BENEFIT COST ANALYSIS OF REMNANT NATIVE VEGETATION CONSERVATION

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EIGHTH REPORT OF THE PROJECT
Economics of remnant native vegetation conservation on private property

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Report 1
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Report 2
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Report 3
Lockwood, M., Carberry, D. (1998) *Stated preference surveys of remnant native vegetation conservation*. Johnstone Centre Report No. 104. Johnstone Centre, Albury.

Report 4
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.

Report 5
Miles, C.A., Lockwood, M., Walpole, S., Buckley, E. (1998) *Assessment of the on-farm economic values of remnant native vegetation*. Johnstone Centre Report No. 107. Johnstone Centre, Albury.

Report 6
Miles, C.A., Lockwood, M., Walpole, S. (1998) *Incentive policies for remnant native vegetation conservation*. Johnstone Centre Report No. 108. Johnstone Centre, Albury.

Report 7
Walpole, S., Lockwood, M. (1999) *Catchment benefits of remnant native vegetation conservation*. Johnstone Centre Report No. 129. Johnstone Centre, Albury.

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As at September 1999, copies of Reports 3, 6, 7 and 8 were available from Michael Lockwood, PO Box 789 Albury, 2640, Phone (02) 6051 9884. Reports 1, 2, 4 and 5 are out of print. Reports 4 and 5 are available by email - contact mlockwood@csu.edu.au

Contents

Abstract

The economic values associated with conservation of remnant native vegetation (RNV) on private property in Northeast Victoria and the Murray catchment NSW were assessed using benefit cost analysis. Landholders were surveyed to measure the costs and benefits they face to conserve RNV. Depending on the assumptions made, the net economic costs to landholders of a change from the current situation to a proposed conservation scenario in Northeast Victoria ranged from $199.1 million to $30.2 million. The corresponding figures for the Murray catchment were $66.5 million to $35.1 million. Community willingness to pay for RNV conservation was assessed using choice modelling. The aggregate benefit of conserving RNV in Northeast Victoria was $60.7 million, and in the Murray catchment $75.6 million. The catchment benefits were assessed in terms of the role RNV conservation plays in mitigating dryland salinity and contributing to carbon sequestration. These net benefits over a 40 year period were estimated to be $7.4 million in Northeast Victoria and $7.9 million in the Murray catchment. The three value components, net on-farm costs, community benefits and catchment benefits, were integrated into a benefit cost analysis. The results of the analysis indicated that under most conditions, there was a net economic benefit in conserving RNV in the two study areas. For example, given a five year time horizon and a discount rate of 7%, governments could spend up to $29.8 million in Northeast Victoria and $40.5 million in the Murray catchment and still achieve a net economic benefit, provided conservation outcomes were achieved.

1. Introduction

Remnant native vegetation (RNV) is a term used to describe those patches of bushland which remain on private property following widespread clearance of native vegetation. In addition to continued clearing, RNV faces incremental degradation from threats such as grazing, timber harvesting, fire, weed invasion, rising water tables and insect attack. Conservation of RNV is recognised as being an important aspect of combating dryland salinity, declining water quality, soil erosion, and loss of biodiversity.

Policies directed towards conservation of RNV have both costs and benefits. A benefit cost analysis (BCA) can provide a rational response to the question 'is the management of RNV for conservation purposes economically desirable?' If it is to incorporate all components of economic value, a BCA must take into account both market and non-market costs and benefits. An analysis that includes consideration of both these value components is sometimes termed an extended BCA.

An extended BCA is based on several requirements and assumptions. It is important to recognise these, as they impose limits on the interpretation and applicability of BCA results. Four of the more important requirements and assumptions are as follows.

1. A BCA of a proposed policy requires that there are identifiable stakeholders who have preferences concerning the issue at hand, and that these preferences meet a set of conditions determined by economic theory (completeness, reflexivity, transitivity, non-satiation and continuity)[1]. Certain personal, social and moral values may not be expressed in a way which is consistent with all these conditions. Such values cannot be meaningfully incorporated into a BCA. A BCA is only a partial value assessment. It is therefore necessary to rely on other participatory and political processes to make a final judgement about the merits of a policy. A BCA may make an important contribution to these judgements.

2. The economic preferences of stakeholders must either:

   (i) be accurately revealed, directly or indirectly, though market transactions; and/or

   (ii) be measured in a survey that enables each stakeholder to accurately state their willingness to pay (or willingness to accept compensation) for the policy. Such surveys are termed 'stated preference' surveys.

3. A BCA usually assumes that it is acceptable to use preferences based on the existing distribution of wealth, which of course affects ability to pay, and therefore willingness to pay.

4. A decision must be made about the aggregate time preference for money. It is usual to discount future benefits and costs back to present values using a discount rate. The higher the discount rate, the lower future benefits and costs are valued relative to the present. Since the discount rate can affect the result of a BCA, and the choice of a rate is to some extent a matter of judgement on the part of the analyst, it is common

[1] See, for example, Gravelle & Rees (1981) for an explanation of these conditions.

to compute the BCA using a number of different discount rates. This enables the sensitivity of the BCA result to the choice of discount rate to be determined.

The basic steps in BCA are:

1. Identify the proposal to be examined, and its ‘lifetime’.

2. Identify the values associated with the proposal that can be measured in economic terms.

3. Identify each of these values as either a benefit or a cost.

4. Quantify these benefits and costs in dollar terms, using a suitable economic valuation methodology.

5. Assess the project according to a decision rule. Two commonly used decision rules are:

   the benefit/cost ratio (a project has positive net social benefit if Benefits/Costs > 1); and

   Net Present Value (NPV) (an activity is economically beneficial if NPV > 0).

In this work, the NPV criterion will be used. The NPV for a proposal is calculated by adding up the net benefits over the lifetime of the proposal, as given by:

$$NPV = \sum_{t=1}^{t=n} \frac{B_t - C_t}{(1 + r)^t}$$

where:

- t is a particular year of the project, which ranges from 1 at the start of the project to the lifetime of the project at n years;
- B_t are the benefits in year t;
- C_t are the costs in year t; and
- r is the discount rate - for a discount rate of 7%, for example, r = 0.07.

RNV has a number of economic value components that can be incorporated into a BCA. RNV 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. RNV may contribute to enhancing the productivity of downstream properties though amelioration of land degradation associated with salinity, water quality decline and soil erosion. Since RNV acts as a carbon storage, preventing clearing is beneficial in terms of reducing carbon emissions to the atmosphere (with the consequent mitigation of global warming). The Australian community also places economic value on certain attributes of RNV such as its scenic amenity and contribution to biodiversity conservation.

These value components have been measured in earlier phases of the project *economics of remnant native vegetation conservation on private property*. On-farm values and opportunity costs are reported in Miles *et al*. (1998a). Community willingness to pay (WTP) for RNV conservation was measured using stated preference surveys as reported in Lockwood & Carberry (1998). The catchment-wide benefits of RNV conservation are reported in Walpole & Lockwood (1999).

This report combines these value components into a BCA of RNV conservation for two study areas - Northeast Victoria and the Murray catchment in southern NSW (Figure 1). Details of the study areas are given in Lockwood *et al*. (1997a, 1997b). The conservation scenario being assessed in the BCA is described in Section 2 of this report. In Sections 3, 4 and 5 we recap the main results from the earlier reports, and modify them to reflect the changes described by the conservation scenario. In Section 6 we integrate the value components into an extended BCA.

2. Conservation scenario

The scenario assessed in this report was based on potential conservation outcomes, rather than the means by which these might be achieved (the latter was addressed in Miles *et al*. 1998b). The BCA was based on a change from the current trends continuing to an improved RNV conservation scenario, as summarised in Table 1.

Two time periods were assessed. The preferred time period is for the policy to run for five years prior to a major review, with subsequent modification or termination where necessary (as per Miles *et al*. 1998b). However, one of the major value components, the opportunity costs of not clearing any RNV, is significantly underestimated over this time period. This is primarily because landholders wanting to clear to establish pasture, hardwood or softwood plantations, or for horticultural activities such as orchards, would not obtain a return on their investment within five years. No opportunity costs have been included in the 5 year scenario.

For this reason, we have also conducted by BCA over a time frame of 40 years. This enables a more realistic assessment of opportunity costs, but requires the following strong (and in several cases unrealistic) assumptions to be made:

- without some new government intervention, current uses of the RNV (grazing, timber production and so on) would remain constant over the next 40 years;
- in the first year, landholders clear the entire area they indicated they intended to clear over the next ten years to establish an alternative land use, and then undertake no further clearing over the rest of the 40 year period; and
- community WTP over a 40 year time frame is the same as the WTP for the five year scenario used in the stated preference surveys.

Despite the limitations on the results arising from these assumptions, the ability to include opportunity costs made it worthwhile to adopt a 40 year scenario as part of the analysis.

Figure 1. Study areas

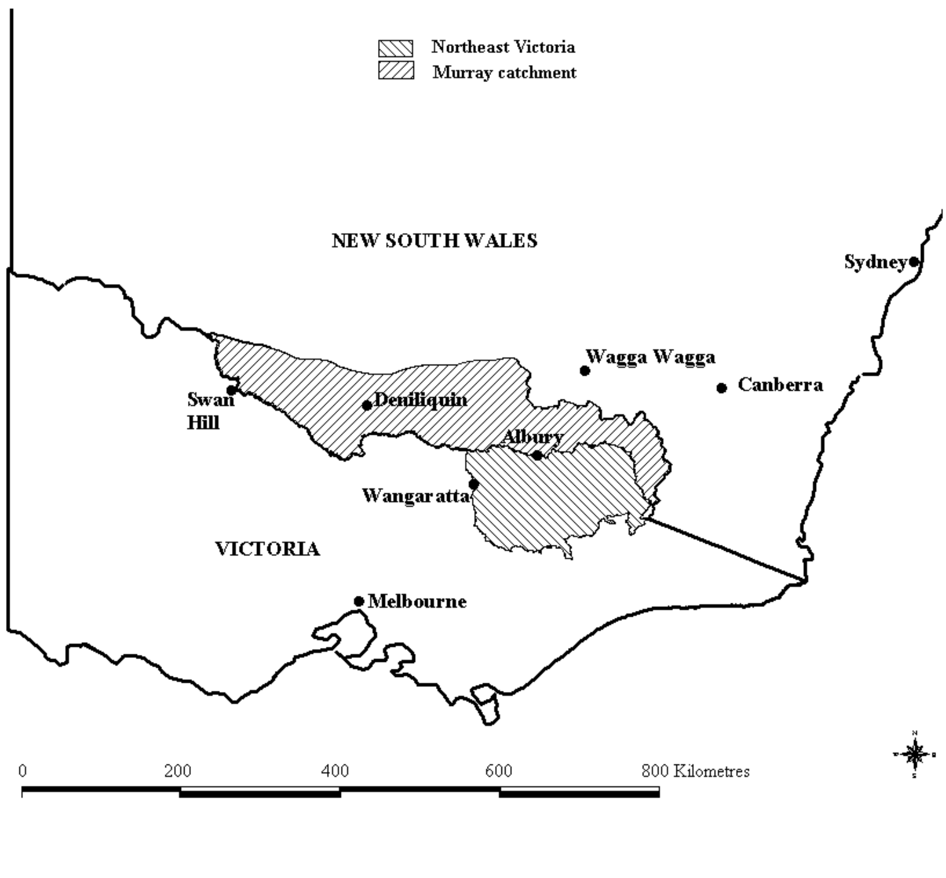
Northeast Victoria
Murray catchment
NEW SOUTH WALES
Sydney
Wagga Wagga
Canberra
Swan
Hill
Deniliquin
Albury
Wangaratta
VICTORIA
Melbourne
0
200
400
600
800 Kilometres

Table 1. RNV conservation scenario

Scenario	*Consequences*
Current situation maintained	• RNV on some properties is extensively grazed and/or used for timber products[1] • RNV on some properties is not fenced[1] • Some landholders have intentions to clear over the next 10 years (7,174 ha in Victoria and 3,425 ha in NSW)[2] • Biodiversity decline will continue on some properties
Improved RNV conservation scenario	• Fence largest RNV block on each property where this is currently unfenced • Prohibit all RNV clearing • Allow grazing consistent with biodiversity conservation[3] • Allow collection of firewood and posts consistent with biodiversity conservation[4] • Rate of biodiversity decline will be reduced

[1]See Miles *et al*. (1998a) for details.

[2]See Section 3 for the method used to derive these estimates.

[3]Based on limiting grazing to a maximum of 10 weeks per year. Details of grazing regimes consistent with achieving biodiversity outcomes need to be determined according for the particular requirements of each vegetation type. At present such detail is unavailable.

[4]Limit firewood and post extraction to a maximum of 0.5 tonne/ha/year. Miles *et al*. (1998a) also assessed the on-farm costs of excluding timber extraction altogether.

The opportunity costs associated with activities such as establishment of orchards and vineyards are very high. It is therefore of interest to also assess the effect of excluding these opportunity cost components from the analysis. Since no NSW participants indicated that they would potentially clear RNV for such alternative uses, this calculation only affected the results for the Victorian study area.

To test the sensitivity of the BCA result to choice of discount rate, the NPV has been computed using rates of 4%, 7% and 10%.

3. Recap and extrapolation of on-farm data

A sample of landholders who owned properties in one of the study areas that featured at least 1 ha of RNV were surveyed to assess the on-farm economic costs and benefits associated with RNV. In the Victorian sample, 100 participants were interviewed between November 1997 and February 1998. In the NSW sample, 122 participants were interviewed between February 1998 and June 1998.

The surveys enabled quantification of the following economic values:

- management costs, including weed control, fencing, pest control, burning, maintaining access tracks and firebreaks, and removal of fallen timber;

- opportunity costs of preventing landholders from clearing RNV to establish pasture, pines, hardwoods, cropping, rice, olives, grapes, or chestnuts; and

- benefits associated with increased stock production, increased agricultural production arising from mitigation of land degradation, increased crop production, and production of timber for firewood and fencing.

As described in Miles *et al*. (1998a), the study areas were stratified according to broad vegetation type (BVT), landform, climate and land use. Combining information on the area of RNV in each strata, the NPV results from each sample of participants, and the strata in which the surveyed properties were located, enables extrapolation of economic values from the individual property level up to the entire area of RNV present in the respective study areas. The NPV per hectare of RNV for properties in the same stratum were averaged, and multiplied by the total area of RNV in that stratum. Unsurveyed strata were given the average value of all the other strata. Since some minor errors in classification of some polygons and in the stratification have been detected since the publication of Lockwood *et al*. (1997a, 1997b) and Miles *et al*. (1998a), the extrapolation of the on-farm data is repeated here, based on slightly revised areas for some strata.

For the NSW study area, the combination of all four land characteristics resulted in a total of 79 strata that contained RNV (Table 2). Of the 79 strata, 42 had less than 500 ha of RNV. Four of these strata were surveyed. Of the 37 strata greater than 500 ha, 33 were surveyed. Strata-specific survey data was therefore available for 183,964 ha (or 90.4 %) of the total RNV area of 203,429 ha.

For the Victorian study area, the combination of all four land characteristics resulted in a total of 55 strata that contained RNV. The distribution of surveys across strata containing RNV is summarised in Table 2. Of the 55 strata, 39 had less than 500 ha of RNV, one of which was surveyed. Of the sixteen strata greater than 500 ha, 12 were surveyed. Strata-specific survey data was therefore available for 103,647 ha (or 91.5 %) of the total RNV area of 113,313 ha.

Table 2. Survey effort across strata

	NSW			Victoria		
	Not surveyed	*Surveyed*	*Total*	*Not surveyed*	*Surveyed*	*Total*
No. strata < 500 ha RNV	38	4	42	38	1	39
Area of those strata (ha) < 500 ha RNV	4,162	1,095	5,257	4,091	14	4,104
No. strata > 500 ha RNV	4	33	37	4	12	16
Area strata of those (ha) > 500 ha RNV	15,302	182,870	198,172	5,575	103,634	109,209
Total no. strata	42	37	79	42	13	55
Total area of RNV (ha)	19,464	183,964	203,429	9,666	103,647	113,313

Survey participants indicated that over the next ten years they may clear 568 ha of RNV in the Victorian study area and 842 ha of RNV in the NSW study area. 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. 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. Clearing for plantations only occurs in the relatively high rainfall eastern part of the Murray catchment. Since the survey was conducted, approval has been given for a new softwood processing mill at Tumut. This new mill has been guaranteed that at least 30,000 ha of new pine plantations will be established. It is likely that some of these will be located in the Murray catchment, leading to additional pressures to clear RNV.

The probability of clearing for the 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. 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 0.6. The probability of clearing for grapes was calculated by multiplying the residual probability of undertaking pasture development (ie. $1 - 0.6$) by the second likelihood, 0.4, to give $(1 - 0.6) \times 0.4 = 0.16$. The same procedure was repeated for the third land use option. 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 area likely to be cleared by each participant was then calculated by multiplying the probability by the area that was intended for clearing. The total area to be cleared in each study area was calculated by obtaining the average proportion of RNV to be cleared in each stratum amongst the surveyed properties, and extrapolating this based on the total area of RNV in each stratum. This resulted in a prediction that landholders desire to clear 7,174 ha in the Victorian study area and 3,425 ha in the NSW study area.

Compilation of the various on-farm economic value components based on the conservation scenario outlined in Section 2, and extrapolation of these values across the two study areas, gives net present values (NPVs) as indicated in Tables 3 and 4. Note that these values are different from those presented in Miles *et al*. (1998a), because of the different time period (Table 3), the different conservation options being assessed, and modifications made to the stratification and areas of RNV.

Under each of the time periods, and for all discount rates, the NPVs for the change from the current situation to the proposed conservation scenario are negative. The Victorian NPVs ranged from -$199.1 million for the 40 year scenario at a 4% discount rate and inclusion of all opportunity costs, to -$30.2 million for the 5 year scenario at a 10% discount rate. The NSW NPVs ranged from -$66.5 million for the 40 year scenario at a 4% discount rate and inclusion of all opportunity costs, to -$35.1 million for the 5 year scenario at a 7% discount rate.

Table 3. On-farm NPVs for the 5 year scenario

	Victoria ($ million)[1]			**NSW** ($ million)[1]		
	Current situation	*Proposed scenario*	*Net change*	*Current situation*	*Proposed scenario*	*Net change*
4% discount rate						
Benefit						
On-farm productivity	27.3	22.4	-4.9	55.7	42.1	-13.6
Cost						
RNV management	28.4	55.2	26.8	16.3	41.7	25.4
NPV (on-farm)			-31.7			-39
7% discount rate						
Benefit						
On-farm productivity	25.1	21.2	-3.9	49.0	38.6	-10.4
Cost						
RNV management	26.1	53.1	27.0	15.9	40.6	24.7
NPV (on-farm)			-30.9			-35.1
10% discount rate						
Benefit						
On-farm productivity	23.2	20.2	-3.0	47.5	36.5	-11.0
Cost						
RNV management	24.1	51.3	27.2	13.9	39.2	25.3
NPV (on-farm)			-30.2			-36.3

[1] rounded to nearest $100,000

Table 4. On-farm NPVs for the 40 year scenario

	Victoria ($ million)[1]			**NSW** ($ million)[1]		
	Current situation	*Proposed scenario*	*Net change*	*Current situation*	*Proposed scenario*	*Net change*
4% discount rate						
Benefit						
On-farm productivity	119.0	93.6	-25.4	270.5	245.1	-25.4
Cost						
RNV management	119.0	146.1	27.1	72.7	98.0	25.3
Opportunity cost (OC)	0.0	146.6	146.6	0.0	15.8	15.8
Limited OC	0.0	15.4	15.4			
NPV (all OCs)			-199.1			-66.5
NPV (limited OCs)			-67.9			
7% discount rate						
Benefit						
On-farm productivity	80.1	71.5	-8.6	182.2	165.4	-16.8
Cost						
RNV management	80.1	108.0	27.9	49.0	74.3	25.3
Opportunity cost (OC)	0.0	76.5	76.5	0.0	10.8	10.8
Limited OC	0.0	9.1	9.1			
NPV (all OCs)			-113.0			-52.9
NPV (limited OCs)			-45.6			
10% discount rate						
Benefit						
On-farm productivity	58.8	59.4	0.6	133.7	121.6	-12.1
Cost						
RNV management	58.8	87.0	28.2	35.9	61.2	25.3
Opportunity cost (OC)	0.0	41.1	41.1	0.0	8.1	8.1
Limited OC	0.0	5.8	5.8			
NPV (all OCs)			-68.7			-45.5
NPV (limited OCs)			-33.4			

[1]rounded to nearest $100,000

4. Recap and re-calculation of community WTP

Since the economic values held by the community for RNV conservation are nonmarket in nature, and cannot be indirectly recovered though surrogate market techniques such as travel cost, they can only be assessed using stated preference methods. As reported in Lockwood & Carberry (1998), we used two stated preference methods, contingent valuation and choice modelling (CM), to assess the nonmarket economic values of RNV in the two study areas. This BCA uses the CM data, since this method enables welfare measures to be calculated on the basis of a change from the current situation to the proposed conservation scenario.

In CM, participants are presented with several sets of choices each involving two or more options. The participant is asked to select their preferred option in each choice set. Each option is typically defined in terms of salient attributes, including a dollar WTP, and the levels of each attribute are varied across the choice set. Choice models produce estimates of the values of changes in individual attributes within an option, as well as the economic value of aggregate changes in environmental quality. The CM results reflect the trade-offs that each individual makes between the attributes of the options.

Based on responses from the focus groups and pretests, four attributes were selected to characterise the choice problem:

- RNV area;
- payment amount;
- future management by farmers; and
- biodiversity.

Selection of attribute levels was constrained by the biophysical attributes of the two study areas and management possibilities for RNV, and informed by feedback from focus group and pretest participants. The attributes and levels used in the CM surveys are shown in Table 5. Each choice set comprised three options. The base levels for each alternative were used to describe the current situation. This option was included in all choice sets. The remaining levels for each attribute were constructed into two alternative choice options, each of which involved an environmental improvement and a WTP component.

Table 5. Attributes and levels used in the CM surveys[2]

Attribute	Levels (NSW)	Levels (Victoria)
Area of native vegetation remaining in five years time	80,000 ha 110,000 ha 140,000 ha	75,000 ha 95,000 ha 115,000 ha
Participants' one-off payment	$0 $10 $50 $150	$0 $10 $50 $150
Future use by the farmers	No use Some use Extensive use	No use Some use Extensive use
Average number of native plants and animals	60 species 85 species 110 species	60 species 85 species 110 species

[2] See Lockwood & Carberry (1998) for a detailed definitions of these attribute levels. Computation of CM models showed that some use $\succ$ current use $\succ$ no use, so the *use* variable was coded such that some use = 1, current use = 0, and no use = -1.

CM survey participants were recruited from a random samples of 1000 Victorian and 1000 NSW voters obtained from the state electoral rolls. CM models were computed using a multinomial logit analysis. The indirect utility functions for the preferred models were specified as follows.

NSW

$V_1 = \alpha + \alpha \textit{animals} + \alpha \textit{scenery} + \alpha \textit{land degradation} + \alpha \textit{sex} + \alpha \textit{education}$
$\quad + \alpha \textit{income} + \beta \textit{dollar} + \gamma \textit{area} + \chi \textit{use} + \delta \textit{species}$
$V_2 = \alpha + \alpha \textit{animals} + \alpha \textit{scenery} + \alpha \textit{land degradation} + \alpha \textit{sex} + \alpha \textit{education}$
$\quad + \alpha \textit{income} + \beta \textit{dollar} + \gamma \textit{area} + \chi \textit{use} + \delta \textit{species}$
$V_3 = \beta \textit{dollar} + \gamma \textit{area} + \chi \textit{use} + \delta \textit{species}$

Victoria

$V_1 = \alpha + \alpha \textit{public forests} + \alpha \textit{income} + \beta \textit{dollar} + \gamma \textit{area} + \chi \textit{use} + \delta \textit{species}$
$V_2 = \alpha + \alpha \textit{ public forests} + \alpha \textit{income} + \beta \textit{dollar} + \gamma \textit{area} + \chi \textit{use} + \delta \textit{species}$
$V_3 = \beta \textit{dollar} + \gamma \textit{area} + \chi \textit{use} + \delta \textit{species}$

The variables in the models were defined as follows:

- *animals*, *scenery*, *land degradation* and *pubic forests* were, respectively, respondents' views on the importance of protecting native animals, scenic attraction, preventing land degradation, and Victorian forests on public land, as measured on a scale of 1 = not important, 2 = slightly important, 3 = important, 4 = very important;

- *sex*, *education*, and *income* were respondents' demographic characteristics; and

- *payment*, *area*, *use* and *species* were as specified in Table 5.

Results for these models are given in Table 6. The values for 'N' indicate the number of choices used in the analysis. Coefficients for the attributes are significant and have the expected signs. Positive WTP values are associated with increasing area of RNV; sound use and management or the remnants; and an increase in the number of native species present in the RNV. Marginal rates of substitution (MRS) indicate the ratio of the marginal utility of each attribute with the marginal utility of income - that is, the dollar value of a unit change in the attribute. Further details on the development, specification and properties of the models are given in Lockwood & Carberry (1998).

Welfare estimates were calculated based on a change from the current situation to the proposed RNV conservation scenario, as defined in Table 1, which corresponds to the values for the *area*, *use* and *species* attributes as given in Table 7. Mean WTP for RNV conservation in the Murray catchment was about \$75. Mean WTP for RNV conservation in the Northeast Victoria was about \$73.

Confidence intervals for the WTP estimates were calculated, after Park *et al*. (1991), using the simulation method developed by Krinsky & Robb (1986). This approach uses a large number of random draws from a multivariate normal distribution of the estimated parameters to build up a distribution for the WTP estimate.

Table 6. Results for CM models

Model	Variable	Coefficient	t value	Significance	Std Error	MRS
NSW model	Area	3.84E-06	2.50	0.0125	1.539E-06	-0.00038
(N = 2085)	Payment	-0.0102	-14.53	0.0000	7.30E-04	1
	Use	0.318	11.73	0.0000	0.0271	-31.15
	Species	0.0172	9.30	0.0000	0.00186	-1.69
	α	1.29E-05	6.73	0.0000	1.912E-06	
	χ^2 (sig @ 4 *df*)	687 (0.000)				
	ρ^2	0.15				
	$\bar{\rho}^2$	0.15				
	IIA test (p)	0.09				
			$CI^-_{0.95}$	$CI^+_{0.95}$		
	Mean WTP	$74.65	$60.53	$89.65		
Vic. model	Area	4.83E-06	2.82	0.0049	2.212E-06	-0.00053
(N = 2258)	Payment	-0.00910	-14.73	0.0000	6.798E-04	1.00
	Use	0.235	8.72	0.0000	0.0263	-25.83
	Species	0.0157	10.61	0.0000	0.00179	-1.72
	α	1.66E-05	2.23	0.0261	2.084E-06	
	χ^2 (sig @ 4 *df*)	739 (0.0000)				
	ρ^2	0.15				
	$\bar{\rho}^2$	0.15				
	IIA test (p)	0.01				
			$CI^-_{0.95}$	$CI^+_{0.95}$		
	Mean WTP	$72.74	$57.35	$89.32		

Table 7. Attribute levels used for calculation of welfare estimates

	Area (ha)	Use[1]	Species
NSW			
Current situation	106,139	0	60
Proposed scenario	113,313	1	85
Victoria			
Current situation	200,004	0	60
Proposed scenario	203,429	1	85

[1]See Footnote 2 for a description of the coding for this attribute

Aggregating the WTP results up to the level of all NSW and Victorian households requires some assumptions to be made. We assumed that all participants whom we categorised as refusing to fill out the survey, together with all those households which apparently received the survey but did not respond in any way, had a zero WTP. The proportion of completed CM responses then gives a factor which can be multiplied by mean sample WTP to give a mean WTP for the population. The aggregate WTP for the population is then this population mean multiplied by the number of households in the respective states. Table 8 gives the results of this aggregation procedure. The aggregate benefit of conserving RNV in the Murray catchment was $75.6 million, and in Northeast Victoria $60.7 million.

Table 8. Aggregate WTP for NSW and Victorian households

	Sample WTP per household ($)	Return rate (%)	Population WTP per household ($)	No. households	Aggregate WTP ($ million)[1]
NSW	74.65	0.47	34.93	2,163,510	75.6
Victoria	72.74	0.53	38.55	1,575,765	60.7

[1]rounded to nearest $100,000

5. Recap of catchment benefits

Dryland salinity and soil erosion are the two main degradation types that may be exacerbated by continuing RNV decline, and may have an impact on downstream rural and urban populations. The catchment benefits of conserving RNV were calculated as the difference between the costs incurred from the current management scenario and those likely to be incurred under the proposed conservation scenario. These benefits were adjusted according to the relative contribution of RNV to water table levels and water quality compared with vegetation on public land, perennial pasture and tree planting on private land. Details of the benefit estimation procedure are given in Walpole & Lockwood (1999). The calculations drew on the work of the Murray-Darling Basin Commission (1996), that attributed the benefits of vegetation impact on the water table and water quality in proportion to the area of remnant vegetation occurring in the catchment. Of the tree cover in Northeast Victoria and Murray catchment, 8.5% and 33.9% respectively is RNV, with the balance being forested public land, hardwood and softwood plantations. For the purposes of this study, these values were used to indicate the proportional contribution RNV makes to the water table and water quality levels in the two study areas.

Based on information available from neighbouring projects, and studies undertaken for the whole Murray-Darling catchment, the following costs were calculated for the Northeast Victorian and Murray catchments:

- costs of remnant vegetation clearance to local government;
- costs of remnant vegetation clearance to non-farm businesses;
- costs of remnant vegetation clearance to urban households; and
- cost of carbon dioxide release following clearing.

The on-farm analysis reported in Section 3 included estimates of the benefits of remnant vegetation in controlling land degradation on these properties. We were unable to include the marginal benefits that preventing clearing makes to the agricultural productivity of downstream properties, because of the difficulty of separating out local from catchment-wide effects. To produce more inclusive results, detailed biophysical catchment models are required that enable estimates to be made of the effect each hectare of RNV has on water tables. These effects could then be translated into impacts on agricultural productivity. Such an analysis is beyond the scope of the work reported here.

In 1994-95, the Australian Bureau of Agricultural and Resource Economics surveyed local governments within the Murray-Darling Basin to determine the impacts of salinity and rising watertables on infrastructure (Oliver *et al.* 1996). All Northeast Victorian councils indicated that they had no repairs and maintenance expenditure related to salinity and rising water tables. Eight of the fifteen councils in the Murray catchment indicated that they had made repairs and maintenance expenditure due to salinity/rising watertables totaling $862,200.

Businesses located in areas affected by salinity and high watertables will incur costs related to damaged capital infrastructure and amenities. A study undertaken for the Loddon and Campaspe catchments (Whish-Wilson & Shafron 1997) found that the average annual cost for non-farm businesses affected by salinity and high watertables was $26. There are 3,994 non-farm businesses in the NSW study area, and 3,069 in the Victorian study area. The calculations of the salinity costs assume that the non-farm businesses in the upper parts of the catchments are not affected by salinity. This reduces the total number of non-farm businesses affected by salinity to 3,859 in the NSW study area, and 2,478 in the Victorian study area. On this basis, the total annual costs are $100,334 and $64,428, respectively.

The Australian Mineral Development Laboratories (AMDEL) assessed the cost to urban households of either repairing, maintaining or replacing items damaged by saline town water (Lubulwa 1997). The AMDEL study included the impact of salinity on pipework and water fittings, hot water heaters, domestic appliances, water softeners, detergents and soaps, clothing, motor vehicles, garden produce, pot plants and evaporative air conditioners. The 1995/96 salinity cost estimate was 0.67 ($/household/year/EC unit). These results can be used to estimate the costs to households from increases in EC units. The calculations of the cost to urban households due to salinity assume that the households in the upper parts of the catchments are not affected by salinity. Based on survey results for the Loddon and Campaspe catchments (Lubulwa 1997), it is also reasonable to assume that ten percent of all households have a rainwater tank, thus negating any salinity damage effects. This reduces the total number of households affected by salinity in the Northeast Victoria to 15,675, and in the Murray catchment to 23,357. The households in Swan Hill, Echuca, Moama and Barham were not included in the analysis, as it was not possible to separate the effects from the Goulburn/Broken and Loddon/Campaspe catchments. If it is assumed that at the current rate of clearing in the catchments, the annual increase in EC units is 1 μS/cm per year (1 EC unit), then the annual costs to all Northeast Victorian and Murray catchment households are $10,502 and $15,649 respectively.

Carbon sequestration has been highlighted by the Centre for International Economics (CIE 1998) as an important off-site use value of remnant vegetation. Preserving and increasing the area of forest can enable Australia to reduce greenhouse gas emissions and meet international commitments under the Kyoto Protocol. The mechanisms necessary to implement the protocol are still being developed. One possibility being considered is to incorporate carbon sinks, such as forest plantations, into an emissions trading system by allocating credits for the amount of carbon sequestered (stored in plants). Preventing clearing of RNV in the two study areas can make a small contribution to reducing greenhouse gas emissions. An indicative value can be put on the carbon sequestration benefits of preventing RNV clearing by equating them with the estimated value of the equivalent carbon credits. We adopted the most conservative of the estimates reported in AGO (1999) of $10 per tonne of carbon dioxide. On this basis, the annual carbon sequestration benefit of not clearing would be $645,660 per year and $308,250 per year for the Victorian and NSW study areas respectively.

Based on the above value components, present value of the catchment benefits (PVBs) due to retaining remnant vegetation are given in Table 9. Due to the lag time between vegetation clearing and water table rises, it is not meaningful to model the catchment benefits over five years. Hence the calculations have only been done for the 40 year scenario. The potential savings to local government, households and non-farm businesses from ceasing RNV clearing are larger for the NSW study area, where RNV makes up a larger proportion of total tree cover compared with Northeast Victoria.

Table 9. Catchment benefits for the 40 year scenario

	Northeast Victoria ($ million)[1]			**Murray catchment** ($ million)[1]		
	Current situation	*Proposed scenario*	*Net change*	*Current situation*	*Proposed scenario*	*Net change*
4% discount rate						
Cost						
Local government	-1.29	-0.93	0.36	-24.20	-16.96	7.23
Non-farm business	-1.81	-1.27	0.54	-2.17	-1.98	0.19
Households	-0.29	-0.21	0.09	-0.35	-0.23	0.12
Carbon	-8.77	0	8.77	-4.19	0	4.19
PVB			9.76			11.73
7% discount rate						
Cost						
Local government	-0.83	-0.62	0.21	-15.82	-11.51	4.31
Non-farm business	-1.18	-0.86	0.32	-1.49	-1.34	0.15
Households	-0.19	-0.14	0.05	-0.24	-0.16	0.08
Carbon	-6.84	0	6.84	-3.27	0	3.27
PVB			7.43			7.80
10% discount rate						
Cost						
Local government	-0.58	-0.44	0.13	-11.26	-8.49	2.78
Non-farm business	-0.84	-0.63	0.21	-1.11	-0.99	0.12
Households	-0.14	-0.10	0.03	-0.18	-0.12	0.05
Carbon	-5.50	0	5.50	-2.62	0	2.62
PVB			5.87			5.58

[1]rounded to nearest $10,000

6. Extended BCA

In this section, we integrate the three value components computed in Sections 3, 4 and 5, net on-farm costs, community benefits and catchment benefits, into an extended benefit cost analysis. The values were combined to give NPVs computed over two time periods - five years and 40 years (Table 10). Note that, as explained in Section 5, catchment benefits have not been included in the 5 year scenario. An important influence on the result of the BCA was the inclusion or otherwise of the opportunity costs (OCs) faced by landholders if they are prohibited from clearing any RNV. As noted above, OCs were not included in the five year analysis, because landholders wanting to clear to establish pasture, hardwood or softwood plantations, or for horticultural activities such as orchards, would not obtain a return on their investment within five years. The opportunity costs associated with activities such as establishment of orchards and vineyards were very high. We therefore also assessed the effect of excluding these opportunity cost components from the analysis (the limited OCs results in Table 10). Since no NSW participants indicated that they would potentially clear RNV for such alternative uses, this calculation only affected the results for the Victorian study area.

Table 10. Summary of BCA results

	Net Present Value ($ million)	
	Victoria	*NSW*
4% discount rate		
5 year conservation program	29.0	36.6
40 year conservation program, all OCs	-128.6	20.8
40 year conservation program, limited OCs	2.6	20.8
7% discount rate		
5 year conservation program	29.8	40.5
40 year conservation program, all OCs	-44.9	30.6
40 year conservation program, limited OCs	22.5	30.6
10% discount rate		
5 year conservation program	30.5	39.3
40 year conservation program, all OCs	-2.1	35.7
40 year conservation program, limited OCs	33.2	35.7

The BCA shows that there is a net economic benefit in moving to the conservation scenario, provided the orchard and vineyard related OCs are not included in the analysis. Two benefit components underlie the BCA results - a private benefit to the condition and productivity of landholders' properties, and a public benefit associated with biodiversity conservation and aesthetic values. Note that the benefits to properties are entirely due to the prohibition on clearing, whereas the improvements in RNV management and preventing clearing both contribute to protection and enhancement of biodiversity. The costs all accrue to landholders in the two study areas. A compensation payment that encouraged or enabled landholders to manage their RNV according to the conservation scenario would, under most circumstances, yield net economic benefits.

A publicly funded incentive scheme that achieved the conservation outcomes specified in Table 1 would yield net economic benefits provided the payments did not exceed the values, (depending on the assumptions made), given in Table 10. For example, given the five year time horizon and a discount rate of 7%, governments could spend up to \$29.8 million in Northeast Victoria and \$40.5 million in the Murray catchment and still achieve a net economic benefit, provided the conservation outcomes were achieved.

However, no policy has guaranteed outcomes. Since the BCA assumed that the desired conservation objectives will definitely be achieved, the net benefits are over-estimated to the extent that this does not occur. Furthermore, the BCA did not incorporate transaction costs associated with establishing and implementing the policy. These costs arise from activities such as acquiring information about policies, analysing their implications, negotiating and administering contracts, and collecting and administering payments. As demonstrated by Whitby *et al*. (1998), the transaction costs that accrue to both public agencies and landholders with respect to implementation of conservation policies can be considerable. The actual budget for the incentive policy should also be such that the desired conservation outcomes are delivered at minimum possible cost. This will ensure that the net economic benefits of the conservation achievements are maximised. That is, the lower the costs, the larger the surplus of economic value that accrues to the community. A cost effectiveness analysis is beyond the scope of our work, as are assessments of transaction costs and the probability that the desired conservation outcomes will be achieved.

It should also be noted that, due to measurement difficulties, several RNV benefits have not been incorporated into the analysis. These omitted benefits include: the value of species supported by RNV that help control agricultural pests; the contribution riparian RNV makes to protecting fish stocks; and perhaps most significant, the contribution RNV makes to the productivity of properties downstream from the property on which the RNV is located. Our on-farm and catchment benefits are therefore probably underestimates. On the other hand, some economists believe that the stated preference methods we used to measure community WTP for RNV conservation tend to overestimate values. RNV clearing will also cause a change in the quantity of water available for domestic, agricultural and industrial uses. Changes in water yields arising from RNV clearing may be positive if the alternative use is pasture establishment, but negative if plantations, which have higher water demand than RNV, are established. Again, we did not attempt to incorporate these values into the BCA.

Despite these qualifications and limitations, we take the view that imperfect and incomplete economic data is better than none at all. In the ninth report in this series we will use the BCA result to help develop an incentive policy for RNV conservation in the two study areas.

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