $/year for each property*			*Total $/year for all properties*	*$/ha of RNV*
		Materials	*Labour*	*Total*		
Weed control	Victoria	831	988	1,818	181,790	27
	NSW	577	514	1086	132,500	7
Fencing	Victoria	222	360	582	58,180	9
	NSW	253	175	426	51,915	3
Pest control	Victoria	172	354	526	52,619	8
	NSW	237	366	600	73,193	4
Other[1]	Victoria	37	136	172	17,225	3
	NSW	124	166	289	35,215	2

[1]Burning, maintaining access tracks and firebreaks, removal of fallen timber, and erosion control

Past clearing and opportunity costs

Twenty one per cent of participants in Victoria and 19% in NSW indicated that they had cleared areas of RNV in the last ten years. On average 22 ha had been cleared by these Victorian participants, and 143 ha by the NSW participants. Reasons for clearing are indicated in Table 9. Pasture establishment was the most common reason in both study areas, but in NSW cropping and rice production were also significant.

Table 9. Reasons for RNV clearing

Reason for clearing	*Victoria (% of participants[1])*	*NSW (% of participants[1])*
Pasture	72	48
Other (mostly access tracks and fence lines)	38	9
Pine plantation	5	13
Native hardwood plantation	5	4
Cropping	-	39
Rice	-	26

[1]More than one alternative could be selected by each participant

Thirty four per cent of Victorian participants said they would consider clearing areas of RNV in the next ten years, compared with 11% in NSW. This difference may reflect the relatively high profile of the now repealed State Environment Protection Policy 46 and the new *Native Vegetation Conservation Act* 1997 in NSW, compared with the corresponding Victorian legislation and regulations. The total potential area of RNV to be cleared in Victoria was 568 ha, compared with 842 ha in NSW. The proposed clearing would reduce the total area of RNV on Victorian participants' properties by 9%, and on NSW properties by 5%. Participants were asked to indicate on a scale from one (very unlikely) to five (very likely), the likelihood of clearing for different land uses (Table 10). Pasture development was the most popular reason for Victorians wanting to clear, although the likelihood of clearing for any of the listed reasons was not strong, with most means below two. Establishment of hardwood plantations was the most likely reason for NSW participants to want to clear RNV.

Table 10. Mean likelihood of clearing RNV for alternative land uses *from one (very unlikely) to five (very likely)*

Land Use	*Victorian participants (mean value)*	*NSW participants (mean value)*
Pasture	3.38	2.38
Other[1]	2.00	1.62
Native hardwood plantation	1.97	2.46
Grape vines	1.41	1.00
Pine plantation	1.24	1.69
Cropping	1.21	2.00
Rice	-	1.92

[1]Olives, chestnuts, timber, access tracks, fences

Participants who had cleared in the past were significantly more likely to clear in the future, both in NSW and Victoria ($p < 0.02$). In both study areas there was a significant

difference in the size of properties between participants who were considering clearing and those who were not ($p < 0.05$), with those having larger properties more likely to clear. There was also a significant difference in the area of RNV on properties between participants who were considering clearing and those who were not ($p < 0.02$), again with owners of properties containing larger areas of RNV more likely to clear.

The likelihood of clearing was not dependent on whether participants were members of Landcare. However, for Victorian participants there was a significant difference in the number of participants who had already fenced areas of RNV between Landcare and non-Landcare members ($p < 0.0001$). This difference was not evident for the NSW participants.

The opportunity costs for participants who suggested they might clear in the next ten years were calculated by obtaining the net present values (NPVs) for alternative land uses and multiplying these figures by the area (ha) to be cleared, and the probability of clearing for the specified purpose. The probability of clearing for specified purposes was obtained by converting the likelihood scales of one to five, to a probability between 0.0 (very unlikely) to 0.8 (very likely).

If participants indicated possible intentions to clear for one alternative land use, the probability was the appropriate figure between 0.0 and 0.8. For example, Victorian participant no. 48 indicated that his/her intentions to clear for pasture development were very likely, thus the opportunity cost would be calculated as follows: $\$1,572 \times 20.25 \times 0.8$, where \$1,572 is the NPV for pasture, 20.25 is the area (ha) to be cleared, and 0.8 is the likelihood. If the participant indicated intentions to clear for several alternative land use practices the probability was calculated as indicated in the following example. Victorian participant no. 40 indicated that he/she would consider clearing for three different purposes - pasture (probability 0.6), grapes (0.4) and hardwood (0.4). The land use with the highest likelihood was calculated as in the previous example. However, the probability of undertaking the second land use was calculated by multiplying the residual probability of undertaking pasture development (ie. $1 - 0.6$) by the second likelihood, 0.4. Hence the net likelihood for grapes is $(1 - 0.6) \times 0.4 = 0.16$. The same procedure is repeated for the third land use option, to give $(1 - 0.6 - 0.16) \times 0.4 = 0.096$. However, since the likelihood of both grapes and hardwood is actually the same, the average of these two probabilities was used (0.128). Therefore the likelihood of clearing for any purpose was $0.6 + 0.128 + 0.128 = 0.856$.

The NPV estimates for the returns from alternative land uses were gathered from relevant research publications and contacts (Table 11). The assumptions underlying these estimates varied according to the life of the projects; the discount rates used; and the regions in which the studies were conducted. In some cases, the raw data were adjusted to obtain a standard measurement of NPV for all alternative land uses. For example, NPVs for projects with shorter time frames than others were recalculated based on the time frame of the longest project, which was 40 years for pines and native hardwood establishment. A seven per cent discount rate was used in the calculation of all NPVs. Results from the opportunity cost calculations are given in Section 3.6.

Table 11. Basis for calculation of opportunity costs

Alternative use	*Derivation of NPV*	*Reference*

Pines NPV/ha = $1,129	NPV based on radiata pine, 40 year rotation, (revenue from timber $2,746 – costs $1,617 + agricultural loss of $656). Agricultural loss was included because the calculations in Kellas (1993) were based on costs and benefits for an open paddock rather than RNV. High rainfall areas (>600 mm).	Kellas (1993, p. 70)
Hardwood NPV/ha = $735	NPV based on blue gum woodlots, 40 year rotation, (revenue from timber $2,443 – costs $1,708 + agricultural loss of $622). Agricultural loss was included for reasons indicated above. High rainfall areas (>600 mm).	Kellas (1993, p. 71)
Pasture NPV/ha = $1,572	NPV based on perennial pasture for vealer production in the upper northeast catchment areas of Victoria, 40 ha paddock. Fourteen year rotations repeated until the 40th year.	Trapnell (1998)
Grapes NPV/ha = $62,997	NPV based on an economic assessment of establishing a 10 ha vineyard irrigated from a bore. The project was based on 15 years, so to standardise with the rest of the opportunity costs, it was extended to 40 years with the assumption that grape prices will rise incrementally by ten per cent each year.	Trapnell (pers. comm.)
Wheat NPV/ha = $2,506	NPV based on the wheat gross margin in north-east Victoria ($188) over 40 year life span (average yield 3 t/ha @$176/t).	Uebergang & Lavis (1998, pp. 8-9)
Barley NPV/ha = $1,347	NPV based on the barley gross margin in north-east Victoria ($101) over 40 year life span (average yield 2.5 t/ha @$164/t).	Uebergang & Lavis (1998, pp. 10-11)
Oats NPV/ha = $2,466	NPV based on the oats gross margin in north-east Victoria ($185) over 40 year life span (average yield 3 t/ha @$93/t).	Uebergang & Lavis (1998, pp. 12-13)
Lucerne (irrigated) NPV/ha = $3,465	NPV based on the lucerne gross margin in the Murray Valley of Southern NSW ($15 establishment (ie. 1st year, where yield = 8t/ha @$130/t, and $320 maintenance, where yield = 13 t/ha @$130/t) with expected stand life of 6 years over 40 year life span.	Elton (1997, pp. 44-47)
Rice (irrigated) NPV/ha = $11,652	NPV based on the rice (medium grain) gross margin in the Murray Valley of Southern NSW ($874) over 40 year life span (8.75 t/ha @ $195/t).	Elton (1997, p. 34)
Chestnuts NPV/ha = $139,211	NPV based on English walnut data, over 15 years. To extrapolate to 40 years the assumption is that the net cost from year 16-40 remain the same as year 15.	Walpole (1994, p. 13)
Olives NPV/ha = $5,000	NPV based on an economic study into dryland olive growing and oil processing in Southern Australia (500-600 mm). Thirty year period of contract harvesting at possible yields, with sale of fresh fruit to oil processing factory at good prices ($0.48/kg).	Hobman (1995, p.39)

3.5 Benefits of RNV

Benefits were assessed by first asking participants whether they considered that they receive a particular benefit type from their RNV. Major benefit types were presented to participants, and they also had the opportunity to indicate benefits not on the list. The 'other' category was divided into response categories after the surveys were completed. Some participants were unable to comment on whether there were particular benefits or not, simply because they did not know, or the benefit was not applicable to their property. Where possible, participants were also asked to quantify the benefits - for example, tonnes of firewood, number of stock grazing in the RNV for a certain time period, and so on. Table 12 indicates the perceived benefits participants receive from their RNV.

Table 12. Benefits of RNV

Benefit	*Victoria (% of participants[1])*	*NSW (% of participants[1])*
Aesthetics	89	95
Timber for firewood and fencing	86	68
Increased agricultural production	77	73
Recreation	73	54
Habitat for animals which help control pests	69	61
Increased stock production	62	84
Cleaner water	60	49
Nutrient cycling / soil formation	45	42
Other	37	38
Increased crop production	0	25
No benefits	0	0

[1]More than one alternative could be selected by each participant

Of the benefits listed in the survey, aesthetics received the highest number of positive responses in both study areas. Victorian landholders next recognised timber for firewood and fencing, increased agricultural production, recreation, and habitat for invertebrate pest predators. About 60% thought that RNV provided increased stock production and water quality. A dominant response by landholders who did not agree that RNV provided an increase in stock production was that the stock (cattle in particular) preferred to congregate around single trees in open paddocks rather than dense areas of bushland. NSW landholders more strongly recognised the benefits of RNV for stock production. Under half of the participants thought there were nutrient cycling and 'other' benefits.

Although only two per cent of Victorian participants had cropping as their main farming enterprise, seven per cent had some cropping areas. Of these seven per cent of participants, none believed there were any crop production benefits associated with RNV. In contrast, about one third of the NSW participants with cropping as a major part of their enterprise recognised some crop production benefits associated with RNV. There were no participants who thought there were no benefits associated with remnants.

The most common benefit reported under the 'other' category was wildlife habitat. Other perceived benefits included value as a windbreak, contribution to quality of life, the effect RNV has on climate, privacy, barrier to noise, maintaining ecological balance, educational value, nature conservation value, provision of sawlogs and as a seed source.

Because of the difficulty of quantifying many of the benefit types, the economic assessment undertaken in this work included only increased stock production, increased agricultural production arising from mitigation of land degradation, increased crop production, and timber for firewood and fencing. Therefore the estimates of total benefits are conservative. The economic values associated with these four benefits were calculated as follows.

Increased stock production owing to shelter and shade

Two aspects of stock production were assessed:

1. the actual grazing benefits that stock derive from spending time in the remnants; and

2. the increased production arising from:

    - enhanced livestock health, including their ability to shelter in the RNV during extreme weather; and
    - enhanced pasture production.

For Victorian participants, the grazing benefit attributable to the time spent in the remnants was computed using the product of the GMs of stock, the number of stock using the RNV, and the length of time spent in the RNV. The potential marginal benefit from the total farm production takes into account the GM, the number of stock using the RNV, and the increase in stock production. Several NSW landholders gave unrealistic answers that were not picked up at the time by interviewers. These landholders asserted that their stock grazed most of the year in the RNV. This was despite the presence of extensive areas of cleared pasture on their properties. Obviously some mis-communication occurred between the landholder and the interviewer. Given this, the grazing benefit for NSW participants was computed on the basis that stock spent twice as much time in the cleared areas as they did in the RNV.

The GMs used for sheep and cattle were based on commodity prices derived from the Australian Bureau of Agricultural and Resource Economics (ABARE) commodity price forecasts (Uebergang & Lavis 1998). The percentage increase in stock production owing to livestock health and pasture production from shelter and shade was set at 20%. This figure was derived from relevant research and estimates obtained from the survey. Even though participants specified different percentage increases in stock production, a 20% value was applied in all cases to be consistent. This value may over-estimate some of the values reported by participants, since the average percentage increase reported was ten per cent. However, the benefits of shelter to stock have been widely researched and represent figures closer to 20%, although this includes the benefit trees provide to both pasture growth and livestock health. Table 13 lists some examples of such research. Note that much of the research undertaken on the benefits of trees for shelter and shade has related to planted shelterbelts and windbreaks, rather than naturally occurring remnants of bushland. However, the figures indicate the possible

Table 13. Effects of shelterbelts and windbreaks on plant and animal production

Research findings	Region/context	Reference
Benefits of trees on crops		
An increase in wheat and crop yields in sheltered zones estimated to be between 22% and 47%.	Rutherglen, Victoria	Bird *et al.* (1993)
Crop yields from windbreaks increased by 25% - although trees rob the crop for a distance equal to about twice their own height, they shelter a much larger area, extending downwind for at least 15 times their own height.	Overseas (not specified)	Dengate (1983)
An increase in lupin yield by 19-22% was measured when the area of shelterbelt was included in the net yield/ha, and an increase of 27% on the lupin crop area between the windbreaks	Gibson, southwest Western Australia	Richmond (1992)
Increased yields of 25%-45% were observed in sheltered crops of wheat, oats and lupins compared with unsheltered crops, and yield increases of 20%-100% in horticultural crops.	Not specified	Fitzpatrick (1994)
An increased net cereal yield of 15% per annum was attributed to sheltering effects of windbreaks.	USA cereal growing area	Adamson (1988)
Benefits of trees on pasture growth		
A 20-30% higher yield was obtained in protected than in unprotected areas of a farm, with annual benefits of $38 to $66 per ha.	Mainland Australia	Fitzpatrick (1994)
A 20% increase in average annual pasture growth was estimated for protected areas of a farm.	Australia and overseas	Radcliffe (1983)
Gross value of pasture output is at its highest level when the proportion of tree area is at 34%. Note that this figure relates to natural remnants of bushland rather than shelterbelts or windbreaks.	Gunnedah, north-west NSW	Walpole (1999)
Benefits of trees on livestock production		
Over a 5 year trial, a 31% wool production increase and 6 kg (21%) more liveweight was found in sheltered areas compared with sheep without shelter. This equated to an increase of $4 per head if sold in August 1984. The plots sheltered by barriers had 18% more pasture.	Armidale, NSW rainfall 860 mm	Lynch & Donnelly (1980), Bird *et al.* (1984), Dengate (1983), Richmond (1992),
From 10 to 16% more lambs present at marking owing to heat load reduction on ewes at joining and lambing, as well as a faster growth rate and more wool from the lambs over their first 16 months of life.	Northern Queensland	Wakefield (1989)
Availability of shelter resulted in a 50% reduction in lambing losses (average losses without shelter were 36% for twins and 16% for single births). When shelter was provided, the figures dropped to 18% for twins and 8% for single lambs.	South-west Victoria, eastern highlands	Bird (1981), Dengate (1983)
Lambing losses decreased from 20% to 10% of the lambs born alive in sheltered areas, (with wind speed halved by adequate windbreaks), resulting in a 5% increase in the percentage of lambs at the end of lambing.	Kangaroo Island	Fitzpatrick (1994)
If the lifetime of the shelter (& fencing) is taken to be 44-60 years, over a 60 years total wool production will increase by 29% and $42/ha of sheltered pasture, and total dairy production will increase by 30% (20% improved pasture growth, 10% improved milk production), and $150/ha of sheltered pasture.	Victoria	Fitzpatrick (1994)
Winter lamb mortality from birth to 48 hours was greater in an exposed group of single lambs (14%), than a sheltered group (4%). Likewise, mortality rates of twins was 9% in shelter and 28% when exposed.	Western Victoria	Squires (1983)
A 27% increase in survival of single lambs was observed in sheltered areas, but no advantage was evident to twins during periods of rain with temperatures <5°C.	Southern Australia	Alexander *et al.* (1980) cited in Bird *et al.* (1984)
Up to 17% increase in dairy milk production was estimated for sheltered areas.	Not specified	Blore (1994)
On a day of 27°C, unsheltered cows will have 26% less dairy milk production than shaded stock.	Australia	Fitzpatrick (1994)

benefit derived from RNV even though the shelter structure is different. Clearly, benefits and costs of RNV will vary from property to property. The type of benefit will depend on the species of trees providing the benefit, the immediate environment and the intended uses of the farm (Scanlan 1992).

Increased agricultural production owing to land degradation control

This benefit was calculated based on the assumption that the presence of certain proportions of RNV can aid in the mitigation of land degradation, and thus can be beneficial to overall farm output. Walpole (1999) calculated increases in pasture output attributable to combating land degradation given a particular level of RNV. Based on the average proportion of RNV of 25% for Walpole's (1999) study area in Gunnedah, northwest NSW, the total benefits of combating land degradation are $13.95/ha. This figure represents the benefits that RNV provides in terms of shelter and shade, as well as land degradation control benefits.

From the benefit calculations described in the previous section, an average marginal benefit of $4.41/ha was determined as a shelter and shade benefit for RNV. Subtracting this from $13.95/ha, gives a $9.54/ha benefit attributable to land degradation alone.

This benefit occurs on cleared parts of the farm, which have less runoff and erosion owing to the presence of RNV further up the slope. We will assume that:

- all RNV is 'upstream' of the grazed area;
- all production benefits from RNV are related to improved grazing; and
- increasing RNV has a constant marginal effect on land degradation control benefits.

Based on these assumptions and the work of Walpole (1999), the contribution of RNV to productivity via land degradation control for each property, LC_i was computed from:

$$LC_i = (9.54)(PrRNV_i/0.25)(CA_i),$$

where $PrRNV_i$ is the proportion of RNV on the property, and CA_i is the cleared area on that property.

Increased crop production

The contribution RNV makes to augmenting crop production benefits is based on the protection RNV provides from wind, thereby reducing moisture loss. It has been estimated that the protection benefits of RNV extend for at least 15 times the height of the tree canopy (Dengate 1983). However, for a distance equal to about twice the canopy height, the protection benefits are offset by shading and moisture competition. If we assume the average height of RNV canopy to be 20 m, crops within 40 m of the RNV do not benefit, but the productivity of crops between 40 m and 300 m from RNV is enhanced by about 20% (Table 13). The survey information was not detailed enough to determine the exact area on each property that was so located. To calculate a

benefit, we have assumed that: (i) benefits were limited to those participants stated that their
crop production is enhanced by the presence of their RNV; and (ii) their crop was assumed to be located adjacent to one side of their largest RNV block, which was assumed to be square (to enable calculation of the length of one side). The benefit is then given by 20% of the product of the sheltered area (less the 40 m zone adjacent to the RNV) and the GM for the crop.

Timber for firewood and fencing

The annual revenue of firewood was calculated by multiplying the number of tonnes extracted per year by $100/tonne (Bartel pers. comm.). The benefit of posts extracted per year was calculated at $10/post, based on quotes given by fencing material suppliers.

3.6 Benefit cost analysis of on-farm RNV values

The issue being addressed in this study is whether the conservation of RNV is economically viable for landholders. Five alternative management scenarios were evaluated, and compared with the maintenance of the current situation (Table 14).

Table 14. Scenarios for calculation of NPV

Scenario	*Management requirements*
Current situation maintained	• RNV may/may not be fenced, grazed or used for timber products • Landholders may/may not have intentions to clear
Scenario 1	• Fence all RNV on property • Strictly enforce prohibitions on all RNV clearing • Cease domestic grazing • Cease collection of firewood and posts
Scenario 2	• Fence all RNV on property • Strictly enforce prohibitions on all RNV clearing • Allow grazing consistent with biodiversity conservation[1] • Allow collection of firewood and posts consistent with biodiversity conservation[2]
Scenario 3	• As for Scenario 2, but only fence largest RNV block
Scenario 4	• As for Scenario 3, but not include horticultural opportunity costs in NPV
Scenario 5	• As for Scenario 3, but not include any opportunity costs in NPV

[1]Limit grazing to a maximum of 10 weeks per year between February and August.
[2]Limit firewood and post extraction to 0.5 tonne/ha/year.

For the five alternative scenarios for RNV management, clearing of RNV is not permitted. Although clearing is currently restricted in both NSW and Victoria, we have still included clearing controls as an opportunity cost for several of the scenarios because:

- as indicated in Section 3.4, landholders have still cleared significant areas of RNV, in some cases apparently in breach of existing regulations; and
- several landholders are considering clearing more RNV, and prohibiting this can be considered an opportunity cost of regulation.

The opportunity costs to those landholders considering clearing RNV were computed as described in Section 3.4, together with subtraction of the costs associated with clearing, estimated at $350/ha (Welsh pers. comm.). Some participants indicated that they may clear in the future to create access tracks for management purposes such as weed control and fence maintenance. We have assumed that such clearing will aid RNV management in all scenarios as well as the current situation, and so have not included this as a component of opportunity cost.

The opportunity costs associated with activities such as establishment of orchards and vineyards are very high. It is of interest therefore to assess, in Scenario 4, the effect of excluding these from the analysis. Since no NSW participants indicated that they would potentially clear RNV for such alternative uses, Scenario 4 has only been computed for the Victorian study area. It is also of interest to exclude consideration of opportunity costs altogether, since in a policy context it may not be appropriate to offer incentives based on what may often be an illegal activity (Scenario 5). It is still of economic importance, however, to compute the net costs of conserving RNV, including the costs of regulation (Scenarios 1, 2 and 3).

Fencing RNV is important for achieving nature conservation objectives since this allows for either exclusion or effective management of stock. Hence a requirement in all of the five scenarios was to fence either part or all of the RNV. Scenarios 1 and 2 involved fencing all RNV on each property. For participants who already had areas of RNV fenced, only the cost to fence the remaining RNV was estimated. For participants who did not have any RNV fenced, the cost was based on fencing all the RNV. However, it may not be practical to fence out all RNV areas. It is likely to be most useful with respect to both land management and nature conservation objectives to fence at least the largest RNV block. Hence Scenarios 3, 4 and 5 only require fencing of the largest block of RNV on each property.

The fencing cost was estimated at $5.40 per metre, including the supply of materials and labour (Edwards pers. comm.). The cost of maintaining the newly erected fence over the 40 year period, as proposed in all four scenarios, was also included. This cost was based on current fence maintenance costs as described by participants.

The removal or reduction of stock access to RNV, as proposed in the five scenarios, will have varying effects, depending on the nature and history of each individual site. Grazing integrated with other methods of weed control such as the use of herbicide, has been found to be a valuable means of reducing weed populations (Allen 1994). Grazing a mixture of cattle and goats in hill paddocks less than 80 ha at a property in Coolah, NSW, has been successful in controlling Blackberries, Briars and Thistles, and reducing St. John's Wort (Arnott & Campbell 1994). Barrett (1997) reported cases where farmers had removed sheep and cattle from patches of woodland and noticed a decline in native bird habitat quality as weeds invaded and native birds moved out. It then took about seven years before the remnants will show signs of recovery with

increases in bird diversity continuing for up to 30 years. However, after this time, bird diversity once again declined, suggesting that light to moderate grazing can contribute to maintaining bird diversity (Barrett 1997). Kirkpatrick & Gilfedder (1997) considered that limited seasonal grazing to be compatible with nature conservation objectives for several Tasmanian vegetation types.

While the optimal management regimes for each strata in the study areas are unknown, we have assumed that some grazing can be carried out without adversely affecting nature conservation values. In the scenarios, grazing is limited to those times of the year that are less crucial for the growth and reproduction of understorey plants - from late Summer through to the end of Winter. Research has also indicated that in many cases stock grazing can provide short term control of weeds. Hence, for Scenario 1, in which grazing is prohibited, the ongoing management costs of weeds, pest animals, and fire control were assumed to increase by one-third, for those participants who currently graze stock in their remnants.

The NPVs for the current situation and each scenario were calculated by subtracting the sum of the present values (PVs) of all the relevant cost components from the sum of the PVs of all the relevant benefit components. A time period of 40 years and a discount rate of 7% were adopted in all cases. The long time period was required because of the need to include the opportunity costs of establishing pine or hardwood plantations. Income from these alternative land uses is typically assessed over 40 years - to adopt a shorter time period would involve serious underestimation of the benefits associated with these enterprises. For consistency, this then requires that all values are assessed over the 40 year time period. While the NPV for each scenario is of interest, the crucial figure is actually the difference between the NPV for the current situation and that for each scenario. This difference is labelled the incremental effect (IE) of each alternative scenario.

The results of the benefit cost analysis (BCA) indicate that the maintenance of the current management regime has an aggregated positive value of $241,983 for the 100 Victorian participants (Table 15), and is worth $11,688,741 to the 122 NSW participants (Table 16). This translates to an average positive return of $2,420 per property, and $36/ha of RNV for Victorian participants (Table 17), and $95,809 per property, and $630/ha of RNV (Table 18). The Victorian NPVs are negative for all scenarios, whereas they are all positive for NSW with the exception of Scenario 1. As expected, the IE values are all negative for both study areas.

Table 15. Aggregate NPV results for Victorian participants

	PV costs ($)			*PV benefits ($)*	*NPV ($)*	*IE ($)*
	Direct	*Opportunity*	*Total*			
Current	4,130,350		4,130,350	4,372,333	241,983	n/a
Scenario 1	6,923,746	3,395,314	10,319,061	2,200,420	-8,118,641	-8,360,624
Scenario 2	6,053,603	3,395,314	9,448,917	3,881,606	-5,567,311	-5,809,294
Scenario 3	5,610,142	3,395,314	9,005,457	3,881,606	-5,123,850	-5,365,834
Scenario 4	5,610,142	543,465	6,153,607	3,757,719	-2,395,888	-2,637,871
Scenario 5	5,610,142	0	5,610,142	3,757,719	-1,852,423	-2,094,407

Table 16. Aggregate NPV results for NSW participants

	PV costs ($)			*PV benefits ($)*	*NPV ($)*	*IE ($)*
	Direct	*Opportunity*	*Total*			
Current	3,903,831	n/a	3,903,831	15,592,572	11,688,741	n/a
Scenario 1	7,428,989	2,969,354	10,398,343	6,196,499	-4,201,844	-15,890,585
Scenario 2	6,576,305	2,969,354	9,545,659	11,470,639	1,924,981	-9,763,761
Scenario 3	5,462,108	2,969,354	8,431,462	11,470,639	3,039,177	-8,649,564
Scenario 5	5,462,108	0	5,462,108	11,278,993	5,816,885	-5,871,857

Table 17. Average NPV results per Victorian participant

	PV costs ($)	*PV benefits ($)*	*NPV ($)*	*IE ($)*	*NPV per ha RNV ($)*	*IE per ha RNV ($)*
Current	41,304	43,723	2,420	n/a	36	n/a
Scenario 1	69,237	33,953	-81,186	-83,606	-1,219	-1,256
Scenario 2	60,536	33,953	-55,673	-58,093	-836	-872
Scenario 3	56,101	33,953	-51,239	-53,658	-769	-806
Scenario 4	56,101	5,435	-23,959	-26,379	-360	-396
Scenario 5	56,101	0	-18,524	-20,944	-278	-315

Table 18. Average NPV results per NSW participant

	PV costs ($)	*PV benefits ($)*	*NPV ($)*	*IE ($)*	*NPV per ha RNV ($)*	*IE per ha RNV ($)*
Current	31,999	127,808	95,809	n/a	630	n/a
Scenario 1	85,232	50,791	-34,441	-130,251	-227	-857
Scenario 2	78,243	94,022	15,779	-80,031	104	-527
Scenario 3	5,673	94,022	24,911	-70,898	164	-466
Scenario 5	5,673	92,451	47,679	-48,130	314	-317

4. Discussion and conclusion

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.

At first glance, the benefits NSW participants currently receive from their RNV ($95,809 per property) might seem unrealistically large. However, a large proportion of the benefit is not a direct contribution to the average landholder's income. The largest benefit component, land degradation mitigation, is a measure of how much productivity would be lost without the RNV. The firewood benefit is money saved, rather than a direct contribution to farm income. Note also that the benefit is a discounted value calculated over 40 years. As such, it only constitutes a small proportion (7%) of the average NSW participant's annual income.

The major actions in the proposed management scenarios were the prevention of clearing, fencing of the RNV, and limitations on grazing and firewood and post removal. These changes would negatively effect most of the participants. In northeast Victoria, for example, with the average RNV area of 66 ha, a large amount of fencing would need to be erected, especially as 70% of the participants would be fencing their remnants for the first time. A large percentage of participants used their RNV for grazing (71% in Victoria, 75% in NSW), so the economic impacts of restricting grazing are significant. In NSW, the proposed restrictions on firewood production also has a major effect on RNV benefits.

About one-third of Victorian participants and about one-tenth of NSW participants indicated they were considering clearing parts of their RNV in the next ten years. For these landholders in particular, it is evident that RNV management is largely driven by economic concerns, rather than environmental and nature conservation considerations. The dominant reason participants had for clearing in the past was for pasture development. This was also the main reason for clearing in the future, although amongst the NSW participants there was also a significant interest in establishing hardwood plantations.

Landholders with large properties, large areas of RNV, and a history of clearing in the past are more likely to clear in the future. Factors such as level of education, whether participants had bought in the last ten years, and age had no effect on participants' intentions. Other studies have found similar results relating to property size, with owners of smaller properties being more likely to conserve RNV and wildlife (Breckwoldt 1983, Griffin 1990, Wilson 1992). Results from a landholder survey on the value of box-ironbark remnants (Hamilton *et al.* 1997) suggested that landholders with larger properties were more concerned about factors that returned a profit, whereas smaller landholders were more concerned about recreation and preservation of habitat. Primary producers are less likely to undertake conservation activities than those with a larger proportion of outside income (Breckwoldt 1983, Reeve & Black 1993). Factors relating to profitability are paramount for larger landholders as they are usually reliant on their property as their main source of income. This is particularly true for the majority of NSW participants.

One of the aims of the National Landcare Program is to develop a stewardship or land ethic, presumably with the view that this will affect the behaviour of landholders, in particular their adoption of practices that would improve farm viability and enhance biodiversity conservation. About half of the participants were members of Landcare. However, these Landcare members were no less inclined to clear in the future than non Landcare members. These findings are consistent with a landholder survey conducted in 1993 examining the relationship between Landcare and stewardship in northeast Victoria (Curtis & De Lacy 1994, Curtis 1997). This work showed that there were no links between Landcare participation, stewardship and adoption of sustainable agricultural practices. There was no significant difference in the level of stewardship ethic between participants in Landcare and non Landcare areas. Even more strikingly, Walpole (1998) found a negative correlation between the proportion of trees on a property and membership of Landcare in a survey of landholders near Gunnedah in northwestern NSW.

Voluntary programs such as Landcare which promote a change in attitudes and awareness are clearly not sufficient to ensure a change in behaviour of land managers. Landcare, as a form of communication and extension, is unlikely to achieve a change in landholder behaviour on a scale likely to have an effect at a landscape level (Curtis 1997). Voluntary programs may create behavioural change incrementally over the long-term, but legislation, incentives and strong political commitment will be required to engender significant changes in the short term (Binning & Young 1997).

It is unfair and unrealistic to expect landholders to address land degradation or conserve biodiversity without significant financial, technical, institutional and moral support (Campbell 1994). The most common goals of farmers are for the business to survive and grow, to set and overcome challenges, and to make a profit while they are on the land (Makeham & Malcolm 1993). Even though some landholders appreciate that conservation may have wider economic rewards, and that land degradation may affect future yields, conservation practices may not be economically rational in the short term (Vanclay 1992), or even in the medium to long-term as found for the majority of participants in this study. If environmental safeguards such as RNV protection reduce the profitability by adding to landholder costs, as is the case for most landholders surveyed in this study, then they simply will not be adopted, and environmental damage will continue to occur.

Landholders often lack the funds to carry out rehabilitative works on their properties (Bryant 1992). Many are trying to pursue conservation activities, but it is becoming financially harder to do so. The scale of the costs associated with any of the management regimes examined in this study illustrates the financial strain placed on landholders when conservation activities are considered. Most of the landholders who are interested in nature conservation, and are doing something about it, are economically secure (Breckwoldt 1983). Most participants indicated that they would undertake activities to conserve their RNV if incentives were available, in particular economic incentives.

This study confirms that one of the major barriers to protecting RNV is the economic costs associated with conservation management. The differences between the NPV of

the current management regime maintained over a 40 year period, and the NPVs of the five management scenarios were large and negative. For Victorian participants, the IE ranged from about -$8 million (Scenario 1) to - $2 million (Scenario 5). For NSW participants, the IE ranged from about -$15 million (Scenario 1) to -$6 million (Scenario 5). In both study areas, the incremental economic costs of the scenarios outweigh the incremental economic benefits for at least 89% of participants.

However, despite this negative incremental effect, between 66% (Scenario 5) and 30% (Scenario 1) of NSW participants still gain a net benefit from their RNV. Fewer Victorian participants (29% for Scenario 5 and 0% for Scenario 1) gain a net benefit under the alternative land use regimes.

The much higher benefits received by NSW participants from RNV compared to Victorian participants, particularly in terms of land degradation mitigation and shelter for stock and crops, are a reflection of the following differences between the two study areas:

- NSW participants manage over 7 times the area managed by Victorian participants;
- NSW participants manage nearly three times more RNV than Victorian participants; and
- on-farm income is much more important for NSW participants than for Victorian participants.

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.

5. Acknowledgments

The project Steering Committee made valuable comments on drafts of the surveys. A focus group of landholders from northeast Victoria provided valuable advice on survey contents and design. Emma Smith and Kylie Scanlon conducted many of the NSW survey interviews. Lindsay Trapnell provided advice on the NPVs for various agricultural enterprises.

Various staff members from the Victorian Shires of Alpine, Indigo, Wangaratta, Wodonga and Towong, and the NSW Shires of Albury, Berrigan, Conargo, Corowa, Culcairn, Deniliquin, Holbrook, Hume, Jerilderie, Lockhart, Murray, Tumbarumba, Urana, Wakool and Windouran assisted in providing landholder information.

We wish to particularly thank the landholders who participated in the surveys.

Published with the assistance of Bushcare - a program of the Commonwealth Government’s Natural Heritage Trust.

An earlier version of this paper was published as: Miles, C.A., Lockwood, M., Walpole, S.C. & Buckley, E. (1998) *Assessment of the on-farm economic values of remnant native vegetation*. Johnstone Centre Report No. 107. Johnstone Centre, CSU, Albury.

6. References

Adamson, E.V.C. (1988) *The relationship between trees and rural productivity*. Ministry for Planning and Environment, Melbourne.

Allen, C. (1994) Grazing management - the animal factor, **in** Garden, D., Michalk, D. (eds) *Putting the farm under the microscope: proceedings of the ninth annual conference of the grassland society of New South Wales*. Grasslands Society of NSW Inc., Orange.

Arnott, R., Campbell, M. (1994) Control of St. John's wort (*Hypericium perforatum* L.) in large paddocks on hill country, **in** Garden, D., Michalk, D. (eds) *Putting the farm under the microscope: proceedings of the ninth annual conference of the grassland society of New South Wales*. Grasslands Society of NSW Inc., Orange.

Australian Bureau of Statistics (1992) *Australia's environment: issues and facts*. AGPS, Canberra.

Barrett, G. (1997) Birds on farms. *Wingspan* 7(4): 11-15.

Beed, T.W., Stimson, R.J. (eds) (1985) *Survey interviewing: theory and techniques*. George Allen & Unwin, Sydney.

Binning, C., Young, M. (1997) *Motivating people: using management agreements to conserve remnant vegetation.* Final report to LWRRDC and Environment Australia national R & D program on rehabilitation, management and conservation of remnant vegetation. CSIRO, Canberra.

Bird, R. (1981) Benefits of tree planting in S.W. Victoria. *Trees and Victoria's Resources* 23: 2-6.

Bird, P. R., Bicknell, D., Bulman, P.A., Burke, S.J.A., Leys, J.F., Parker, J.N., van der Sommen, F.J., Voller, P. (1993) The role of shelter in Australia for protecting soils, plants and livestock, **in** Prinsley, R.T., Allnut, J. (eds*) The role of trees in sustainable agriculture.* Kluwer Academic Publishers, Dordrecht.

Bird, P.R., Lynch, J.J., Obst, J.M. (1984) Effect of shelter on plant and animal production. *Animal Production in Australia* 15: 270-273.

Blore, D. (1994) Benefits of remnant vegetation: focus on rural lands and rural communities. Paper prepared for the 'protecting remnant bushland' seminar, Orange Agricultural College, October 1994.

Breckwoldt, R. (1983) *Wildlife in the home paddock: nature conservation for Australian farmers*. Angus & Robertson, Sydney.

Bryant, L. (1992) Social aspects of the farm financial crisis, **in** Lawrence, G., Vanclay, F., Furze, B. (eds) *Agriculture, environment and society: contemporary issues for Australia.* Macmillan, Melbourne.

Campbell, A. (1994) *Landcare: communities shaping the land and the future*. Allen & Unwin, St Leonards, NSW.

CLIB91 (database) (1994) 1991 Census of population and housing. Release 2. Australian Bureau of Statistics, Canberra.

CLIB96 (database) (1997) 1996 Census of population and housing. Release 1. Australian Bureau of Statistics, Canberra.

Curtis, A., De Lacy, T. (1994) *Landcare: does it make a difference?* Johnstone Centre of Parks, Recreation and Heritage, Charles Sturt University, Albury.

Curtis, A.L. (1997) Landcare, stewardship and biodiversity conservation, **in** Klomp, N., Lunt, I. (eds) *Frontiers in ecology: building the links*. Elsevier Science, Oxford.

Dengate, J. (1983) Windbreaks and shade trees help landowners and wildlife. *Habitat* 11(1): 14-15.

Elton, K. (1997) *Farm budget handbook 1997: southern NSW - irrigated summer crops*. NSW Agriculture, Sydney.

Fitzpatrick, D. (1994) *Money trees on your property: profit gained through trees and how to grow them*. Inkata Press, Sydney.

Griffin, E.A. (1990) *Floristic survey of remnant vegetation in the Dandaragan area, Western Australia.* Resource management technical report 143. Western Australian Department of Agriculture, South Perth.

Hamilton, S.D., Dettman, P.D., Curtis, A.L. (1997) *Landholder perceptions of remnant vegetation on private land in the box-ironbark region of northern Victoria*. Dookie College, Institute of Land and Food Resources, The University of Melbourne, Dookie, Victoria.

Hobman, F. (1995) *An economic study into dryland olive growing and oil processing in Southern Australia.* Rural Industries Research and Development Corporation, Canberra.

Kellas, J. (1993) Timber products from agroforestry, **in** Race, D. (ed) *Agroforestry: trees for productive farming*. Department of Agriculture, DCNR and Agmedia, Melbourne.

Kirkpatrick, J., Gilfedder, L. (1997) *Bushland module 1: guide and summary*. Department of Geography and Environmental Studies, University of Tasmania, Hobart.

Lockwood, M., Buckley, E., Glazebrook, H. (1997a) *Remnant vegetation on private property in northeast Victoria*. Johnstone Centre Report No. 94. Johnstone Centre, Albury.

Lockwood, M., Buckley, E., Glazebrook, H. (1997b*) Remnant vegetation on private property in the southern Riverina, NSW*. Johnstone Centre Report No. 95. Johnstone Centre, Albury.

Lockwood, M., Carberry, D. (1998) *Stated preference surveys of remnant native vegetation conservation*. Johnstone Centre Report No. 104. Johnstone Centre, Albury.

Lynch, J.J., Donnelly, J.B. (1980) Changes in pasture and animal production resulting from the use of windbreaks. *Australian Journal of Agriculture* 31: 967-979.

Makeham, J.P., Malcolm, L.R. (1993) *The farming game now*. Cambridge University Press, Cambridge.

Miles, C.A. (1998) An assessment of the on-farm economic values of remnant native vegetation in north-east Victoria. Honours thesis, School of Environmental & Information Sciences, Charles Sturt University, Albury.

Nadolny, C., Burrows, W. H., Pickard, J., Hannam, I. (1991) Tree clearing in Australia. *Search* 22(2): 43-52.

Radcliffe, J.E. (1983) Grassland responses to shelter - a review. *New Zealand Journal of Experimental Agriculture* 11: 5-10.

Reeve, I.J., Black, A.W. (1993) *Australian farmers' attitudes to rural environmental issues.* University of New England, Armidale.

Richmond, E. (1992) *Economic benefits to the farmer of maintaining and protecting remnant native vegetation on farms in south-west of Western Australia.* Water Authority of Western Australia, Leederville.

Scanlan, J.C. (1992) A model of woody of woody-herbaceous biomass relationships in eucalypt and mesquite communities. *Journal of Range Management* 45: 75-80.

Squires, V.R. (1983) The value of trees as shelter for livestock, crops and pastures: a review, **in** van der Sommen, F.J., Boardman, R., Squires, V. *Tree in the rural environment: towards a greenprint for South Australia,* Roseworthy Agricultural College, Roseworthy, South Australia.

Trapnell, L. (1998) *Management practices to minimise nutrient runoff from farms in catchment areas o upper north East of Victoria - their costs and expected benefits.* DNRE, Benalla.

Uebergang, C., Lavis, P. (1998) *North-east gross margins 1997-1998*. DNRE, Benalla.

Vanclay, F. (1992) Farmer attitudes or media depiction of land degradation: which is the barrier to adoption? *Regional Journal of Social Issues* (26): 41-50.

Wakefield, S.M. (1989) *Farm trees series 1: why you need trees on your farm*. NSW Agriculture and Fisheries, Sydney.

Walpole, M.D. (1994) Economics of walnut production in the north-east Victorian river valleys, paper presented at the Annual Australian Nut Industry Council Conference, Mildura.

Walpole, S.C. (1996) An economic assessment of management programs for land degradation on a regional, farm and paddock basis. B Nat Res (Ph.D.) Thesis, University of New England, Armidale.

Walpole, S.C. (1999) Assessment of the economic and ecological impacts of remnant vegetation on pasture productivity. *Pacific Conservation Biology* 5:(in press).

Walpole, S., Lockwood, M, Miles, C.A. (1998) *Influence of remnant native vegetation on property sale price*. Johnstone Centre Report No. 106. Johnstone Centre, Albury.

Wilson, G.A. (1992) A survey of attitudes of landholders to native forest on farmland. *Journal of Environmental Management* 34: 117-136.

Personal communications

Bartel, G. (1998) Firewood supplier, Wodonga, Victoria.

Edwards, G. (1998) Rural fencing contractor, Barnawartha South, Victoria.

Trapnell, L. (1998) Senior Resource Management Analyst, Department of Natural Resources and Environment, Benalla.

Welsh, M. (1998) Divisional Planning Forester, State Forests, Albury.