Valuing the Protection of Victorian Forests: Murray River Red Gums, and East Gippsland*

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Abstract

The Victorian Environmental Assessment Council, in developing recommendations for the Victorian Government on the future management of public lands forests along the Murray River, and in East Gippsland, commissioned an analysis of environmental protection values. This paper reports the results of a choice modeling application that provides that analysis. Values for improved environmental conditions, as described by attributes relating to the forest composition, its wildlife characteristics and recreational opportunities, were estimated for sub-samples of households in Melbourne and in various regions around Victoria. The usefulness of the results as inputs to benefit cost analyses of policy alternatives is assessed.

Key words: forests, Victoria, choice modeling, benefit cost analysis

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1 Introduction

The Victorian Environmental Assessment Council (VEAC) is an independent Victorian Government statutory body appointed by, and reporting directly to, the Minister for Environment. VEAC works closely with other Government Agencies, particularly the Department of Sustainability and Environment (DSE).

In April 2005, VEAC commenced a major investigation on the River Red Gum (RRG) forests along the length of the Murray River in Victoria and a number of major tributaries and in December 2005 commenced an investigation into old growth forests in the Goolengook Forest Block in East Gippsland (EG)[5]. Maps of the two study areas are shown in Appendices 1 and 2. The VEAC website provides access to a RRG Discussion Paper and information on the Goolengook study.

As part of its statutory role, under the Victorian Environmental Assessment Council Act 2001, VEAC must take into account "the potential environmental, social and economic consequences of implementing" its proposals. Social benefit-cost analysis and social impact assessments are completed for each investigation.

While commercial resource use, and recreation and tourism values are either well known or readily quantifiable, some non-consumptive or non-use values and other un-priced values are harder to quantify and for many areas, relatively poorly known. In previous VEAC assessments these values were extrapolated from other studies using various forms of 'Benefit Transfer'.

The study reported here aims at producing baseline data on unpriced values relating to Victoria's public land. These data will be of immediate use as an input to the separate benefit-cost analysis for VEAC's current River Red Gum investigation. It is also anticipated that the study will have relevance for future VEAC investigations and many DSE projects.

The study is managed by VEAC assisted by a steering committee with joint VEAC and DSE membership.

Victoria has some 8.4 million hectares of public land. VEAC and its predecessors have, since 1971, carried out investigations on behalf of the Government and made land use recommendations for this estate. Successive governments have formally approved the vast majority (over 96 percent) of these recommendations.

[5] The Victorian Government formally stopped VEAC's investigation of the Goolengook Forest Block shortly after the recent election as it had promised that the block would be incorporated into a national park shortly before the election. However, the study described in this paper refers to all of East Gippsland's forests on public land, of which the Goolengook block is a small part (see Appendix 2).

DSE has jurisdiction over almost all of the estate and has been responsible for implementation of recommendations accepted by Government.

2 Background

The Victorian River Red Gum Forests, wetlands and floodplains of the Murray Valley, and the forests in East Gippsland, are valuable environmental resources with many, sometimes competing, land uses giving rise to benefits for a wide range of people. Determining the appropriate balance of these uses from a society-wide perspective requires information about the relative values generated from those uses. It is only with access to such information that trade-offs between competing uses for the resources can be assessed and sound policy and management decisions made. For example, the forests may be managed for recreational use or for timber harvesting. Making that choice is facilitated where information about the benefits society enjoys if an area of forest is set aside for recreational purposes can be directly compared against the benefits generated from the harvesting of its timber. In the case of the RRG forests, grazing is a licensed activity. Significant ecological values may be affected by these or other activities. Or the forests could be managed for a range of recreation, conservation and minor resource uses, as was recommended for the Forest Park category of land use in the recent Otway Ranges investigation undertaken by VEAC.

Information about the commercial value of timber production, mining and grazing in the River Red Gum and East Gippsland Forests is readily available from the markets in which the products are exchanged. More problematic is the estimation of values associated with forest benefits that are not marketed. These benefits arise from recreation and tourism activities, ecosystem conservation and protection of cultural heritage.

If resource management decisions are made with reference only to information on the values of the marketed benefits, there is a risk that the outcome will not be in the best interests of society as a whole. Efforts to estimate the non-marketed (un-priced) benefits are therefore to be encouraged in order to secure balanced decision making.

The non-market values of forests can be based on evidence of such values collected from other case studies. For example, the international EVRI database maintained by the Canadian EPA sets out the results of non-market valuation exercises in a wide range of different contexts. Value estimates could be extracted from that database and used as approximations for the values of the River Red Gum Forests. This practice – called ‘benefit transfer’ – is prone to inaccuracies if there is no strict comparability between the circumstances of the case at hand and those pertaining to the original study site. This is likely to be the case with the River Red Gum and East Gippsland Forests because their characteristics, both in terms of their ecology and the human communities that enjoy their benefits, are not represented in any existing valuation study. Hence, using benefit transfer as a means of generating value information for resource management decisions may not be satisfactory in these cases.

The alternative is to conduct original research with the specific goal of estimating the non-marketed benefits of the River Red Gum and East Gippsland Forests. Because of the need to collect primary data in order to pursue this alternative, this type of original research is normally more expensive than a benefit transfer exercise. However, given the economic, environmental and social significance of the forests under review, the improvement in information precision achieved by conducting a specific valuation exercise is likely to be worth the additional costs. The case studies span widely different forest types, providing useful valuations for use in other investigations.

Considerable effort has been applied to the development of specific non-market valuation techniques over the past 30 years. Of specific interest in the context of the River Red Gum and East Gippsland Forests is the Choice Modelling (CM) technique[6]. In brief, the technique involves a sample of people enjoying the forest's non-market benefits being asked to make a sequence of choices between alternative resource management strategies. From their choices, it is possible to infer the values that they place on the various benefits they enjoy from the forests. The technique's flexibility in application enables it to be adapted to the specifics of the decision making context at hand. Its development over the past ten years has shown it to be a robust and reliable tool for natural resource management. In the context of the VEAC study, Choice Modelling can be used to compare the values of marketed and non-marketed benefits of forest management options, including any recommended changes to non-commercial activities such as recreational opportunities.

In our experience a practical outcome of quantifying non-market benefits is that it assists in resolving conflicts between the various vested interest groups and helps to clarify the choices open to those who ultimately make decisions on the balanced use of public land[7]. The values derived from this exercise can be directly included in social benefit-cost analysis and social assessments of VEAC's draft proposals and final recommendations.

3 Questionnaire Development

The first task in designing the application of the choice modeling methodology is to define the set of attributes used to describe the benefits derived from forests. This requires that the views of forest managers and scientists (who 'supply' the attributes) and the views of the communities (who 'demand' the attributes) be considered. Both groups must be involved in the process of attribute definition – the former through consultation with forest managers and other experts, the latter through focus groups.

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[6] Use of this technique was favoured by VEAC in its brief for the project. See references by Bennett et al., Rolfe, and Van Bueren for discussion of this method.

[7] See references by Dumsday et al. and URS for earlier studies based on benefit transfer.

The second task involves setting the ranges over which the attributes are varied for each forest area.

The third task involves developing questionnaires to assess the values attaching to the attributes in each relevant community.

The final task is to design and print the questionnaires.

Each of the tasks is now considered in more detail.

3.1 Developing sets of attributes

The purpose of this task is to develop a set of attributes that can be used to describe the non-marketed benefits of forests.

(a) 'Supply-side' issues

The attributes defined as the 'supply-side' determinants of the final set of attributes, are those considered relevant to the management of a forest from the perspective of the policy makers, forest managers and their scientific advisers. From the 'supply-side' perspective, the attributes must be useful in the policy determination process. Therefore, they must be consistent with the environmental variables scientists are able to predict will change when forest management actions change, and for which scientific information is available. Experts from Deakin University, Arthur Rylah Institute (ARI), DSE and VEAC staff, and land managers (see Appendix 3) were consulted in this 'supply-side' process of attribute definition. The purpose of these consultations was to decide the short list of the forest attributes in the various categories that best represents the management and scientific perspective.

An initial meeting of the selected experts, VEAC staff and the authors led to a preliminary set of attributes being constructed and justified. Subsequent refinement of the set, in particular as a result of feedback from the 'demand-side' perspective, involved meetings of the expert group and several meetings between VEAC staff and the authors.

It was considered desirable to restrict the final number of attributes to four (excluding the 'cost' attribute) in order to make the exercise tractable for those responding to the questionnaire.

(b) 'Demand-side' issues

On the 'demand-side', the forest attributes were refined through a sequence of focus groups designed to reflect the understanding of forest issues by members of the general public. Focus group meetings involving about 10 participants each were held in Melbourne, Echuca (RRG), and Bairnsdale (EG).

From the perspective of the 'demand-side', the attributes must be meaningful to the respondents in the choice modeling survey. Environmental attributes that are outside the experience of respondents are unlikely to encourage reliable responses.

The first focus group was held in Melbourne at which it became apparent that there was little understanding of the issues involved in the two study areas. Draft questionnaires and information sheets were developed for the meetings in Echuca and Bairnsdale at which the participants were asked to complete the draft questionnaires as part of the exercise.

(c) Attribute selection

The authors in conjunction with VEAC staff and members of a steering committee (see Appendix 3) selected the final set of attributes from consideration of both the 'demand-side' and 'supply-side' perspectives.

3.2 Setting levels and ranges of attributes

In consultation with staff from VEAC, DSE, ARI and land managers, and from information gained from the focus groups, two sub-tasks were undertaken. The first was to specify the quantities or qualitative descriptors for each attribute. The second sub-task was to determine, for each of the forest areas, the appropriate ranges over which the attribute levels may vary in the future, say, over the next 20 years, under current management strategies, and with management options determined by VEAC staff, the steering committee and experts in the relevant fields.

The resulting attributes that were finally selected, together with their levels, are shown in Table 1 for River Red Gum Forests and Table 2 for East Gippsland Forests.

Table 1 Attributes and their Levels for River Red Gum Forests

Attribute	Description	Levels
Cost	Compulsory annual payment ($)	0, 20, 50, 100
Healthy RRGs	Area in hectares	54000, 67000, 74000, 80000
Threatened Parrots	Number of breeding pairs	900, 1200, 1500, 1800
Murray Cod	And other threatened native fish. Percentage of pre-European numbers	10,20, 40, 60
Recreation Facilities	Number of campsites with facilities	6, 9, 12, 18

Table 2 Attributes and their Levels for East Gippsland Forests

Attribute	Description	Levels
Cost	Compulsory annual payment ($)	0, 20, 50, 100
Threatened Owl Species	Number of breeding pairs	400, 440, 460, 500
Threatened Long-Footed Potoroos	Number of individuals	2000, 2500, 3000, 4000
Significant Rainforest Sites	Number of hectares protected	3350, 4000, 4500, 5000
Old Growth Forest	Number of hectares protected	172000, 190000, 215000, 240000

3.3 Finalising the Choice Modeling questionnaires

This stage included the determination of an appropriate context or frame for the questioning, a statement of the relevant forest issues, potential strategies to deal with the forest issues, an appropriate payment vehicle, and a range of matters relating to the presentation of the questionnaires and the information embedded therein.

The survey materials contained the following main elements:

- background information about the forest areas in the form of separate full colour information sheets which also contained maps of the study areas;
- questions relating to respondents attitudes towards, and uses of, the forest area;
- explanations of the issues and trade-offs in use of the forests, ways in which management might be improved, why people should have to pay for improving forest health, how they might do this, and what could be achieved;
- the choice sets;
- debriefing questions; and
- questions to establish the socio-economic characteristics of respondents.

Much of this development was informed by material on potential respondents' attitudes and capacities collected during the focus groups. Two basic versions of the questionnaire were developed – one for each of the two study areas (RRG and EG). Development and testing of the questionnaires involving peer review, discussions with VEAC staff and consultation with selected experts. Earlier versions of the questionnaires had been piloted in the focus groups.

3.4 Designing and Printing Questionnaires

Professional graphic designers, and appropriate print quality were used to ensure that the questionnaires were taken seriously by the respondents with the aim of eliciting a high response rate from respondents with diverse backgrounds and educational levels.

Final versions of the questionnaires and information sheets are available from the authors. An example choice question is shown in Appendix 4.

4 Survey Logistics

4.1 Sample selection

Previous research has found it appropriate to involve both the community within each region and the general community outside the region. In order to reduce funding requirements for this study, only one out-of-region sample for each forest area was used. These samples will be used to confirm whether the attribute values of the out-of-region community (eg. Melbourne) differ from those of the within-region community.

VEAC required representation from rural areas, rural urban areas, as well as Melbourne in the selected samples.

The sampling design is summarised in Table 3.

Table 3 Selection of Samples

	REGION				
	Melbourne (out of region)	**Murray Region**		**Gippsland Region**	
STUDY AREA					
River Red Gums (RRG)	1. Metro	2. Echuca/ 3. Mildura/ 4. Wodonga	5. Rural	6. Bairnsdale (out of region)	
East Gippsland Forests (EG)	7. Metro	8. Rural (out of region)		9. Bairnsdale	10. Rural

4.2 Survey method

Experience in recent CM surveys has demonstrated that mail out surveys are becoming increasingly difficult to manage – mainly because of privacy laws which restrict access to up-to-date databases of potential respondents. Other options considered included telephone contacting of potential respondents followed by mail out; and face to face interviews of respondents. These methods were ruled out because of cost considerations.

VEAC applied on our behalf to have access to the electoral roll but the application was rejected.

The 'drop off/pick up' (DOPU) method was finally selected – with some trepidation due to possible blow-outs in cost. At the suggestion of Leo Hamilton, a consultant and member of the Lions Club in Bairnsdale, we opted to contract the Lions Clubs in each of the urban survey regions to undertake the surveys for a fixed fee per completed questionnaire completed. This arrangement worked well for both parties, particularly in rural towns where the Lions Clubs are well known and widely respected. Rural areas outside towns and cities were managed by Catchment Management Authorities (CMAs) and Landcare Groups, but as is shown in Appendices 3 and 4, collection rates in these areas were low, with collectors suggesting that the drought had a major impact on response rates.

The DOPU method involved random selections of streets and households within streets, for each of the urban and rural areas to be sampled[8].

Determining actual response rates, which allow for rejection by households, has not yet been completed as it involves analysis of a large number of records kept by survey collectors. However, response rates in rural towns were generally high (around 75%) compared with those in Melbourne (around 50%), East Gippsland Rural (50%), or other rural non-urban areas (around 15%).

5 River Red Gum Forests Along the Murray

5.1 Sample Characteristics

A total of 1,017 surveys were collected (Table 4), with 451 respondents from the in-catchment urban sub-samples of Echuca, Mildura and Wodonga. 257 surveys were collected in the outside-catchment urban sub-sample (Melbourne) and 237 surveys in the rural outside-catchment sub-sample (Bairnsdale). There were 72 respondents from the in-catchment rural subsample.

The average household income is highest in the Melbourne sample with $71,957 per year and lowest in the Bairnsdale subsample with $48,475 per year. The total sample is comprised of around 45% males, with a mean age of 50 years and a mean education level of 12.3 years. The majority of the sample respondents (nearly 75%) have children.

As well as socio-economic variables, data were collected on membership of an environmental organisation, affiliations with the agricultural industry and affiliation with the timber industry. On average, 17.7% of the respondents, or a member of their close

[8] The degree to which the samples are representative of the regional populations is yet to be formally tested.

family, is a member of an environmental organisation, with the highest proportion in the in-catchment rural subsample (61%)[9] and lowest in the Mildura subsample (10%). Association with the agricultural industry is nearly 30% for the total subample, varying from 85% in the in-catchment rural subsample to 11% in the Melbourne subsample. Association with the timber industry is generally low at less than 7%.

Data on visitation of the River Red Gum Forests and levels of confusion caused by the choice questions were also collected. Nearly 75% of all respondents had visited the forests at least once. Approximately 30% of the respondents agreed with the statement that the choice questions were confusing.

Table 4 Sub-sample Characteristics – River Red Gum Forests

Variable	Total	Melbourne	Echuca	Mildura	Wodonga	Murray Rural	Bairnsdale
Sample size (# resp)	1,017	257	165	155	131	72	237
Income (av $ pa)	59,047	71,957	55,671	55,558	60,654	57,669	48,475
Gender (% male)	44.8	52.5	61.8	66.5	55.0	50.0	49.8
Age (av. yrs)	50	45.3	57.3	50.7	51.2	45.4	51.6
Education (av. yrs)	12.3	12.9	11.9	12.1	12.4	12.8	12.0
Children (% with)	74.7	62.7	83.6	83.2	80.2	63.9	76.4
Member of environmental organisation (%)	17.7	15.6	18.2	9.7	13.0	61.1	14.4
Associated with timber industry (%)	6.5	2.3	5.5	3.2	2.3	13.9	13.9
Associated with agricultural industry (%)	29.5	10.9	39.4	36.1	23.7	84.7	24.9
Visited RRG forest (%)							
Never	25.9	34.2	8.5	7.1	23.7	8.3	47.7
Once – ten times	37.3	55.3	15.8	21.3	30.5	50.0	43.0
More than ten or living near RRG	36.5	10.5	75.8	70.3	45.0	41.7	8.9
Choice sets were confusing (%)							
(Strongly) agree	30.4	22.2	37.6	27.7	40.5	29.2	30.8
Neither	27.0	26.5	26.1	29.0	25.2	26.4	28.3
(Strongly) disagree	38.9	49.0	29.1	40.6	31.3	43.1	36.7

[9] The small numbers of respondents in this sub-sample suggests that this proportion is the result of a non-representative sample.

5.2 Choice Models

Data from the sub-samples for Melbourne, Bairnsdale and all three in-catchment sub-samples (Echuca, Mildura and Wodonga) were analysed using conditional logit models. Results of the modeling are reported in Table 5. The 'within-region' sub-sample is an aggregate of the Echuca, Mildura and Wodonga sub-samples in Table 6. Due to the small number of respondents, it was not possible to estimate choice models for the in-catchment rural sub-sample (sub-sample 5).

Of the total 1,017 respondents, 98 did not answer the question relating to income. Rather than dropping these respondents from the analysis, their income was taken to be the average value of all respondents who had provided an answer. A dummy variable was included to account for any systematic differences between respondents who did not reveal their income and those who did. The same strategy was followed for the 25 respondents who did not answer the education question.

Two choice models are presented for each sub-sample: one that involves only the choice attributes as explanatory variables and a second that also incorporates significant socio-economic and attitudinal variables ('full model'). The 'Cost', 'Parrots' and 'Cod' attributes are highly significant in all sub-samples with the expected signs. 'Healthy RRGs' is significant and positive in the Melbourne and Bairnsdale sub-samples. The results from Table 5 indicate that reducing the costs, increasing the area of healthy RRG forests, increasing the number of breeding parrot pairs or increasing the percentage of pre-European numbers of Murray Cod and other threatened native fish will increase the probability of choosing that specific choice alternative. The Alternative Specific Constant (ASC) is negative and significant in all three full models reported in Table 5. This indicates that respondents have a systematic tendency to choose the status-quo option over the change alternatives.

The socio-economic variables must be interacted with the ASC to avoid singularities in the determining matrix. Most of the significant socio-economic variables have the expected signs. Visitation and education are both positive, as is understanding of the information provided on the survey poster. The confusion variable is negative and significant, indicating that respondents who are confused by the choice questions are more likely to choose the status quo alternative over the other forest management alternatives. A consistent result across sub-samples is that respondents who did not reveal their income are less likely to support changes in forest management. As expected, respondents who are a member of an environmental organisation (green) are likely to support changing forest management and respondents who are associated with the agricultural industry (farm) are likely to prefer the current situation. Different activities in the Murray River Red Gum forests are significant across subsamples. While bushwalking is postive and significant in the Melbourne and Mildura subsample, it is bird-watching that is postive in the Echuca

subsample. Fishing is negative and significant in the Melbourne and Bairnsdale subsamples.

Table 5 River Red Gum Choice Models

MELBOURNE SUB-SAMPLE			BAIRNSDALE SUB-SAMPLE			WITHIN REGION SUB-SAMPLE		
Variable	Attributes only	Full	Variable	Attributes only	Full	Variable	Attributes only	Full
ASC	.46806127*	-3.2533998***	ASC	-.9732347***	-3.319104***	ASC	.58576016***	-2.5477564***
Costs	-.01864674***	-.01918739***	Costs	-.0061489***	-.0071015***	Costs	-.01249953***	-.01278176***
Healthy RRGs	.00001538*	.00002335***	Healthy RRGs	.00002825***	.00002745***	Healthy RRGs	-2.448e-06	-3.811e-06
Parrots	.00082225***	.00078771***	Parrots	.00054297***	.0007266***	Parrots	.00035025***	.00041489***
Cod	.01641934***	.01856602***	Cod	.00931378***	.0101509***	Cod	.01426017***	.01500962***
Recreation	-.00751282	-.0104725	Recreation	-.00449364	-.00655402	Recreation	-.00642559	-.00684472
kidsasc		-.68570687***	hhasc		.20171602***	genasc		-.32734978***
hhasc		.15036556**	noincasc		-1.099954***	eduasc		.20683764***
eduasc		.15140103**	noeduasc		-1.922081***	noincasc		-.84587054***
noincasc		-.60282061***	visasc		.7739641***	noeduasc		.78547883*
visasc		.32884282***	underasc		1.0787074***	visasc		.12345404***
underasc		1.0386463***	infoasc		.37965786***	underasc		.69820839***
infoasc		-.3824247***	confasc		-.4604429***	confasc		-.25202418***
confasc		-.41258228***	greenasc		.54862523**	greenasc		.31592196
greenasc		.60266056**	fishasc		-1.554244***	farmasc		-.32743651**
walkasc		.63709436**				walkasc		.33075197**
fishasc		-.71376916**				birdasc		.49415085**
Observations	3735	3405	Observations	3210	2748	Observations	6309	5709
Pseudo R^2	0.1324	0.2043	Pseudo R^2	0.0224	0.1386	Pseudo R^2	0.0645	0.1245
Log likelihood	-1186.74	-992.19	Log likelihood	-1149.13	-866.88	Log likelihood	-2161.32	-1830.35

Notes: Significance levels indicated by: * 0.1, ** 0.05, *** 0.01

Table 6 Individual Choice Models for Echuca, Mildura and Wodonga

ECHUCA SUB-SAMPLE			MILDURA SUB-SAMPLE			WODONGA SUB-SAMPLE		
Variable	Attributes only	Full	Variable	Attributes only	Full	Variable	Attributes only	Full
asc	.28207326	-.24450679	asc	.55332021*	-4.1185374***	asc	1.0655748***	-12.725356***
Costs	-.01272969***	-.01354269***	costs	-.01016432***	-.01161112***	costs	-.0153459***	-.01656593***
Healthy RRGs	-4.039e-06	-9.033e-08	Healthy RRGs	-2.041e-06	-.00001048	Healthy RRGs	-6.961e-07	-6.656e-06
Parrots	.00019931	.00034834	parrots	.00045077**	.00055754**	parrots	.00040762*	.0004718*
Cod	.01412797***	.01360857***	cod	.01573862***	.01663345***	cod	.01268265***	.01294256***
Recreation	.00878649	.01315162	recreation	-.0041664	-.00351118	recreation	-.02703123*	-.03054834*
genasc		-.41429394**	genasc		-.48426858**	logincasc		1.1635493***
noincasc		-1.0495774***	eduasc		.37989301***	visasc		.30875901***
visasc		.15351043**	visasc		.13593121*	underasc		.55531552***
underasc		.80427969***	infoasc		-.32623746**	infoasc		-.56441834***
confasc		-.3647774***	confasc		-.26353495*	greenasc		3.10055***
walkasc		-.83615024***	farmasc		-.66262746***			
birdasc		1.325478***	walkasc		1.4372984***			
Observations	2271	2076	Observations	2160	1950	Observations	1878	1743
Pseudo R^2	0.0468	0.1271	Pseudo R^2	0.0771	0.1458	Pseudo R^2	0.0975	0.1890
Log likelihood	-792.71	-663.61	Log likelihood	-730.02	-609.99	Log likelihood	-620.69	-517.66

Notes: Significance levels indicated by: * 0.1, ** 0.05, *** 0.01

5.3 Implicit prices

The full models reported in Table 5 and Table 6 have been used to estimate the marginal values of the Healthy RRGs, Parrots, Cod and Recreation attributes. These values are expressed in terms of implicit prices; the marginal willingness to pay for a one-unit increase in the attribute. Implicit prices are calculated by dividing the estimated coefficient for the attribute by the estimated coefficient on the cost attribute.

The results in Table 7 show that respondents in the Bairnsdale and Melbourne sub-samples are willing to pay $3.90 and $1.2 respectively for a 1,000 hectare increase in the area of healthy River Red Gum forest. Within region respondents recorded implicit prices that are not significantly different from zero. Respondents – apart from those in Echuca and Wodonga – were found to attach a positive value to the number of breeding pairs of parrots, ranging from three to ten cents. The willingness-to-pay for a one-percent increase in the number of Murray Cod and other threatened native fish species varies from $0.78 in the Wodonga sub-sample to $1.40 in the Bairnsdale sub-sample. Implicit prices for recreation are not significant for any of the sub-samples.

Table 7 Implicit Price Estimates for River Red Gums

Sub-sample	Bairnsdale	Melbourne	Within region	Echuca	Mildura	Wodonga
Attribute						
Healthy RRGs	0.0039*	.0012**	-.0003	-6.67e-06	-.0009	-.0004
	(-.001 ~ .009)	(.000 ~ .002)	(-.002 ~ .001)	(-.002 ~ .002)	(-.003 ~ .002)	(-.003 ~ .002)
Parrots	0.102*	.041***	.032**	.0257	.048**	.028
	(-.010 ~ .215)	(.019 ~ .063)	(.004 ~ .060)	(-.022 ~ .074)	(-.006 ~ .102)	(-.011 ~ .067)
Cod	1.429*	.968***	1.174***	1.005***	1.433***	.781**
	(-.149 ~ 3.01)	(.542 ~ 1.39)	(.704 ~ 1.64)	(.252 ~ 1.76)	(.565 ~ 2.30)	(.159 ~ 1.40)
Recreation	-.923	-.546	-.536	.971	-.302	-1.84
	(-5.64 ~ 3.79)	(-1.91 ~ .818)	(-2.23 ~ 1.16)	(-1.79 ~ 3.73)	(-3.98 ~ 3.38)	(-4.33 ~ .64)

Notes: Significance levels indicated by: * 0.1, ** 0.05, *** 0.01
95% confidence intervals in parentheses.

6 East Gippsland Forests

6.1 Sample characteristics

A total of 722 surveys were collected (Table 8), with 269 surveys from the outside-region urban (Melbourne) sub-sample, 316 surveys from in-region urban sub-sample (Bairnsdale) and 112 surveys from the in-region rural sub-sample. There were insufficient respondents (26) in the outside-region rural (Murray) sub-sample to warrant model estimation.

The average household income is highest in the Melbourne sub-sample with $77,747 per year and lowest in the Bairnsdale sub-sample with $48,084 per year. The total sample is comprised approximately of 49% males, with an average age of 48.5 years and an average education of 12.4 years. The majority of the sample respondents (nearly 75%) has children.

Table 8 Sub-sample Characteristics – East Gippsland Forests

Variable	Total	Melbourne	Murray Rural	Bairnsdale	East Gippsland Rural
Sample size (# resp)	722	269	25	316	112
Income (Av $ pa)	60,565	77,747	53,547	48,620	48,084
Average age (yrs)	48.5	43.2	45.5	52.2	51.2
Education (Av yrs)	12.4	12.7	13.0	11.9	12.6
Gender (% male)	49.3	43.1	56.0	53.8	50.0
Children (% with)	74.7	32.0	32.0	17.7	25.0
Member of environment org (%)	21.1	11.9	56.0	11.1	63.4
Associated with timber industry (%)	10.3	2.6	8.0	14.6	17.0
Associated with agricultural industry (%)	25.0	10.0	68.0	24.4	52.7
Visited EG forest (%)					
Never	18.7	39.8	36.0	6.0	0.0
Once – ten times	29.7	55.0	48.0	14.9	7.1
More than ten or living near EG forests	50.4	4.8	16.0	77.5	91.1
Choice sets were confusing (%)					
(Strongly) agree	34.2	23.4	16.0	41.5	43.8
Neither	23.7	26.8	36.0	20.3	23.2
(Strongly) disagree	36.5	48.7	44.0	29.4	25.9

On average, 21.1% of the respondents are members of an environmental organisation, with the highest proportion in the East Gippsland Rural subsample (63%) and lowest in the Bairnsdale subsample (11%). One-quarter of the all respondents, or a member

of the close family, is associated with the agricultural industry. As in the River Red Gum Forest survey, the association with the timber industry is low at about 10%.

Not surprisingly, all respondents in the in-region rural sub-sample had visited the East Gippsland forests or lived in the region. Overall, more than 80% of the respondents had visited the East Gippsland forests at least once. Approximately 34% of the respondents agreed with the statement that the choice questions were confusing.

6.2 Choice models

Data from three sub-samples were analysed using conditional logit models: Melbourne, Bairnsdale and East Gippsland Rural. There were insufficient observations to include the rural outside-region sub-sample (sub-sample 8) in the analysis.

A total of 77 out of 722 respondents (or 11%) did not answer the income question. For these respondents, income was replaced by the sample average and a dummy variable for no-reported income was included in the analysis.

Table 9 presents two choice models for each sub-sample. One model includes only the choice attributes as explanatory variables, the second (full) model includes additional significant socio-economic and attitudinal variables. Other than Rainforest in the Bairnsdale sub-sample, all choice attributes are significant across the three samples with their expected signs. Increasing the numbers of Owls or Potoroos and increasing the area of protected Rainforest or Old growth forest will increase the well-being of respondents. The ASC is negative and significant in most choice models, revealing a bias towards the status quo choice.

The effects of socio-economic characteristics on East Gippsland forest management alternatives differ across sub-samples. While age is positive in the Melbourne sub-sample, it is negative in the Bairnsdale sub-sample. Log of income and education are both positive, indicating that higher income or more years of education increase the probability of supporting changed forest management. Confusion by the choice questions is negative across the sub-samples, as is the dummy variable for no reported income.

Of the activity variables, swimming and fishing are important for the Melbourne respondents, bird-watching and hunting for the Bairnsdale respondents and bird-watching and fishing for the East Gippsland Rural sub-sample.

Table 9 East Gippsland Choice Models

MELBOURNE SUB-SAMPLE			BAIRNSDALE SUB-SAMPLE			EAST GIPPSLAND RURAL SUB-SAMPLE		
Variable	Attributes only	Full	Variable	Attributes only	Full	Variable	Attributes only	Full
Asc	.5952771***	-6.8534876***	Asc	-.3610463	-7.255519***	Asc	-.71379347*	-44.309432***
Costs	-.01678974***	-.01792745***	Costs	-.0144656***	-.0158214***	Costs	-.00631806***	-.00670313***
Owls	.00273692*	.00324457*	Owls	.00305966*	.00389473**	Owls	.00436147*	.00444153
Potoroos	.00025118***	.00027287***	Potoroos	.00016089**	.00018706***	Potoroos	.00034026***	.00029472***
Rainforest	.00020306**	.00019481*	Rainforest	.00002518	.00011036	Rainforest	.00040883**	.00039903**
Old growth forest	.00001067***	.00001141***	Old growth forest	4.912e-06**	4.792e-06**	Old growth forest	.00001471***	.00001601***
ageasc		.04730653***	ageasc		-.0146095***	genasc		-1.5198387**
kidsasc		-1.2368817***	genasc		-.6367498***	hhasc		.59890809***
hhasc		.14439161*	hhasc		-.13332198**	logincasc		1.2552134**
eduasc		.38489649***	logincasc		.38760872***	eduasc		1.6176147***
noincasc		-.62226053**	eduasc		.24166295***	noincasc		-2.3326497**
underasc		1.1029487***	noincasc		-.4449471***	visasc		3.4008838***
infoasc		.20148238*	visasc		.18062465***	infoasc		1.242989***
confasc		-.30639092***	underasc		.89066649***	confasc		-1.1031643**
greenasc		.82026988**	confasc		-.1781715**	farmasc		-5.2573421***
farmasc		-1.0903175***	birdasc		1.2915415***	timbasc		-2.4038793***
swimasc		1.6124005***	huntasc		-.55977745**	birdasc		6.5262408***
fishasc		.98577952**				fishasc		-2.1586713***
Observations	3951	3744	Observations	4374	3846	Observations	1467	1272
Pseudo R^2	0.1306	0.2007	Pseudo R^2	0.0677	0.1513	Pseudo R^2	0.0953	0.3657
Log likelihood	-1257.93	-1095.89	Log likelihood	-1493.41	-1195.26	Log likelihood	-486.03	-295.47

Notes: Significance levels indicated by: * 0.1, ** 0.05, *** 0.01

6.3 Implicit prices

The final Conditional Logit models are used to generate attribute implicit prices (Table 10). The marginal willingness to pay for increasing the number of breeding pairs of threatened owl species is only significant for the Bairnsdale sub-sample. The willingness to pay for increasing the number of threatened long-footed potoroos by 10 individuals varies between $0.12 for Bairnsdale respondents to $0.15 for Melbourne respondents. Respondents in the Bairnsdale and Melbourne sub-sample are willing to pay, on average, three to six cents for a 100 ha increase in the area of protected old growth forest. None of the attribute implicit prices are significant in the East Gippsland rural sub-sample.

Table 10 Implicit Price Estimates for East Gippsland Forests

Sub-sample →	Bairnsdale	Melbourne	East Gippsland Rural
Attribute ↓			
Owls	.246*	.181	.663
	(-.015 ~ .507)	(-.045 ~ .407)	(-8.21 ~ 9.54)
Potoroos	.0118**	.0152***	.044
	(.0015 ~ .022)	(.0053 ~ .025)	(-.198 ~ .29)
Rainforest	.0069	.0109	.059
	(-.010 ~ .024)	(-.004 ~ .025)	(-.791 ~ .910)
Old growth forest	.0003*	.00064***	.0024
	(.000 ~ .0006)	(.000 ~ .0009)	(-.013 ~ .018)

Note: Significance levels indicated by: * 0.1, ** 0.05, *** 0.01
95% confidence interval in parentheses.

7 Application to BCA of Policy Options

The implicit prices estimated from the choice data are directly applicable to the consideration of alternative forest management options. Specifically, they are compatible, as welfare change measures, with the principles of Benefit Cost Analysis (BCA). The process of employing implicit prices in BCAs involves four basic stages.

1. Predicting the impact of a management change on the attributes used in the choice modeling exercise relative to the predicted continuation of the 'status quo'.

2. Multiplying the implicit prices by the respective predicted attribute change to estimate the per respondent household willingness to pay for each attribute change.

3. Aggregating the per respondent household willingness to pay across all attribute changes.

4. Extrapolating across the relevant population, using the survey response rate, to estimate the societal willingness to pay for the management change.

These stages can be made more sophisticated through the recognition of divergences between the survey respondent characteristics and those of the population, the prospect of survey non-respondents having positive values for attribute impacts and different sub-samples having different implicit prices, socio-economic characteristics and response rates.

An example will illustrate these key stages and their potential complexities.

Consider a policy initiative – perhaps the setting aside of more River Red Gum Forests as nature reserves rather than production forests. Consultation with bio-physical scientists and forest managers yield predictions that the change in land use will cause (over the next 20 years):

- 500 more hectares of healthy River Red Gum Forests
- 10 additional breeding pairs of parrots
- 5 per cent more of pre European numbers of Cod
- 2 more camping sites with facilities

In Table 11, a spreadsheet approach to developing the per respondent household benefit associated with these changes is set out.

Table 11 Calculating Benefits from a Management Change for RRGs

Column	1	2	3	4	5	6	7
		Bairnsdale		Melbourne		In-catchment	
Attribute	Physical change	Implicit price	Benefit/ respondent h'hold ($) (1x2)	Implicit Price	Benefit/ respondent h'hold ($) (1x4)	Implicit Price	Benefit/ respondent h'hold ($) (1x6)
Healthy RRGs	500	.004	2.00	.001	0.50	0	0
Parrots	10	0.10	1.00	0.04	0.40	0.03	0.30
Cod	5	1.43	7.15	0.97	4.85	1.17	5.85
Camping sites	2	0	0	0	0	0	0
Total			10.15		5.75		6.15

To extrapolate these sample estimates to the wider population, the number of households in each of the regions from which the sub-samples have been drawn is required. The response rate is then used in the extrapolation process on the conservative assumption that non-respondents receive no benefit from the projected physical changes:

Benefit = Σ (Benefit per respondent household × regional population × sample response rate)

Implementing this approach to the illustrative case above:

Benefit ($m) = (10.15 × Victorian outside-region rural centres' populations of households[10] × Bairnsdale response rate[11]) + (5.75 × Melbourne population of households × Melbourne response rate) + (6.15 × Victorian in-region urban centres' populations of households × in-region urban response rate)

= (10.15 × 0.3 × 0.7) + (5.75 × 1.3 × .5) + (6.15 × 0.1 × 0.8)

= $6.36m per annum over 20 years

With this estimate of the environmental benefits arising from the change in forest management, it is possible to assess the net impact on community well-being that results from the change using BCA. This would require estimation of the opportunity costs imposed by restricting other uses of the land area, such as timber harvesting or grazing. In this way, the implicit prices determined in the choice modeling exercise

[10] Assumed no. of households (2006) = 1.8m for Victoria; 1.3m Melbourne; 0.4 m rural towns; 0.1m Vic rural; 0.1m Murray region towns; 0.3m out of region towns (estimated based on 2001 ABS data).
[11] Response rates = 70% for Bairnsdale; 50% Melbourne; 80% in region urban centres.

are a key component of the information required by decision makers to assess alternative future management options.

8 Conclusions

Beyond providing an outline of the VEAC-commissioned valuation study, a key aim of this paper has been to demonstrate the use of choice modeling as a practical tool to assist natural resource managers in deciding between alternative future management options. For many years, the use of BCA as a decision making tool was limited in contexts where non-marketed environmental benefits and costs were important, simply because of the economics profession's inability to generate robust and accurate estimates of value. The development of non-market valuation techniques over the past 30 years has resulted in the establishment of BCA as a useful and now practical aid to decision makers.

In particular, Choice Modelling has been shown to have particularly attractive features as a non-market valuation technique. Its capacity to generate implicit prices for environmental attributes that can then be used in a spread sheet or decision support tool format to allow the estimation of values arising from multiple scenarios of resource management is useful when specific alternatives have not been predetermined in the policy process. In the VEAC application outlined in this paper, the flexibility this characteristic of choice modeling affords makes it especially suitable. Because of the consultative nature of the VEAC inquiry process, no alternative forest management options have yet been designated. Choice modeling results of the type presented here allow decision makers to explore the benefits of multiple alternatives through a single study.

Finally, there have been few original surveys of the type reported here and the results will be useful in further applications of benefit transfer.

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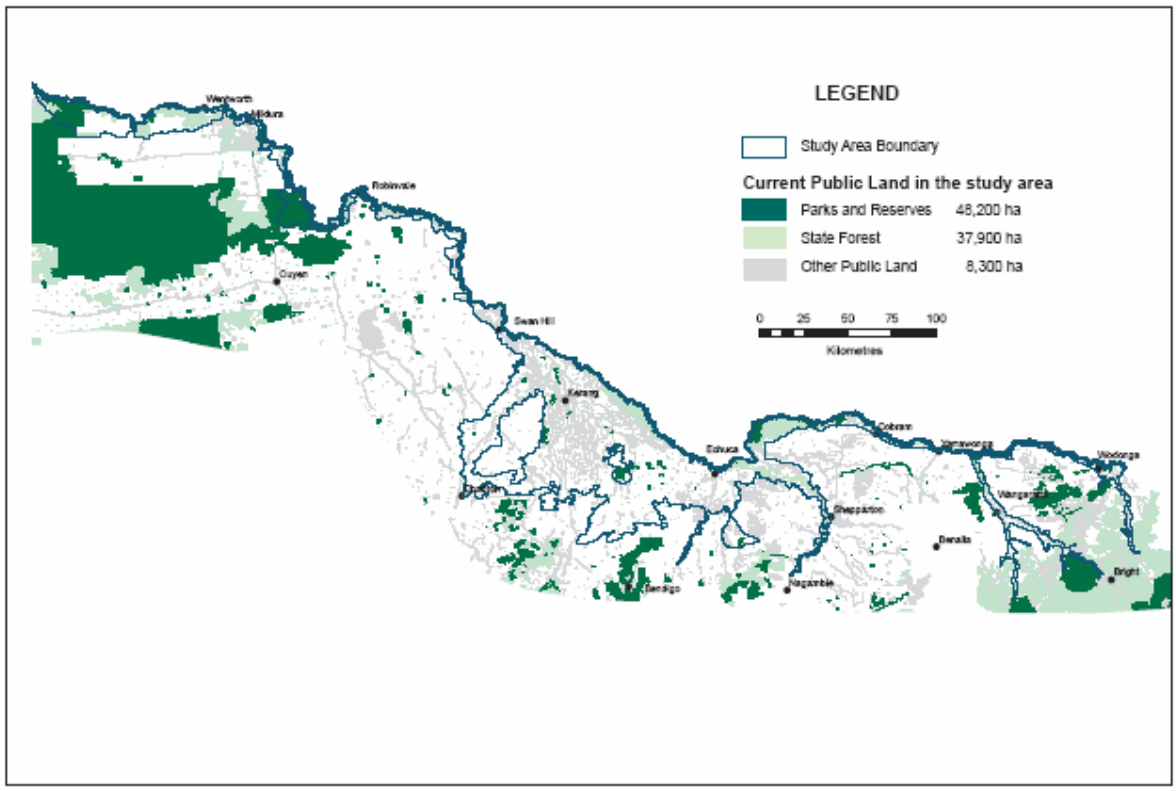
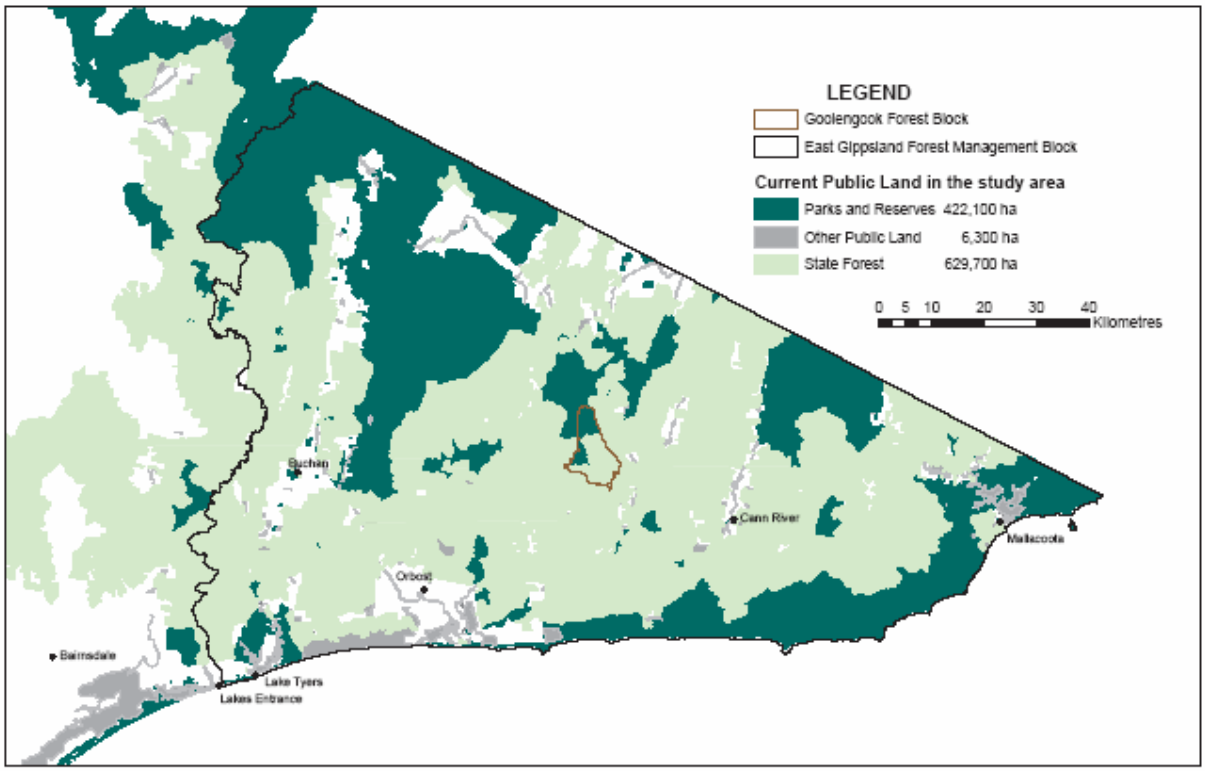
VEAC's website: http://www.veac.vic.gov.au/

Appendix 1 Study Area for the River Red Gum Forests



Appendix 2 Study Area for the East Gippsland Forests



Appendix 3 Experts Consulted

Members of the expert panel which developed and refined the attributes:

Dr Andrew Bennett, Deakin University; Dr David Parkes, DSE; Peter Menkhorst, DSE

Shane Dwyer, Simon Ransome, Paul Peake, Fred Cumming, Dr Natasha McLean and Dr James Fitzsimons, VEAC

Others consulted over attributes:

Richard Loyn, Arthur Rylah Institute (ARI); Dr John Koehn, ARI; Dr Alison King, ARI; Dr Stephen Henry, DSE

Members of the Steering Committee:

Ray Jeffery, Deputy Chief Economist, DSE

Gary Howell, Executive Director, Environmental Flows & River Health, DSE

Dr Paul Smith, Director, Biodiversity Policy & Programs

Associate Professor David Mercer, VEAC Council Member

Shane Dwyer, Joan Phillips (CEO), Simon Ransome, VEAC

Appendix 4 Example Choice Question

Question 4

Consider each of the following three options for managing the River Red Gum forests. Suppose options A, B and C are the only ones available. Which one would you choose?

ATTRIBUTES		HEALTHY RIVER RED GUMS *Area in hectares*	THREATENED PARROTS *Number of breeding pairs*	MURRAY COD *And other threatened native fish*	RECREATION FACILITIES	
						
CONDITION NOW		67,000 ha	900 pairs	10% of pre-European numbers	6 campsites with facilities	
OPTIONS	**MY ANNUAL PAYMENT**	**CONDITION IN 20 YEARS**				MY CHOICE *tick one*
Option A *no new initiatives*	**$0**	54,000 ha	900 pairs	10% of pre-European numbers	6 campsites with facilities	☐
Option B	**$50**	80,000 ha	1,200 pairs	60% of pre-European numbers	18 campsites with facilities	☐
Option C	**$20**	80,000 ha	1,500 pairs	20% of pre-European numbers	18 campsites with facilities	☐