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SURVEY METHODS OF VALUING THE CONSERVATION OF ENDANGERED SPECIES

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ABSTRACT

In conducting a cost-benefit analysis of a program to conserve an endangered species, some value of conservation must be estimated Because one of the types of benefit is non-use, survey methods are employed. This paper reports on the application of two survey approaches to valuing endangered species in Victoria: contingent valuation for Leadbeater's possum; and contingent rating for the eastern barred bandicoot.

The merits of the two approaches are evaluated and suggestions made for future work.

Key words: Contingent valuation, Contingent rating, Endangered species

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INTRODUCTION

To what extent is Society worse off if a species becomes extinct? Current use values, consumptive and non-consumptive, such as farming, hunting and observing, are lost. Future use value, perhaps not yet identified in the case of pharmaceutical products, may be lost. The loss has an ecological impact on the populations of other species, including humans. There is also the loss of non-use or existence value, the value people ascribe to knowing that a species exists.

Because most species are not owned by private individuals or interest groups, governments are faced with having to decide what resources to allocate to prevent an endangered species becoming extinct. In most cases the political process arrives at a decision in response to political pressures created by media exposure of arguments between opposed pressure groups, such as loggers and conservationists. Can economists influence the political decision more directly and efficiently by providing information on the costs and benefits of preserving an endangered species?

The aim of this paper is to consider the success of some existing methodologies for estimating existence values of species. Revealed preference approaches are of limited use in estimating existence values if the loss of a species has no observable impact on markets or even on human activity. An alternative approach is to ask people directly what value they place on the existence of a species. The problem with survey approaches is that there are many ways of putting the question, and many ways of interpreting the answers.

Two case studies in which different survey techniques have been used to estimate values of different Victorian endangered species are reported in the following sections. The first study summarises some of the contingent valuation work conducted by Jakobsson (1994) in estimating the value people resident in Victoria place on preservation on Leadbeater's possum. Estimated values are based on the responses to a mail questionnaire. Values obtained from the analysis of answers to two sequential dichotomous choice questions are given. The detail of the effects on valuations of different questioning procedures, including asking open-ended valuation questions and asking for values for preserving all endangered species in Victoria, may be found in Jakobsson (1994).

The second case study is a pilot study conducted by Elliott (1994) using contingent

rating to value preservation of the eastern barred bandicoot. Whereas in a dichotomous choice contingent valuation survey respondents are asked whether or not they are willing to pay $x to preserve a particular species, respondents are asked to rate on a Likert scale a small number of alternative programs, differing in some attributes of species preservation and program cost. Ordered probit analysis is used to estimate the tradeoffs between the preservation attributes and program cost. It was thought that alternatives would appear more realistic to respondents if program costs were given as total cost rather than estimated proportional cost to be born by the individual, say in terms of increased tax contribution. This approach differs from the usual contingent valuation approach of asking for individual willingness to pay questions, and from the relatively few previous contingent ranking and contingent rating studies.

As has been argued by Kennedy (1994), there is no point in estimating existence values unless they can be used operationally with decision-aiding tools. Kennedy and Jakobsson (1993) describe one start in this direction. The intended uses of existence values should guide the design of the survey that is to elicit them. Amongst the many questions that must be thought through are the dynamic and stochastic dimensions of programs to preserve species, and the role of individual's values, informed or uninformed in the determination of social policy. As no preservation program can guarantee survival, but can only hopefully raise the probability of survival, should respondents be burdened with answering probabilistic valuation questions? The contingent valuation study did not put any probabilistic valuation questions. The contingent ranking study had as one of the program attributes the probability of survival over a ten-year period. This issue is discussed in more detail later, together with whether consumer or citizen values are being elicited in these studies, and whether they can be used in cost-benefit analysis.

Some of the weaknesses and strengths of contingent valuation methodology are given an airing in an excellent debate between Hanemann (1994) and Diamond and Hausman (1994), in the wake of the findings of the US NOAA Panel on Contingent Valuation (Arrow *et al.* 1993). The application of contingent ranking and rating methods for valuing environmental flows and assets is still in its infancy, and has not received much scrutiny. Mackenzie (1993) compares the all three methods to one case study and finds contingent rating to be the statistically most efficient method. Bennett and Carter (1993) in reviewing the prospects for contingent valuation end by recommending contingent ranking methods as worthy of further testing. Halbrendt *et al.* (1994) report on an innovative application of contingent rating to pork attributes allowing for interactions between attributes. Two early influential studies on the methodology and application of contingent ranking applied to the environment are those by Smith and Desvousges (1986) and Lareau and Rae (1989).

CONTINGENT VALUATION SURVEY - LEADBEATER'S POSSUM

A contingent valuation survey was conducted to estimate the willingness to pay for the preservation of Leadbeater's possum in Victoria and to investigate some of the methodological issues associated with contingent valuation. Leadbeater's possum was selected because the opportunity cost of preservation is likely to be higher than for many other species and there is the potential for considerable conflict over its management plan.

Leadbeater's possum (Gymnobelideus leadbeateri) is a small, arboreal, nocturnal marsupial that is particular to Victoria. As one of Victoria's two State faunal emblems, it has unique value. It was thought to be extinct for many years, but was rediscovered in 1961 (Wilkinson 1961). It is considered to be one of the most important rare faunal species in Australia. The Council of Nature Conservation Ministers (1989) classifies it as endangered. It is considered to be under considerable threat of extinction over the next 50 years as a consequence of current and past management practices. It is confined to the mountain ash forest in the Central Highlands area of Victoria and is currently spread over an area of about 11,000 ha although a considerably larger area is potentially suitable habitat. It is one of the very few endangered Victorian species to be the subject of a management plan, albeit still in draft form.

The survey

A survey of 1950 Victorians was carried out by mail, as resources were too limited for a personal or telephone survey. Survey respondents were chosen randomly from the Victorian Electoral Roll. The response rate was about 33 per cent, which is within the range often experienced for a mail survey of the general population.

Each respondent was requested to complete one of five versions of the basic questionnaire. The different versions were designed to determine the sensitivity of estimated preservation values to: (i) the type of stipulated payment mechanism (State tax or donation to a private conservation organisation); (ii) information supplied describing the possum (picture of a possum or none); and (iii) the type of value elicited (willingness to pay to prevent loss of the possum or willingness to accept compensation for loss of the possum). Lack of sensitivity would suggest that elicited values were robust. On the other hand, sensitivity would lead to suggestions for survey design in future applications.

Survey design to counter strategic bias

Strategic bias occurs when respondents believe their answers will influence policy decisions. Respondents may over or understate their WTP to influence the end result. There is no *a priori* expectation about the direction of the bias. For example, a committed conservationist may overstate their value, but someone who believes conservation programmes reduce employment opportunities may understate their value.

There has been extensive use of laboratory and field experiments to test for strategic behaviour in contingent valuation studies. Overall, the evidence from these studies suggests that strategic bias is not a serious problem, although it is not completely conclusive. Hoehn and Randall (1987) and Mitchell and Carson (1989) show that incentives for strategic

behaviour in most contingent valuation studies are weak and that if any such behaviour does occur it is likely to have little effect on mean values.

In the possum survey the covering letter for the questionnaire stressed the policy relevance of the questions in order to motivate respondents to answer. It is not clear how successful this was, but if some respondents did believe their answers would influence policy they may have answered strategically. However, in the Kakadu study conducted by the Resource Assessment Commission, Imber, Stevenson and Wilks (1991) found that 73 per cent of Australians felt their input would have no influence on government policy. Comments made by respondents in the possum survey conducted also indicated that many were sceptical of the Government's intentions. This suggests there was little incentive to answer the valuation question strategically. On the other hand, if respondents do not believe the good as described will be provided they may understate their value (Mitchell and Carson 1989).

It is difficult to test for strategic bias unless a survey is specifically designed to do so. However, if the estimated bid functions explain the data reasonably well, as in the possum study, then strategic bias is generally not considered to be a problem.

Survey design to counter hypothetical bias

Hypothetical bias is defined as the difference between the stated payments in response to a hypothetical opportunity to pay and actual payments when presented with the opportunity in reality. It is one of the most troublesome issues in contingent valuation. It may occur because respondents are trying to predict what their behaviour would be in a hypothetical situation. They may not be able to visualise the situation, or it may not seem realistic enough to spend time thinking it through. The question of concern is whether the hypothetical nature of contingent valuation surveys generates a systematic error (bias) in one direction or another. The main test of this question has been to compare responses to a hypothetical survey with actual payments. It has been possible to do this in a number of studies, with mixed results. In some studies hypothetical payments were higher than actual payments and in others lower or the same. Mitchell and Carson (1989) provide a comprehensive review. It is probable that the hypothetical nature of contingent valuation surveys increases the variability of responses over an actual situation, but there is little evidence of a systematic error in one direction.

Generally, the response to the problem of the hypothetical nature of contingent valuation is to make both the hypothetical situation and the payment vehicle as credible and realistic as possible (Arrow et al. 1993, Mitchell and Carson 1989).

The possum survey was hypothetical and so may have been subject to hypothetical bias. A directive in the questionnaire to 'remember this is imaginary and the money will not be collected' may have 'set up both an overstatement of WTP and signalled to respondents that they did not have to answer carefully' (Loomis *pers. comm.* 1993).

Responses to the general questions

Before putting a valuation question to respondents, two attitudinal questions were asked. The first question sought a rating of the importance of protecting Leadbeater's

possum. The aim was to test for consistency between the importance rating and elicited values. About 65 per cent of respondents felt protecting the possum was 'very important', with another 20 per cent stating it was 'moderately important'. Possible explanations for the high proportion of 'very important' responses are: (i) a large proportion of the population genuinely believes species preservation is important; (ii) there was a bias towards people who favoured preservation amongst those answering the survey; and/or (iii) many people are prepared to agree with idealistic statements that preservation is important without meaning to imply active support. Certainly the proportion of people who stated they were actually prepared to pay for preservation was significantly lower at 46 per cent, although respondents' answers to this question did have a significant influence on their preparedness to pay.

The second question was included to establish the relative importance of existence, bequest and option values as motivations for preserving Leadbeater's possum. About 65 per cent of respondents felt existence and bequest values were 'very important' reasons for preserving the possum and another 20 per cent felt these values were 'moderately important'. The option of seeing the possum in the future was felt to be 'very important' by only 41 per cent of respondents, indicating that existence and bequest values are more important than use values. This result would be expected given the inaccessibility of Leadbeater's possum. Most people are unlikely to ever see a Leadbeater's possum in the wild because they are nocturnal, extremely shy and usually remain high in the canopy. Early contingent valuation studies often attempted to elicit separate values for option, bequest and existence values, but the difficulties respondents face in distinguishing between these motivations for preservation are now recognised.

The effect of payment mechanism on elicited value

A variety of payment mechanisms have been used in Australian contingent valuation surveys (Jakobsson 1994). In cases where there is no appropriate mechanism such as an entrance fee, the payment method most commonly used is an increase in taxation or reduction in take-home pay. Two studies (Rogers 1992 and Stone 1992) used a donation to independent conservation organisations for the specific purpose described in the survey and two (Tracey 1992 and Lockwood, Loomis and DeLacy 1993) used a donation to an Australian Heritage Commission trust fund. Some other studies have used both mechanisms or have given respondents a choice (Bennett 1981).

In the possum study, some versions of the questionnaire asked the respondent how much they would be prepared to pay in increased State tax to preserve Leadbeater's possum, whilst others asked how much they would be prepared to donate to an independent conservation organisation to achieve the same end.

The estimated mean willingness to pay values were significantly higher when payment was through taxation than through donation. Estimates of the mean ranged from about $30 to $70 for the taxation mechanism and from $0 to $25 for the donation mechanism, the ranges being due to different treatments of 'protest bids'.

The difference in the estimates for the two payment mechanisms is not an incongruous result. It is well recognised that the way in which a good has been provided

and paid for will affect willingness to pay (Mitchell and Carson 1989). The nature of institutional arrangements may be one explanation for the effect of varying the payment mechanism. Two characteristics of a satisfactory contingent valuation scenario prescribed by Rowe and Chestnut (1983, p 70) are that it must be 'realistic by relying upon established patterns of behaviour and legal institutions; and have uniform application to all respondents'. Payment by donation meets neither of these criteria for this case.

Management of public land and species protection in Australia is, and always has been, the responsibility of state governments with some input from the Federal Government. There is very little experience of private organisations undertaking these tasks in Australia, in contrast to the experience in some American states where there are more and higher profile independent organisations that own and/or manage large areas of land for conservation purposes (Stevens *et al.* 1991).

Conservation organisations in Australia have, in general, focussed on education, research and political lobbying and have no track record in managing large conservation areas. Hence, environmental protection is generally seen as being the responsibility of government and the community as a whole rather than something private individuals should provide. Respondents may have been sceptical about the ability of a conservation organisation to provide the level of species protection described in this survey question. Doubts about the provision of a good may result in respondents understating their value (Mitchell and Carson 1989). Given the much lower willingness to pay elicited when payment is by donation, the conclusion from this study is that taxation is the more appropriate payment vehicle in the Australian institutional environment.

The effect of inclusion of a picture of the possum on elicited values

In some contingent valuation surveys estimates of value have been found to vary with the information provided about the good being valued. Clearly, information is likely to affect elicited values to the extent that respondents are unfamiliar with the good. In this survey, a picture of the possum was included in some versions of the questionnaire and not in others to test whether there was any difference in estimates of value. About 45 per cent of respondents had never heard of Leadbeater's possum prior to the survey and would have had to rely on the limited information given in the questionnaires. As there is a range of species of possum in Australia, some of which are quite common, it is fairly certain that most respondents would have a general idea of a possum as a furry, tree dwelling marsupial. However, the common possums are considerably larger than the Leadbeater's possum and can cause domestic problems such as noise and fruit damage. Respondents thinking of these possums may express lower willingness to pay than if they had more information.

It might be expected that respondents who were already aware of Leadbeater's possum would be more prepared to pay for its protection, either because they were already concerned about threats to its continued existence, or because they were more interested in environmental issues to begin with. Cross-tabulations of the binary variable 'willing to pay or not willing to pay' with 'know of the possum' are shown in Table 1.

Table 1: Cross-tabulation of response to the discrete choice willingness to pay question and whether or not respondents had heard of Leadbeater's possum[1]

	Not willing to pay	Willing to pay	Total
Not heard	140	39	179 (44.9%)
Heard or known	131	89	220 (55.1%)
Total	271 (67.9%)	128 (32.1%)	399 (100%)

[1] Chi square value is 15.78 with 1 df and significance level of .00007.

The results show that those who knew of the possum prior to the survey were more likely to say 'yes' to the willingness to pay question.

The inclusion of a picture of the possum did not give more information about its survival prospects, but it may have triggered sympathy for 'cute furry animals' as opposed to say spiders, and could have increased elicited values accordingly. In the event, inclusion of the pictures did not result in a significant change in the estimate of willingness to pay.

Differences between willingness-to-pay and willingness-to-accept values

In some versions of the questionnaire, respondents were asked about their willingness to pay (WTP) to prevent loss of the possum, and in others about their willingness to accept (WTA) in compensation for loss of the species. Either value might be relevant in a cost-benefit analysis. Following Mishan's (1988) advocacy of compensating variation values rather than equivalent variation values for use in cost-benefit analysis, WTP values would be relevant in a project to save the possum from otherwise inevitable extinction, and WTA values in a project such as timber harvesting which jeopardised the future of the possum.

WTA compensation questions are seldom used in contingent valuation studies because of perceived problems of the validity of responses, and greater than expected differences from WTP estimates. In early contingent valuation literature, it was expected that differences in WTP and WTA valuations should be small and explainable by the different income effects of the two questions. In practice, WTA values have usually been found to be far greater than WTP values for the same goods (Knetsch 1993) and it is now recognised that there is no theoretical justification for the values to be close (Hanemann 1991).

Contingent valuation studies using WTA compensation elicitation questions have typically 'received a large number of protest answers such as "I refuse to sell" or "I want an extremely large or infinite amount of compensation for agreeing to this" and have frequently experienced protest rates of 50 per cent or more', although these problems

diminish when real money is offered as compensation (Mitchell and Carson 1989). Similar results were obtained in the possum study, with only 11 per cent of respondents being prepared to consider accepting compensation. It was not possible to estimate a meaningful value from the responses. Generally, respondents seemed very uncomfortable with the idea that they should be compensated for the loss of a species and some were quite offended by the suggestion, stating that no amount could compensate.

Estimating the aggregate willingness to pay

Once individual estimates of mean or median WTP have been made, the next step is to estimate aggregate WTP. One issue is the extent of the market, or what population the estimates should be aggregated over. In this study, estimates of value were aggregated over the population of Victoria. This results in an underestimate of value to the extent that people outside Victoria may also hold values for Victorian species.

There are several problems involved in extending the information gathered from a particular sample to the population from which it came. Firstly, there is the question of whether the mean or median estimate should be used. Another issue is how to deal with respondents who give a zero WTP. Should zero bids be regarded as protest bids and be excluded, or should they be included as genuine? Both approaches were followed to obtain lower and upper bounds for the estimates.

A third issue, which becomes particularly important in surveys with low response rates, is how to deal with the non-respondents. In the possum survey, the response rate was 33 per cent. There are two approaches which may be taken. All non-respondents can be treated as zero (Boyle and Bishop 1985) which gives a conservative aggregate estimate. Alternatively, assuming that respondents reflect the general population from which they were drawn, the non-respondents can be treated as missing values and assigned the mean or median WTP estimated from those who did respond (Kriström 1990). The second approach was followed in the possum study as there was no strong reason to assume all non-respondents have a zero value. There were no significant differences between the socioeconomic characteristics of the respondents and those of the population from which the sample was drawn.

Another question is whether values should be aggregated over individuals or over households. The WTP question in this survey asked for individual WTP. However, analysis showed that joint income was significant in determining WTP, suggesting that at least some people treated household income as their budget constraint. This was supported in some cases by individuals' comments. As a consequence, aggregate estimates have been made over both households and individuals.

Mean WTP estimates were based on responses to questions with the taxation payment mechanism only, as the tax payment mechanism was believed to be the more appropriate one for protection of endangered species in Victoria. Minimum and maximum estimates of the mean using the results from the discrete choice analysis were $29.4 and $75.7 per year. At the time of the survey, there were about 2.89 million adults and 1.36 million households in Victoria (1986 census). Estimates aggregated over households therefore range from $40 million to $103 million per year.

CONTINGENT RATING SURVEY - EASTERN BARRED BANDICOOT

The objective of the study was to use the contingent rating method to estimate the willingness to pay value for programs that increase the survival probabilities of the eastern barred bandicoot. The steps taken to implement and complete this study were: formation of survey design; selection of the sample population; selection of an appropriate model for analysis; pretesting; collection of data; and evaluation of results.

Survey design

Smith and Desvousges (1986) considered the following factors to be important when designing contingent ranking surveys: the number of attributes used to define the alternative; the range and selection of combinations of values for each factor in each alternative; the number of alternatives presented to each individual in a given ranking task; and the relationship between the sets of alternatives presented to each individual across the sample.

Three attributes were used for the bandicoot survival programs: (i) probability of survival, (ii) total cost, and (iii) cat control. They are discussed below.

(i) Survival probability

The survival probability of the one remaining eastern barred bandicoot population was considered to be the most important attribute. It was decided that the simplest way to include survival probabilities in the programs was to include a hypothetical figure indicating the probability (as a percentage) that the eastern barred bandicoot species would still be found in the wild, in 10 years time. It was hypothesised that as probability of survival increased, the willingness to pay for a bandicoot survival program would increase.

The probability of survival percentages were selected at 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100, to allow for a broad range of survival probabilities.

(ii) Total cost

Since most survival programs for endangered species are primarily government funded, it was deemed more appropriate to specify a total cost of the program, rather than an individual cost. This differs from most contingent valuation and ranking studies which only attempt to determine the willingness to pay of each individual. It was thought that determining the amount people wanted a government agency to spend on provision of an environmental good was more useful from a policy perspective than determining how much an individual would pay out of their own income.

To ensure respondents considered the total cost when evaluating each program, (since it was not an individual cost to themselves) a paragraph was included in the

questionnaire that stressed that government funding for a bandicoot program would result in less funding for other government provided services. To reinforce this trade off, the costs of providing two government services were given: the cost of building a country road (at $600,000 per kilometre) and the cost of running a hospital bed for a year (at $100,000 per year). This emphasised the connection or trade off between increased probability of survival and increased cost to the respondent through reduced government services. This connection is very important since the theory behind contingent methods depends on establishing a hypothetical market which provides a realistic link between the cost of obtaining the environmental good (in this study the bandicoot program) and willingness to pay.

Lareau and Rae (1989) suggest that the alternatives must be carefully designed to provide a range of prices that force a tradeoff among attributes. If prices are set too low, respondents are likely to order alternatives by focusing on the environmental attribute. In contrast if prices are too high, respondents order alternatives according to the price attribute. These researchers suggest that precise tradeoff estimates cannot be determined in either case. Therefore, it was decided that a large range of total costs would be included in an attempt to reduce this potential problem.

Levels of total cost were randomly selected from 30 values between $50,000 and $2,000,000 and were specified as a total cost over five years.

(iii) Cat control

The third attribute was cat control. One of the major threats to the success of a bandicoot preservation program is the implementation of effective measures to reduce domestic and feral cats preying on bandicoots.

A cat registration fee was chosen because of the ease of specifying levels of control.. However, more satisfactory measures that may have improved respondents' consideration of this attribute were night curfews, culling of feral cats, and compulsory desexing of domestic cats. These measures were considered, but were abandoned in favour of the registration fee because of the difficulty of quantifying the other options for use in a questionnaire setting.

The surveys contained a random selection of four levels of cat control. Each level was specified as a registration fee of $10, $20 or $50, or as no fee (represented as $0).

Number of alternative programs

Reported studies have shown that respondents can effectively rank only a limited number of alternatives, with four to six choices yielding the most consistent responses (Smith and Desvousges, 1986; Lareau and Rae, 1989). Furthermore, complex alternatives requiring difficult tradeoffs may increase the number of people refusing to complete the survey. Those who do consent to undertake the survey may be motivated to take shortcuts, such as identifying their most or least preferred choice, then randomly ranking (or rating) the remaining alternatives. For this reason the number of alternatives (bandicoot programs) presented to each respondent was restricted to five.

Rating levels

Respondents were asked to indicate their preference for each of the five survival programs by circling a number from one to five. The level of satisfaction associated with each numerical rating was:

1 = Completely unsatisfactory program
2 = Unsatisfactory program
3 = Satisfactory program
4 = Very satisfactory program
5 = Ideal program

Equating this level to the number of alternative programs ensured respondents were not forced to make ties between alternatives.

Socioeconomic variables

To keep the survey design simple, respondents were not asked question about their socioeconomic status. Including personal questions, such as level of income, attitude to conservation, use of government provided services etc., increases the probability of people refusing to undertake the survey. Many people are unwilling to divulge such information, and also it increases the time respondents have to spend completing the survey. This was of particular concern in the bandicoot study since it was necessary to survey respondents face to face rather than by mail.

Survey content

Respondents were asked to complete a questionnaire after carefully reading the information provided. The information familiarised respondents with the eastern barred bandicoot and explained the reasons why it was facing imminent extinction. Respondents were then shown five hypothetical bandicoot programs to increase the probability of survival. Each program contained different levels of the three attributes already described. To avoid one program dominating another, increases in the probability of survival were always associated with increases in total cost. Respondents were asked to consider the levels of the three attributes in each program, then rate their satisfaction with each program by circling a 1,2,3,4 or 5. No two respondents were given the same five alternative programs.

Selection of sample population

Most programs dealing with endangered species are government funded They are decided upon primarily by government employees, generally after consultation with 'experts' in the field. This prompted the question of whether people funding the programs, (the average taxpayer) obtained similar levels of satisfaction from the attributes of these programs to the levels of those involved with the programs or with extensive knowledge of the species under threat. A similar question arose over the attitude toward attributes of

Hamilton versus non-Hamilton residents. The sample was therefore split four ways to cover the all combinations of the splits expert/non-expert and Hamilton/non-Hamilton (Melbourne). Therefore, it was decided to survey respondents from the general public, and compare them with people involved in the eastern barred bandicoot program or who were familiar with the conservation of endangered species.

A satisfactory sample of respondents for this study was difficult to obtain because of the short time horizon of the project. The respondents selected to represent the general public in Melbourne were all located at La Trobe University. Surveying people only from La Trobe, as a representative sample of the Victorian taxpayer, would not be satisfactory in a more thorough study of this type. Nevertheless, to overcome this problem an attempt was made to survey people with a range of characteristics similar to that of the general population, (eg male, female, old, young, students, academics, administration staff, shop attendants). Melbourne residents involved with the bandicoot program or with good knowledge of conservation of endangered species were selected from the Schools of Biology, Genetics and Human Variation at La Trobe University.

Non-expert respondents from Hamilton were randomly selected from the main-street shopping area. Again, an effort was made to survey people who would represent the general population. Hamilton residents involved in the eastern barred bandicoot program were surveyed at the Hamilton Institute of Rural Learning, which operates a bandicoot enclosure. Other people involved in the program were mailed a survey because they were not available in the two-day period surveying took place at Hamilton.

The survey sample consisted of 27 respondents. Surveying took place at La Trobe University and Hamilton in Victoria. Surveys were personally administered by the author in a face-to-face manner. Approximately three people refused to fill out a survey. Surveying 27 respondents allowed 135 observations (usable program ratings) to be collected.

Model Specification

Respondents' preference ratings were specified by the indirect utility function:

$$U = A + b_1 SP + b_2 \text{Log}_{10} TC + b_3 \text{Log}_{10} CC + b_4 REG + b_5 PRINV$$

where

SP = probability of survival of the bandicoot after 10 years
TC = total cost of the program ($) over 5 years
CC = cat registration fee ($/year)
REG = dummy variable for respondent's residential region (Melbourne or Hamilton)
PRINV = dummy variable for respondent's previous involvement with or knowledge of eastern barred bandicoots or endangered species generally.

The ratings from each respondent were processed using SAS Probit to estimate the attribute coefficients. The data was also regressed using SAS ordinary least squares, using

the same specification. The total cost and cat control values were logged because of the large range of values represented.

Willingness to pay for an increase in the probability of survival

Given the indirect utility function (as specified in the previous section), to hold utility constant for small changes in SP and TC it must be that:

$$dU = (\partial U/\partial SP) \, . \, dSP + (\partial U/\partial TC) \, . \, dTC = 0$$

where

$$\partial U/\partial SP = b_1$$
$$\partial U/\partial TC = b_2 / TC$$

It follows that

$$dTC/dSP = - b_1 . \, TC^* / b_2$$

evaluated for $TC = TC^*$, the mean total cost.

Pretesting

A pretest of the survey was conducted on a sample of employees from the School of Agriculture, La Trobe University, which led to a change in the specification of the cat control attribute.

Results

SAS Probit and least squares regression procedures were used to estimate parameters for the survey sample and various sample subsets. Coefficients estimated using the probit procedure for the entire sample are shown in Table 1. Chi-square critical values obtained for the parameters indicated that only the coefficients for the probability of survival (SP) and cat control (LCC) attributes were statistically significant. Apart from a probit analysis of the ratings obtained from the subset 'experts', all other procedures estimated a total cost coefficient which did not differ significantly from zero. This meant that a willingness to pay for an increase in the probability of survival could only be calculated for the expert group.

The insignificance of the total cost coefficient across all respondents suggests that respondents did not consider reductions in government services as significantly reducing their utility. This may be the result of the cost attribute being specified as a total cost borne by the taxpayer rather than as a proportionate cost for each individual.

Table 2: Ordered Probit Estimation for total sample

Parameter	Coefficient	Standard Error	Chi-square
INTERCEPT	-2.1573	1.6855	1.638
INT2	-1.0985	0.1473	
INT3	-2.0100	0.1929	
INT4	-3.0935	0.2726	
SP	0.0166	0.0065	6.529*
LTC	0.2824	0.3267	0.747
LCC	0.6647	0.2037	10.653*
REG	-0.0156	0.1929	0.007
PRINV	-0.3389	0.2203	2.367

*Chi-square critical values significant at the 5 per cent level.

The willingness-to-pay value by people with knowledge of the bandicoots could be estimated because all coefficients were significant at the 5 per cent level. The value was estimated at $340,660 per percentage point increase in probability of survival. Equivalently, this reflects a willingness to pay of $34 million to change the prospects for the eastern barred bandicoot over the next ten years from certain extinction to certain survival.

DISCUSSION

In this section the following issues are discussed in relation to contingent valuation versus contingent ranking and rating: valuing survival probabilities; strategic and hypothetical bias; the embedding problem; and the nature of existence value.

Survival probabilities

An important attribute in appraising any species management program is the resulting change in the probability of survival of the species. The contingent rating and ranking approaches enable the tradeoff between probability of survival and program cost to be estimated directly by including survival probability as a program attribute. Of course, the tradeoff can be directly estimated under the contingent valuation method if open-end

valuations are sought.

In the contingent rating study, utility was a linear function of the probability of survival. Other functional forms could be experimented with, but it almost certainly must be linear if the expected utility theorem is to hold. Suppose utility is the following additively separable function of probability of survival p and of individual income y:

$$u\{p,y\} = af\{p\} + bg\{y\}.$$

Guaranteed survival is given by $u\{1,y.\}$ If the expected utility theorem holds, then utility for p and y equals the probability weighted sum of the utility of guaranteed survival and the utility of guaranteed extinction, so that:

$$u\{p,y\} = p(af\{1\} + bg\{y\}) + (1-p)(af\{0\} + bg\{y\})$$

$$= a(pf\{1\} + (1-p)f\{0\}) + bg\{y\}$$

Thus for the expected utility theorem to hold, $f\{p\}$ must be a function such that:

$$f\{p\} = pf\{1\} + (1-p)f\{0\}$$

which holds for $f\{p\} = p$, but probably not for any other functional form. For example, it does not hold for $f\{p\} = p^n$ for $n \neq 1$, nor for $f\{p\} = \ln(p)$.

Because the independence axiom is not universally accepted, and there are known to be problems with the accuracy of perception of probabilities, particularly low and high probabilities, experimentation with different functional forms would still be of interest.

Hypothetical and Strategic bias

If attribute levels for the alternatives to be ranked or rated are set according to an experimental design or at random, the alternatives are likely to appear hypothetical to the respondent. This is one source of hypothetical bias. Another is a perception of the respondent that any choices made by the respondent are not going to be used in any real world decision making. This latter source, however, is also likely to reduce strategic bias. The first source can be reduced by making the actual range of alternative management programs, say those proposed by Maguire *et al.* (1990) for the eastern barred bandicoot. This would mean presenting all respondents with the same alternative programs to rank or rate. There would probably be a tradeoff between respondent precision and statistical precision.

The scope for strategic bias is probably just as great. For example, a conservationist might always rank highest a project with the highest probability of species survival regardless of program cost, if she supposes that this will increase the chances of the program actually being adopted, and that program costs are unlikely to be passed on to her.

The embedding problem

Ranking and rating methods offer scope for testing for the embedding problem, which manifests as elicited values insensitive to the scale of the environmental good saved or lost. In species preservation, population level could be made an attribute of the management programs to choose between. Another possibility would be to make a range of endangered species with enhanced survival prospects an attribute of management programs.

Insensitivity of existence values to population levels does not necessarily indicate a valuation problem. It may be that people assign say zero utility for a state in which a species is extinct, and one unit of utility to a state of species survival whatever the population level. However, evidence from an open-ended willingness-to-pay contingent valuation study by Loomis and Larson (1994) can be cited against this. They found that diminishing marginal values for population level of the gray whale, above current and minimum viable levels. Until recently the gray whale was an endangered species.

The nature of existence value

Milgrom (1993), amongst others, has queried whether existence value can be taken to be a serious concept. If someone is told that a species, which they had never heard of before, currently exists but is about to become extinct, could this information make them worse off? Milgrom would probably argue that it cannot. In the Leadbeater's possum study, 45 per cent of respondents were unaware of the existence of the possum before the study. Does this mean that willingness to pay for preservation of the possum expressed by these people should be discounted? Milgrom's argument ignores the fact that whilst people may be in a state of blissful ignorance, they may attach utility to not being in that state.

Accepting that existence values for environmental assets do exist, what is the nature of the estimates of existence value derived by contingent survey methods? Do they reflect the values people place on only their own private appreciation of an environmental asset, or do they include considerations of being better off if others are better off? There are differing views on whether, if values reflect ideas of altruism and moral obligation, this invalidates the values for decision making. Hanemann (1994) cites Diamond and Hausman (1994) and Milgrom (1993) as seeing the values as flawed if they do, and Arrow (1963) and Becker (1993) as holding that how individuals have determined their values is irrelevant. Blamey and Common (1992), who contend that there is evidence that contingent valuation studies elicit citizen rather than consumer values, would probably support the former position.

The eastern barred bandicoot study could be seen as eliciting citizen rather than consumer values because total government expenditure is traded off for survival probability. It is probably more satisfactory to release claims that citizen valuations are the conceptually correct values to use in cost-benefit analyses based on the potential Pareto improvement criterion. However, the values can be seen as relevant in other types of cost-benefit analysis (such as those discussed by Pearce and Nash, 1981), taking a 'management science' approach.

CONCLUSIONS

Results from the contingent valuation study of values for preservation of Leadbeater's possum have provided much experience for guiding future studies on valuing endangered species. Some of the particular findings that have been discussed in this paper are that pictures of the endangered species do not appear to influence elicited values, that at least in the Australian context taxation is a preferred payment mechanism, and that there do appear to be problems in eliciting willingness-to-accept values.

The experience of the contingent rating pilot study of preservation values of the eastern barred bandicoot suggests that rating program alternatives does not meet with much respondent resistance. Three out of thirty people approached refused to take part in the survey. One factor in this would have been short duration of the questioning procedure. The number of program attributes was kept to three, and the number of alternative programs to rate to five. The non-significance of coefficients on the total program-cost variable may have been due to difficulty in relating to government expenditures, or to the small sample size.

It is clear that there is an interactive relationship between the design of the survey procedure and the decision-making approach and tools for which the elicited values will be input. More work needs to be done on devising decision-aid procedures that meld the understanding of complex systems of experts and the general public's values of environmental assets, which must be elicited for a simple scenario.

REFERENCES

Arrow, K J (1963), *Social Choice and Individual Values*, 2nd Edition, Yale University Press, New Haven.

Arrow, K., Solow, R., Portney, P.P., Leamer, E.E., Radner, R. and Schuman, H. (1993), "Report of the National Oceanic and Atmospheric Administration Panel on Contingent Valuation." *Federal Register*, Vol, 58, No. 10, January 15, 4602-4614. USA.

Becker, G S (1993), "Nobel Lecture: The Economic Way of Looking at Behavior", *Journal of Political Economy*, 101(3), 385-409.

Bennett, J.W. (1981), Evaluation of the benefits of natural ecosystem preservation with special reference to existence values. Unpublished PhD thesis. Australian National University, Canberra.

Bennett, J. W. and Carter, M. (1993), "Prospects for Contingent Valuation: Lessons from the South-East Forests", *Australian Journal of Agricultural Economics*, 37(2), 79-93.

Blamey, R.K. and Common, M. (1992), "Sustainability and the limits to pseudo market valuation." pp 117-146, In Lockwood, M. and DeLacy, T. (eds). *Valuing natural areas: Applications and problems of the contingent valuation method*, Johnstone Centre, Charles Sturt University, Albury.

Boyle, K.J. and Bishop, R.C. (1985), "The total value of wildlife resources. Conceptual and empirical issues. Invited paper." Association of Environmental and Resource Economists workshop on recreational demand modelling. Boulder, Colorado, May.

Council of Nature Conservation Ministers. (1989), *List of Australian endangered vertebrate fauna,* Australian National Parks and Wildlife Service Canberra.

Diamond P A and Hausman, J A (1994), "Contingent Valuation: Is Some Number Better than No Number?", *Journal of Perspectives*, 8(4), 45-64.

Elliott, M (1994), The Use of Contingent Rating to Value Attributes of Endangered Species' Preservation Programs, B Agr Res Econ 4th-Year Thesis, La Trobe University, Melbourne.

Halbrendt, C., Pesek, J., Parsons, A. and Lindner, R. (1994) 'Consumer preference for PST-Supplement pork' *Australian Journal of Agricultural Economics*, 38(2); 189-202.

Hanemann, W. M. (1991), "Willingness to Pay and Willingness to Accept: How Much Can They Differ?", *American Economic Review*, 81(3), 635-647.

Hanemann, W M (1994), "Valuing the environment through Contingent Valuation", *Journal of Economic Perspectives*, 8(4), 18-43.

Hoehn, J.P and Randall, A. (1987), "A satisfactory benefit cost indicator from contingent valuation." *Journal of Environmental Economics and Management*, 14(3), 226-247.

Imber, D., Stevenson, G. and Wilks, L.C. (1991), *A contingent valuation survey of the Kakadu Conservation Zone*, Resource Assessment Commission. Research Paper No. 3, Vol 1. Australian Government Printing Service, Canberra.

Jakobsson, K.M. (1994), "Methodological issues in contingent valuation: An application to endangered species." Unpublished PhD Thesis, La Trobe University, Melbourne.

Kennedy, J O S and Jakobsson, K (1993), Optimal Timber Harvesting for Wood Production and Wildlife Habitat, Proceedings of 29th Annual Conference of the Operational Research Society of New Zealand, Auckland, August, 234-241.

Kennedy, J.O.S. (1994), "Optimal management of multiple-use forest under risk." Paper to the Australian Agricultural Economics Society, Annual Conference, Wellington New Zealand, February.

Knetsch, J.L. (1993), *Environmental valuation. Some practical problems of wrong questions and misleading answers*", Occasional Publication Number 5. Resource Assessment Commission, AGPS, Canberra.

Kriström, B. (1990), "Valuing environmental benefits using the contingent valuation method. An econometric analysis." Umea Economic Studies No. 219. University of Umea, Sweden.

Lareau, T. J. and Rae, D.A. (1989) 'Valuing WTP for Diesel Odor Reductions: An Application of Contingent Ranking Technique.' *Southern Economic Journal*. 55(3): 729-742.

Lockwood, M., Loomis, J.B. and DeLacy, T.P. (1993), "A contingent valuation survey and benefit-cost analysis of forest preservation in East Gippsland, Australia." *Journal of Environmental Management*, 38, 233-243.

Loomis, J B and Larson, D M (1994), "Total Economic Values of Increasing Gray Whale Populations: Results from a Contingent Valuation survey of Visitors and Households", *Marine Resource Economics*, 9(3), 275-286.

Mackenzie, J. (1993) 'A Comparison of Contingent Preference Models' *American Journal of Agricultural Economics*. 75: 593-603.

Maguire, L.A., Lacy, R.C., Begg, R.J., Clark, T.W. 'An analysis of Alternative Strategies for Recovering the Eastern Barred Bandicoot in Victoria.' in Clark, T.W. and Seebeck J. H. (eds) *Management and Conservation of Small Populations*. Chicago Zoological Society, Chicago. (1990).

Milgrom, P (1993), "Is Sympathy an Economic Value? Philosophy, Economics, and the Contingent Valuation Method", In Hausman, J A (ed), *Contingent Valuation: A Critical Assessment*, New York, North-Holland, 417-441.

Mishan, E. J. (1988), *Cost-benefit analysis: An informal introduction*, Fourth edition. Winchester, Mass. and London: Unwin Hyman.

Mitchell, R.C. and Carson, R.T. (1989), *Using surveys to value public goods. The contingent valuation method*. Washington DC: Resources for the Future.

Pearce, D. W. and Nash, C. A. (1981), *The social appraisal of projects : a text in cost-benefit analysis*, Macmillan, London.

Rogers, M.F. (1992), "The allocation of old growth forest between preservation and logging in NSW." pp 79-88. In Lockwood, M. and DeLacy, T. (eds). *Valuing natural areas: Applications and problems of the contingent valuation method*, Johnstone Centre, Charles Sturt University, Albury.

Rowe, R D and Chestnut, L G (1983), "Valuing environmental commodities revisited", *Land Economics*, 59(40),404-410.

Smith, V. Kerry, and Desvousges, W.H. *Measuring Water Quality Benefits*. (1986). Boston, Kluwer-Nijhoff Publishing.

Stevens, T.H., Echeverria, J., Glass, R.J., Hager, T. and More, T.A. (1991), "Measuring the existence value of wildlife: What do CVM estimates really show?" *Land Economics*, 67(4), 390-400.

Stone, A. (1992), "Assessing the economic value of wetlands." pp 47-70. In Lockwood, M. and DeLacy, T. (eds). *Valuing natural areas: Applications and problems of the contingent valuation method*, Johnstone Centre, Charles Sturt University, Albury.

Tracey, P.J. (1992), "An assessment of the non-market conservation and heritage values relating to cattle grazing on the Bogong High Plains, Victoria. Honours Thesis, Charles Stuart University, Albury.

Wilkinson, H.E. (1961), "The rediscovery of Leadbeater's possum." *Victorian Naturalist*, 78, 97-102.