Valuing conservation in the Kakadu Conservation Zone

to the Resource Assessment Commission
Australian Bureau of Agricultural and Resource Economics

Submission 91-2

to the Resource Assessment Commission

Valuing conservation in the Kakadu Conservation Zone

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Foreword

In April 1990 the Resource Assessment Commission was asked by the Prime Minister to inquire into the options for use of the Kakadu Conservation Zone. The proposed Coronation Hill mine represents an important potential use of the Zone. In its initial submission to the inquiry the Australian Bureau of Agricultural and Resource Economics assessed the proposed mine to have an expected net present value, exclusive of environmental cost, to the Australian economy of $82 million.

An important aspect of the Commission’s task is to provide insight into the values derived from the conservation of the Zone and the possible impact of mining on those values. In an attempt to assess such values, the Commission carried out a ‘contingent valuation’ survey of Australia’s willingness to pay for incorporation of the Zone into Kakadu National Park and consequent avoidance of any environmental damage which might result from mining.

The purpose of this second submission is to supplement ABARE’s initial submission to the Inquiry by providing an examination of the decision making framework in which contingent valuation is used, and to analyse the methods applicable to the data collected in the survey. It is hoped the discussion contained in this submission will assist the Commission in deciding how much emphasis it should put on the results of its analysis of the survey when preparing its final report on the issue of mining in the Kakadu Conservation Zone.

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Acknowledgments

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SUMMARY

In December 1990 the Resource Assessment Commission released the results of its contingent valuation survey for the Kakadu Conservation Zone. In that report, the interpretation of survey results was that Australians would be willing to pay $647 million a year for ten years to have the Kakadu Conservation Zone incorporated in the Kakadu National Park.

The contingent valuation technique is a method of estimating people's willingness to pay for goods by direct questioning of a sample of the population. The technique has gained a degree of acceptance in some circles, particularly in the United States, and in some particular circumstances. However, there are a number of unanswered questions about its usefulness in providing plausible estimates of monetary value for goods which people are not accustomed to valuing or paying for directly. In particular, it is not clear that the method can be used to supply reliable economic information about a politically sensitive matter. As well, there are a number of unanswered questions about appropriate ways of defining the relevant population and about methods of aggregation of individuals' expressions of willingness to pay to obtain estimates of total value.

In a number of ways, responses to the Commission's survey resemble answers to a simple opinion poll. The way in which many respondents reacted to alternative degrees of possible environmental damage from mining more closely resembled a response on the basis of prior beliefs about conservation and mining, than the views of people who had carefully considered the new information presented in the survey and were attempting to provide realistic money assessments of the value to them of the environmental goods in question.

Each participant in the survey was asked to indicate willingness or unwillingness to pay an initial amount for the inclusion of the Conservation Zone in Kakadu National Park. Each was then asked to indicate willingness or unwillingness to pay a second amount, which depended on the initial value and on the participant's response to that value. The initial values ranged from $5 to $100 a year. The sample was also split into two groups, one of which was told that the detrimental effect of mining could be widespread and the other that the effects could be more limited.

The combined proportion of people who indicated either that they would pay the highest, or would not pay the lowest, of the three money values proposed in the questions asked of them was large, and varied little with the actual money values put. An informal examination of the survey results leads to the suggestion that around 70 per cent of the people sampled may have answered the questions in ways consistent rather with expression of their prior beliefs about the desirability of conservation and mining than with providing carefully considered estimates of the money value of a good. Approximately 42 per cent could be described as providing strongly pro-preservation views. A further 6 per cent might be described as responding in a more moderately pro-preservation manner. About 21 per cent appear to have responded in a manner consistent with the expression of prior beliefs which were strongly in favour of mining.

It would be expected that the price people would be willing to pay for a good
such as environmental services would increase with their income. Preserving a small area of the Kakadu Conservation Zone is only one of many conservation options, and conservation is only one of a wide range of things on which individuals may wish to spend their limited funds. However, no relationship between income and stated willingness to pay was evident in the survey responses, again suggesting that they were not primarily attempts at valuation in money terms.

A related observation concerns the size of the estimated total willingness to pay, relative to the apparent importance of the Kakadu Conservation Zone in Australian conservation issues and relative to Australian incomes. If Australians were willing to pay the same per square kilometre for the whole of Kakadu National Park as the expressed value for the Conservation Zone, the implied value would be $276 billion a year. This would appear inconsistent with the facts that total private consumption expenditure in the Australian economy was only $195 billion in 1989-90, that the park is one of many existing and potential conservation areas in Australia and that it was mentioned only by 2 per cent of those interviewed by the Commission as being among the two or three ‘environmental matters most important to Australia’.

A statistical test is provided in this submission of the proposition that only some of the respondents reacted as the survey designers intended (that is, by giving measures of valuation), while others treated the survey as an opinion poll on the issue of conservation or development of the Zone. By this formal procedure it is estimated that 53 per cent or more of the sample appear to have treated the survey as an opinion poll, rather than attempting to provide meaningful measures of money value.

Thus, although attempts were made in designing and carrying out the survey to elicit accurate estimates of willingness to pay, it seems that these were largely unsuccessful. There is considerable doubt as to the ability and willingness of respondents to provide meaningful estimates of individual willingness to pay for the narrowly defined conservation package in question. Further, there is some doubt about the choice of the whole Australian population as the appropriate market for preservation of the Conservation Zone. The results of the survey are best interpreted as indicating that, on the basis of prior beliefs, a bare majority of Australians favour inclusion of the Conservation Zone in the Kakadu National Park, with a substantial minority strongly in favour of mining Coronation Hill. No significance should be attached to the estimated willingness-to-pay estimates derived from the survey data.
1. Introduction

1.1 The inquiry

On 26 April 1990 the Resource Assessment Commission received its terms of reference from the Prime Minister for an inquiry into the options for uses of the Kakadu Conservation Zone. The Commission's activities to date have included the use of a wide range of studies of the benefits of mining and of conservation. One potentially important avenue of research involved the commissioning of a contingent valuation survey designed to provide estimates of the willingness of Australians to pay for the preservation of natural features of the Conservation Zone. The results and an interpretation of that survey are reported in Imber, Stevenson and Wilks (1990).

In its draft report (Resource Assessment Commission 1991) the Commission requested comment on the usefulness of the contingent valuation method for determining appropriate policies for the management of the Kakadu Conservation Zone. The Commission's final report is due to be published by 26 April 1991.

1.2 Scope of the present submission

This submission supplements ABARE’s initial submission (ABARE 1990b) to the inquiry. That submission contained a discussion and application of a cost-benefit framework for evaluating resource use in the Conservation Zone. The net present value of benefits of mining, exclusive of any environmental cost or cost to tourist industries, were estimated at $82 million. It was suggested in the submission that the contingent valuation approach may prove an appropriate tool for estimating benefits of conservation of the Zone. However, it was pointed out that, under some circumstances, the method may not provide credible and accurate estimates of willingness to pay.

This submission contains a further examination of some aspects of the decision making framework in which contingent valuations are used, and an analysis of the method’s application by Imber et al. (1990). A brief discussion of the type of values which may be important in the Kakadu Conservation Zone is presented in chapter 2. A distinction is made between on-site values arising from direct use of the resources of the Zone and off-site values, such as those which may accrue to people who gain satisfaction from the knowledge that the Zone’s resources are being used, or conserved, in a particular way.

Chapter 3 contains a discussion of cost-benefit frameworks for analysing public policy, particularly the total valuation framework in which the contingent valuation method is used. The chapter includes an overview of the nature of off-site values and a consideration of the extent to which such values might be attached to mining and preservation in Kakadu. The contingent valuation technique is discussed in chapter 4. It is argued that the open-ended elicitation methods used in most studies (though not in the Commission’s study) have proved unsatisfactory. The referendum method, which was used in the Commission’s survey, is analysed in the context of models of voting behaviour. An alternative interpretation of the survey results to that proposed by Imber et al. (1990) is provided in chapter 5. At least 53 per cent of the survey participants appear to have...
responded by expressing their prior beliefs in favour of or against mining or conservation, rather than assigning a specific money valuation to the particular conservation option presented in the survey. The final chapter contains an overall assessment of the usefulness of the Commission's survey results for policy decisions.
2. Alternative uses of the Conservation Zone

The Kakadu Conservation Zone is an area of high mineral prospectivity. In addition to the Coronation Hill mine site several other areas within the Zone have been identified as being likely to contain significant mineral deposits (Wyborn, Valenta, Needham, Jagodzinski, Whitaker and Morse 1990).

Along with the surrounding Kakadu National Park, the Conservation Zone has the potential to supply the base for a range of recreational and tourist activities. Those activities are primarily dependent on the conservation of natural geological and biological features of the region, although the nature and degree of conservation necessary may vary between activities. There is no obvious reason that users could not be charged entry and other use fees. Such charges would serve to ration access and finance management of the Zone, although any decision to charge would depend on the costs as well as any benefits of doing so. User charges would also provide a clear measure of the value users placed on access to the Zone.

There are no existing user charges for Kakadu National Park which provide indications of the site value of the Zone or its surrounds. So any attempt to value the conservation aspects of the Zone needs to include on-site values as well as the off-site values discussed below and in section 3.3. The estimate of on-site value may also include any option price which people are willing to pay for the option of future access, in addition to payment for actual use.

Off-site values include a number of types of benefit (distinguished in the next chapter) which conserved areas within the park and the Conservation Zone may provide to non-visitors, in addition to serving as a base for on-site activities. People who are unlikely ever to visit wilderness areas may, nevertheless, support the preservation of these areas and express a willingness to pay for their preservation. Imber et al. (1990) report that 95 per cent of respondents to the Commission’s contingent valuation survey agreed with the statement ‘It is important to have places where native wildlife and plants are preserved, even if I never go there to actually see them’, with 82 per cent indicating strong agreement. It is such ‘existence’ values, not associated with actual or potential on-site use, which were the primary focus of the Resource Assessment Commission’s survey.

There are also potentially important Aboriginal cultural values associated with various physical features and broader aspects of the environment of the Conservation Zone. However, these issues are not considered explicitly in this submission.
3. Frameworks for making social choices

In a market economy issues of valuation and choice are resolved by the interaction of individual consumers and producers in markets. There are a number of preconditions for successful operation of such markets, including the existence and enforcement of individual rights of ownership over goods. For at least some of the services which can be derived from the Conservation Zone, most of those conditions are absent. In part, that is because of the nature of some of those services. On-site recreational activities can be marketed through entry fees and other user charges. However, at least some aspects of the satisfaction which people receive from the knowledge that plants, animals and other features are preserved, separately from on-site use of those features, are probably inherently unmarketable (although those aspects transmitted through such media as television and magazines clearly are marketable).

As well as inherent difficulties in marketing some conservation benefits, there are complexities in the management of the Conservation Zone resulting from the mix of Northern Territory government ownership of mineral rights, Commonwealth responsibility for some environmental matters, and other tribal and broader community interests. Because of the absence of markets for many of these aspects of natural resources, and the complexity of public involvement in natural resource management, some formal framework must be used to guide overall public decision making.

3.1 Cost-benefit frameworks

Most public decision making involves some formal or informal system for considering trade-offs between costs and benefits of alternative decisions. For many decisions the processes are informal and the cost and benefit information used is incomplete. The development of cost-benefit analysis has been intended to provide a formal, quantitative structure for handling some public decisions. A general cost-benefit framework is outlined in ABARE (1990b). That framework provided the basis for ABARE's assessment of the direct benefits and costs of the proposed Coronation Hill mine.

Cost-benefit analyses have always provided partial, rather than complete, information on the potential effects of particular decisions. There are two broad reasons for the incompleteness. First, many public decisions involve costs and benefits which, because there are not markets for all goods, are not easily measured. In this context, loss of amenity resulting from disturbance of fauna and flora during mining is listed by ABARE (1990b) as a cost of mining, but no quantitative measure could be provided. Second, public decisions may have effects on the distribution of income or wealth or on cultural or religious values which are often considered to be outside the scope of purely economic judgments.

Deciding when and how to value non-market effects of policy options has always posed problems for cost-benefit analysts. The traditional approach has been to estimate market or shadow prices (opportunity costs to society) for all of the goods and services used up or produced by a given policy proposal, such as preservation of a wilderness area or construction of a dam, and aggregate the net value across all affected individuals. Until recently, measures of the values of
Market goods tended to have the dominant influence in most cost-benefit studies because of the absence of simple measures of non-market benefits and costs. Thus, cost-benefit analysis failed to produce a complete evaluation of projects where non-market benefits were important. Nevertheless, as is evident from the treatment of spillover effects, including environmental effects, by Mishan (1971) and Dasgupta and Pearce (1972), consideration of non-market effects has long been given some importance in setting up the analytical framework for cost-benefit studies.

3.2 The total valuation framework

During the 1980s non-market aspects of resource use have been considered in greater depth, and a number of attempts have been made to develop measures of 'total valuation' in which quantitative measures of all non-market costs and benefits are included with those of market goods. Central to this development is the concept of existence value. The term 'existence value' refers to those values that people place on things, such as unspoiled wilderness, separate from their physical use. Proponents of the approach have generally supported use of the contingent valuation method to estimate existence values. The use of contingent valuation for this purpose is based on the proposition that existence value can be expressed in money terms as willingness to pay, even though payment is not possible in reality.

Proponents of the total valuation approach purport to provide, at least in principle, a complete monetary evaluation of any policy proposal. One interpretation of the concept is that, provided quantitative valuations were available for all things which people valued, no scope would remain for 'non-economic' considerations of any kind. In this view, if estimates of total valuation were accepted as accurate, the only issues that would remain properly within the sphere of political processes would be those concerned with the distribution of wealth.

Although the use of the total valuation framework has been confined to resource and environmental policy, this appears to be an historical accident. At least notionally, the framework could be used to evaluate proposals, such as those for laws on freedom of speech, that lie completely outside the sphere of traditional economic analysis. But there is an important distinction (see Buchanan and Tullock 1962) between the establishment of constitutional rules in a society and the day-to-day decision making within the agreed rules. 'Constitutional' rules, both those embodied in a written constitution and those accepted as social conventions, form part of the framework in which decisions such as those about the use of natural resources are taken. The boundaries between rules within which a cost-benefit analyst should operate and options to which the analyst can legitimately apply cost-benefit methods are not, however, always clear.

Users of the total valuation framework have not always appreciated the difficulties discussed above. For example, Imber et al. (1990, p.12) state '... not all aspects of environmental value can be assigned a dollar price. There are important ethical aspects of environmental issues that cannot be turned into economic trade-offs, and which need to be explored. Attitudinal questions can help do this.' But they provide no discussion of the attitudinal questions asked in their survey except as they relate to willingness to pay, nor do they provide any indication of which ethical values cannot be assigned dollar prices. If some aspects of the issue which could be classed as ethical, such as bequest value and altruism (see below), are captured, but unspecified other aspects are not, it is difficult to see what interpretation can be given to the resulting...
number. In the total valuation literature, statements of moral attitudes unsupported by willingness to pay (for example, protest responses) have either been dismissed or have been treated as elicitation failures which can and should be remedied by appropriate changes in suggested ways of payment or other aspects of questioning procedures. Yet such statements, or refusals to participate, may be legitimate rejections of the valuation method itself.

There has been considerable debate over the validity of the total valuation approach. Critics have included economists (see Mendelsohn 1986) and psychologists (for example, Kahneman 1986). Defenders of the approach, such as Mitchell and Carson (1989), have argued that, while there are numerous technical difficulties associated with the application of contingent valuation to estimates of total valuation, the approach is fundamentally sound. Thus far, the supporters of the total valuation method have dominated the debate. Smith (1991) is more cautiously optimistic than most supporters about the usefulness of the method to estimate existence values. He raises a number of important issues concerning the definition of the appropriate ‘market’ for conservation goods and concerning procedures for aggregating individual responses. These issues are discussed in section 4.4.

3.3 Existence values

The concept of existence value — here used in the sense of off-site values in general — covers a range of values which people may derive from the knowledge that a particular natural feature is preserved or a particular development occurs. Since the initial discussion of the concept by Krutilla (1967), there have been a number of attempts to impose some sort of logical order on the notion of existence values (McConnell 1983; Randall and Stoll 1983; Boyle and Bishop 1985). There have also been a number of critiques of the concept (for example, Mendelsohn 1986). Existence values of environmental assets can be subdivided into subcategories such as:

- *vicarious consumption* – the enjoyment of natural phenomena through such media as magazines and television;
- *altruistic benefits* – the satisfaction arising from the knowledge that others have access to natural assets;
- *bequest value* – the satisfaction arising from the knowledge that natural assets are conserved for future generations;
- *stewardship value* – the satisfaction taken in having 'looked after' resources or having managed them carefully.

This listing of subcategories, or sources, of existence value may not be exhaustive or mutually exclusive. For example, bequest values are often treated as a category of values separate from existence values. However, the listing does provide a reasonably comprehensive way of viewing the concept.\(^1\)

Comparatively little attention has been paid to the question of how, if at all, such values might be integrated into an efficiency-based cost–benefit framework. An exception is the work of Brookshire, Eubanks and Sorg (1986). However, they argue that there are limits to what can be included: that to attribute 'intrinsic' value to wildlife preservation is inconsistent with the efficiency framework, and that willingness to pay based on 'ethical'...
considerations of this kind should be excluded from cost–benefit analysis. Mitchell and Carson (1989), similarly, claim that anything from which people gain satisfaction and express willingness to pay should be counted, though ‘economic theory does reject the notion that “trees have rights”’. The aggregation issues raised by Smith (1991) and others and discussed in section 4.4 are also relevant in this context.

3.4 The limits of existence values

It is important to consider what aspects of any proposal might involve existence value. Most analyses of existence benefit have concerned environmental amenities of various kinds. If the Mitchell and Carson (1989) view is accepted — that willingness to pay for anything which people value should be counted — the class of potential valuers is very large. However, there remains the possibility, discussed above, that the community may not accept the extension of a monetary cost–benefit framework to some social issues.

In the context of nature conservation, it is important to note that existence values may be imputed not only to a given area in a state of preservation, but also to the results of not preserving it but developing its resources for commercial gain. There has been a long tradition of public support for government assistance to industries to create jobs and to promote development, notably in northern Australia. While much of that support may have been from the potential direct beneficiaries of such assistance, some may also have been from those with nothing at stake personally but with a wish that benefits of development be conferred on others.

Most of the usual subcategories of existence value may be applied in relation to mining. Altruistic benefits may arise because mining is seen as creating jobs for the unemployed. Bequest value may arise because mining is seen as providing a healthier economic legacy for future generations. Stewardship value may arise from the view that development is the most responsible use of our mineral resources. There may also be vicarious consumption, for example on the part of engineers (and others) not directly involved in a given project who follow the solution of any significant technical problems via the literature (and, in particularly dramatic cases, via the mass media).

The possibility that existence values are relevant to a wide range of development, as well as conservation, options implies that the consistent adoption of a total valuation framework may have critical, and sometimes surprising, implications for cost–benefit analysis of resource projects. In particular, it is worth considering that a variety of proposals for irrigation schemes, notably in northern Australia, have been put forward over the years, and many would have had negative net benefits on traditional cost–benefit criteria. Given the social attitudes prevailing until very recently, it is possible that in some of these cases a total valuation estimate, taking into account willingness to pay for northern development, would have yielded a positive estimate of net benefit.
4. The contingent valuation technique

Contingent valuation typically involves carrying out a survey designed to elicit willingness to pay for a particular good. Several variants of the method have been developed, but all depend on attempts to set up a hypothetical market for the good in question. Because of the hypothetical nature of the questions, development of internal checks on the consistency of answers has been important.

A considerable part of the literature on contingent valuation has concerned the potential for various forms of bias. Detailed discussion of those potential problems and of proposed solutions is contained in Cummings, Brookshire and Schulze (1986) and Mitchell and Carson (1989). A number of difficulties, such as compliance bias (a bias resulting from respondents' attempting to comply with what they presume are the interviewers' expectations), have been shown to be capable of resolution. Others, such as strategic bias, which results from survey respondents providing distorted values to further their own interests, have been handled successfully at least in experimental settings. However, a number of key issues remain unresolved because the method has rarely been applied to issues which have been the subject of extensive public controversy. Freeman (1986) has predicted that the application of contingent valuation to estimates of total valuation is likely to be unsuccessful when such issues are involved. Similarly, Rose (1990) warned of the likelihood of bias in the methods when used for politically contentious issues. No studies of this kind appear to have been published in the major economic journals, and hence subjected to detailed peer review. The listing of previous Australian applications of contingent valuation given by Wilks (1990) indicates that the Resource Assessment Commission study under consideration here is the first — with the arguable exception of Hundloe, McDonald, Blamey, Wilson and Carter (1990) — which deals with a major policy controversy. Thus, apart from its policy implications, the Commission's study is of considerable scientific interest.

It is useful to consider some of the experience of actual applications of contingent valuation in the total valuation framework. The principal technical problem has been seen by practitioners as the development of appropriate elicitation methods and of ways of conveying a sense of reality in the presentation of hypothetical payment options.

4.1 Use of open-ended questions

The most frequently used elicitation methods have been open-ended questions of the form 'How much are you willing to pay for X?' and payment cards. These approaches have not always proved satisfactory. Table 1, derived from Wilks (1990), contains a summary of most Australian applications of contingent valuation other than those which have measured private benefits (for example, for park visitors) and those in which the referendum method discussed below is employed (Hundloe et al. 1990; Imber et al. 1991). The non-market goods for which values are elicited range from the preservation of an individual tree to the management of the Great Barrier Reef and control of urban air pollution. The range of estimated willingness to pay is from $4.23/y (research to identify potential forest conservation areas in south-east
New South Wales: Young and Carter 1990) giving (or showing willingness to give) as such. This distinction is consistent with 'warm glow' theories of charitable giving developed by writers such as Andreoni (1989, 1990). The 'satisfaction in giving' interpretation is bolstered in a number of cases by the fact that the selected method is a voluntary donation to a charitable fund.

Even assuming that there is a meaningful existence value, it is not clear whether an expression of willingness to contribute will be an overestimate or an underestimate of this value. Overestimation may arise from the reason given above: because expressed willingness to contribute includes an element of personal satisfaction derived from the fact that the good exists, but satisfaction in the act of giving (or showing willingness to give) as such. This distinction is consistent with 'warm glow' theories of charitable giving developed by writers such as Andreoni (1989, 1990). The 'satisfaction in giving' interpretation is bolstered in a number of cases by the fact that the selected method is a voluntary donation to a charitable fund.

One possible interpretation of expressed willingness to pay is that it represents, not (or not only) an evaluation of the personal satisfaction derived from the fact that the good exists, but satisfaction in the act of preservation. Even assuming that there is a meaningful existence value, it is not clear whether an expression of willingness to contribute will be an overestimate or an underestimate of this value. Overestimation may arise from the reason given above: because expressed willingness to contribute includes an element of personal satisfaction derived from the fact that the good exists, but satisfaction in the act of preservation.

### Results of Australian contingent valuation studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Good valued</th>
<th>Sample</th>
<th>Payment vehicle</th>
<th>Elicitation method</th>
<th>Mean WTP</th>
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<tr>
<td>Bennett (1984)</td>
<td>Nadgee Nature Reserve</td>
<td>544 Canberra residents</td>
<td>Tax increase</td>
<td>Open-ended / donation</td>
<td>$27.08</td>
</tr>
<tr>
<td>Carter et al. (1988)</td>
<td>Great Barrier Reef</td>
<td>130 non-users</td>
<td>Donation</td>
<td>Open-ended</td>
<td>$12.43</td>
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<tr>
<td>Ekanayake &amp; Sinden (1985)</td>
<td>Eucalypt woodland</td>
<td>136 Armidale households</td>
<td>Donation</td>
<td>Open-ended</td>
<td>$17.20</td>
</tr>
<tr>
<td>Scott &amp; Co. (1982)</td>
<td>Clean air</td>
<td>501 Sydney residents</td>
<td>Increase in prices</td>
<td>Open-ended / Payment card</td>
<td>$17.66/y</td>
</tr>
<tr>
<td>Sinden (1987)</td>
<td>Soil conservation</td>
<td>NSW residents</td>
<td>Increase in bread price</td>
<td>Open-ended / Closed-ended</td>
<td>$15/y</td>
</tr>
<tr>
<td>Sinden et al. (1982)</td>
<td>Eucalypt woodland</td>
<td>120 Armidale area residents</td>
<td>Donation</td>
<td>Open-ended</td>
<td>$28.80</td>
</tr>
</tbody>
</table>
| Young & Carter (1990)| Forestry research            | 1031 residents of ACT and NSW   | Tax increase / donation | Payment card             | South-east forests: $4.23/y  
                              |                              |                                |                         |            | Aust. forests: $17.19/y  |

Source: Adapted from Wilks (1990)
government). Underestimation may arise because charitable contributions suffer from the free-rider problem (provision of the good may occur even if the individual questioned offers nothing) and also from uncertainty as to whether the desired goal will be achieved.

A number of other problems have arisen with open-ended elicitation procedures. 'Protest' responses, in which respondents say that the good in question is of no value to them because they object to the notion of placing a monetary evaluation on the environment, have been common. At the other extreme, implausibly large responses have been observed, reflecting either strategic bias or unwillingness to take the procedure seriously.

4.2 The referendum method

Dissatisfaction with the performance of open-ended elicitation methods has led to increasing interest in the 'discrete response' or 'referendum' method of elicitation, in which respondents are asked to approve or disapprove one or more discrete values, rather than being asked an open-ended question about value. The first use of such methods was by Bishop and Heberlein (1979), who elicited willingness to pay for hunting permits, a market good. The term 'referendum method' is usually associated with a discrete response survey having three general characteristics:

- the survey is aimed at estimating existence values and other benefits from goods for which there are inherent difficulties in using markets;
- the method of payment suggested in the survey is an increase in taxes; and
- the question is presented in the form of a choice such as might conceivably be put to a referendum vote, though different payment amounts are proposed to different participants.

The Resource Assessment Commission survey satisfied the first two conditions, and employed a modification of the third. In the standard referendum method, each participant is asked a single question about willingness to pay. However, a modification which greatly increases the efficiency of various estimation techniques involves asking two questions of each respondent, such as, 'Are you willing to pay $X?' and 'Are you willing to pay $X +/- Y?' That is, if the response to the first question is yes, the second question is: 'Are you willing to pay $X + Y?' If the answer to the first question is no, the second question is: 'Would you be willing to pay $X - Y?' This approach was followed in the Commission's survey.

Most of the literature on the referendum method has been concerned with the derivation of estimates of average willingness to pay. An alternative to averaging the amounts, arguably closer to the spirit of the referendum approach, has been the use of a median estimate. Provided it is estimated correctly, the median willingness to pay is the largest amount which would be approved in a real referendum decided by simple majority. The median approach is used by Imber et al. in obtaining an overall valuation from their survey.

Studies using the referendum method have generally shown an improvement in performance over other elicitation methods, in that protest responses have been largely eliminated and respondents have been more motivated to participate.

4.3 The meaning of responses to a contingent valuation survey

Two common and related problem areas in carrying out any market or political survey concern the way respondents interpret and react to the survey, and the way the survey responses should be interpreted. In any contingent valuation survey, two important questions arise. The
first concerns the ability of the respondents to understand the issues and to conceive of meaningful monetary estimates of the values in question. The second question concerns the way respondents react to the survey: in part, whether they approach it as a game to win or as a responsibility to provide useful information within the constraints suggested by the structure of the interview.

A considerable part of the discussion of contingent valuation methods has been concentrated on the possibility of 'strategic bias' — that is, bias introduced by respondents giving untruthful answers in order to influence the results of the survey, and consequent policy, in line with their own preferences or interests. However, the discussion of strategic bias seems mostly to be based on a presumption that people have a clear idea of their own preferences concerning the goods in question. Much less attention has been paid to the questions of whether people can, and are willing to, think of all things which are of value to them in monetary terms. The process of making individual, or family, decisions about purchases of market goods is quite different from that involved in making public policy choices.

In making everyday consumption decisions, a person is faced by a need to choose that bundle of available goods which provides the greatest satisfaction possible within a budget. Decisions about public supply of goods are made through quite different processes, which differ from the private consumption process in two ways. First, the budget constraint is on the government, or the community as a whole, rather than on individuals. The budget constraint is also complex. The community's potential income, and thus expenditure opportunities, ultimately include such things as the potential return from commercial uses of resources currently allocated to conservation or other uses, as well as taxation revenue. Second, the relationship between individual preferences and final public decisions is distant and rather nebulous. Individuals may influence the pattern of public expenditure through voting behaviour or lobbying activities, or more passively through their participation in opinion polls. However, without the input of a great deal of effort no individual is likely to have much effect. Many will choose to do little to influence public choices.

Mitchell and Carson (1989) argue that the referendum method, because it closely resembles the voting process by which some political decisions are made, is well suited to eliciting information on willingness to pay. Yet the decisions which voters make in referendums are between support for and rejection of a proposition. More generally, voters must make a decision on which individual or party is likely to express their wishes most effectively over a wide range of issues. Such decisions may not involve any explicit estimation of money values by voters. When voters accustomed to making Yes–No decisions about proposals are asked a series of questions about money value, they may choose that money value which they believe most likely to convey their chosen Yes or No answer to the interviewer.

A number of writers (for example, Margolis 1982) have argued that both the decision to vote in an election or referendum and the decision on how to vote cannot be explained in terms of narrowly defined self-interest, and must reflect other concerns. As was demonstrated by Downs (1959), the probability of casting a decisive vote is so small that, even when the costs of voting are low, rational self-interested voters will abstain. Nevertheless, in most democracies a majority of people vote and in few is there any element of compulsion as in Australia. A number of solutions to this 'paradox of voting' have been proposed. Although no completely satisfactory solution has been proposed, it is clear that the apparently
hard-nosed strategy of 'hip pocket voting' is among the least rational available. Thus, voting behaviour seems likely to reflect broad judgments of social welfare, as opposed to pure self-interest. As a corollary, an elicitation procedure which simulates a referendum vote will yield, not estimates of the value to the respondent, but some indication of the respondent's view of the project's social benefits. If this is the case, then it is not clear that any aggregation of the individual estimates will give a valid estimate of total benefits. Issues of aggregation are further discussed in section 4.4.

A valuation exercise using the referendum method with median estimates differs from a traditional opinion poll in only one important respect. Whereas in a standard opinion poll all respondents are asked the same question, in the referendum method different respondents are presented with different cost estimates for the proposal under consideration. This provides a range, within which the median estimate determines the maximum cost at which the proposal will be acceptable to a majority.

There are significant problems, however. As noted above, voters are not usually accustomed to expressing numerical estimates of the values of alternatives. In standard referendum contexts, this is not a serious problem. In most modern democratic systems, the majority of decisions are made by elected representatives (or delegated by them to public servants), and referendums are reserved for cases when representatives are unwilling to make decisions, or when significant groups are dissatisfied with the decisions produced by the processes of representative democracy. In relation to environmental issues, this means that there is a considerable winnowing of the issues which might come to a referendum vote. Only 'tough decisions' are likely to come to a referendum. For example, if an environmental amenity judged to be important by conservation groups can be preserved at very low cost, it is likely that standard political processes will lead to its preservation. Conversely, if an amenity is not judged particularly important and would be costly to preserve, environmental groups are unlikely to organise a campaign which would encounter well-financed opposition and could not achieve much anyway. Thus, an issue is not likely to come to a referendum unless the decision is fairly finely balanced.

Paradoxically, this balance probably reduces the cost of voting for most citizens. For example, those who believe that not enough is being done to preserve the environment do not need to scrutinise individual referendum proposals particularly closely. If an environmental issue has come to a referendum, it is likely that its costs and benefits are nearly balanced in terms of the standard political process. The belief that environmental concerns are underweighted in this process implies that a pro-environment vote will improve welfare. Conversely, a belief that environmentalists have too much influence will support a pro-development vote.

This 'winnowing' effect may also present problems for the use of the referendum method of contingent valuation. Respondents who think that too much (or not enough) is being spent on the environment may assume that a valuation survey would not be carried out on an issue unless the political process were evenly balanced, and vote accordingly without paying close attention to the stated costs. When the issue is one which has been the subject of extensive controversy, it is likely that many respondents will already have made up their minds. If so, they will naturally respond in accordance with their adopted position, without placing much weight on either the dollar values put to them or on the details of the scenario presented.

Estimates of mean willingness to pay will in that case be rendered meaningless.
A mean value is strongly influenced by extreme values. The magnitudes of extreme values will depend on experimental design, and their frequency on the relative willingness of supporters and opponents of preservation to disregard the dollar values presented to them and choose on the basis of prior beliefs. Thus an estimate of the mean has essentially no inferential value.

Estimates of the distribution of willingness to pay will be somewhat more informative. If all respondents answer strictly in terms of prior beliefs in the way described above, responses will follow a bimodal distribution, all lying at either the minimum or maximum allowable values. This observation underlies the observation of Walsh, Loomis and Gillman (1984) that a bimodal response pattern in a contingent valuation survey may be a sign of strategic bias and, therefore, invalidate its results. If all participants give extreme values, a simple head count determines the majority view and the information yielded by the contingent valuation method is the same as that yielded by a traditional opinion poll. Obviously, the numerical estimate of median value is of no interest in this case, being determined entirely by the choice of minimum and maximum values.

Interpretation becomes more difficult if some respondents behave in the manner described above, while others take account of the stated dollar values and of the details of the scenario in the manner assumed in standard accounts of the referendum method. Another mixed case is that where respondents answer in terms of prior beliefs over a wide range of preferred money values, but change their response to one of choosing values when the suggested monetary amounts become very large.

There are further possible response patterns. Respondents who have considered the issue in question may remain undecided or adopt some intermediate position. In the two-question referendum method, these respondents may indicate that they are willing to pay something for preservation, but not too much, by responding 'Yes' to the first question and 'No' to the second, regardless of the dollar values given. This response may (in conjunction with other responses) create an illusory impression of a well-defined downward sloping demand curve for environmental amenity.

4.4 Aggregation issues

There are two broad sets of issues concerning the aggregation of individual responses to contingent valuation surveys to produce measures of aggregate benefits. The first, some aspects of which have been discussed in section 4.3, concerns the nature of individual responses and their consistency across the sample. The second concerns what Smith (1991) refers to as 'extent of the market'.

Aggregation across the sample

Contingent valuation surveys can be used to obtain reliable estimates of aggregate social values of goods provided that the respondents to the surveys give realistic estimates of individual willingness to pay. Two alternative possibilities are mentioned above. First, at least some of those interviewed may respond on the basis of a Yes-No choice about a project. The estimates of money value given by such respondents are purely products of the survey procedure. The implied Yes-No votes can validly be aggregated as votes, but the monetary measures have no meaning.

A second possibility is that some respondents will provide estimates of money value, but will not confine their estimates to valuation of the good itself from their own standpoint. They may include some estimate of what they believe to be the gross or net value of the project to others. And they may be influenced by
the satisfaction of giving, as modelled by Andreoni (1989, 1990) and discussed above. In these cases, aggregating values across all individuals has a meaning which is either ambiguous, or of no obvious value as a benefit measure to be added to market measures of other costs and benefits in a cost–benefit framework.

It is quite possible that different respondents will respond in different ways. In such cases, it would be invalid to add up value estimates across the whole sample. If it were possible to separate the responses into groups depending on manner of replying, it might be possible to draw a number of separate, usable inferences. However, it is not clear whether it can be established which groups particular respondents fit into.

The extent of the market

Smith (1991) argues that the most important issue to be resolved in the use of the contingent valuation technique concerns the definition of the extent of the relevant market. First, the market must be defined geographically. Smith uses as an example the question of the geographical definition of the extent of the market for on-site recreational activities. However, the same problem also arises, and may be more intractable, in the case of existence values. The implicit assumption in Imber et al. (1990) is that the whole of the Australian adult population is the relevant market for the potential benefits of preserving the Kakadu Conservation Zone. However, it is not clear on what basis that assumption was adopted.

A second aspect of the problem of defining the extent of the market concerns the nature and definition of the ‘goods’ derived from conservation of natural resources. As is noted by ABARE (1990a), the value of a given additional measure of conservation for a particular species or habitat may depend critically on whether the existence values of what is conserved are largely related to simple survival (reduction of the risks of extinction) or to size of population. If the concern is largely with survival of species or representative habitat, the marginal gain from further conservation may drop very sharply once a critical level of conservation is achieved. On the basis of such considerations, Smith (1991) argues that in contingent valuation of existence values, the questions need to be presented in the context of the full range of relevant conservation projects. He suggests that, in treating a single project in isolation, the risk is run that people will offer, as values for the single project, their values for a broader conservation package.

4.5 Information and contingent valuation

A further question about the likely validity of contingent valuations concerns the role of information provided before or during the survey. Individual responses to contingent valuation questionnaires have been shown to be strongly influenced by the information provided with the questionnaires and the context in which the questions are asked. Two observations are relevant to the Kakadu survey. First, Samples, Dixon and Gowen (1986) found, in relation to preservation of whales, that both the specific information supplied as part of the survey and the process of being surveyed and thinking about environmental issues appeared to raise the participants’ expressed willingness to pay. Second, Bergstrom, Stoll and Randall (1990) found that reminding respondents of the types of values associated with use of environmental assets increased their expressed willingness to pay, even though the people they surveyed were active users of those assets who could be expected to know the issues well. These findings raise further serious questions about the likelihood of consistent measures of willingness to pay being extracted via contingent valuation.
Despite the technical innovations associated with the referendum method, the fact that it is, in essence, an opinion poll should be borne in mind. Thus, acceptance of total valuation as a summation of welfare, incorporating estimates derived from the referendum method, involves substantial reliance on opinion polling as a basis for policy formulation.

4.6 Contingent valuation and market goods

It should also be noted that while existence values can be measured only by hypothetical approaches such as the contingent valuation method, it is not true that such methods are confined to non-market goods. The contingent valuation method has been used, with some success, to estimate willingness to pay for private consumption goods such as water services and access to national parks (see, for example, Bishop and Heberlein 1979, 1986). Closely related market research techniques have long been used to estimate demand for actual and potential market goods. The successful use of the contingent valuation method in these contexts suggests that, if in fact people have valuations which can be elicited by questioning, contingent valuation may provide accurate measures. However, the validity of the contingent valuation method as a measurement technique for private consumption goods implies nothing about the validity of the total valuation approach.
In trying to assess the meaning of the responses to the Commission’s survey, two general questions are important. First, what was the Commission trying to value? Second, were the respondents able to conceptualise the issue in a way which allowed them to provide meaningful money values for the resource being valued? What the Commission set out to measure is reasonably straightforward, although not precisely defined. This is discussed in section 5.1 below. The question of whether the survey respondents were able to conceptualise an implied market for preservation of the Kakadu Conservation Zone, and therefore respond to the survey questions on the basis of a meaningful money value for this preservation is much more difficult to answer, however. This issue is taken up in sections 5.2 and 5.3 below.

5.1 The survey and its analysis

In setting up the contingent valuation exercise, the Commission appears to have been largely concerned with the establishment of some measure of the existence value for conservation which would be lost by the mining of Coronation Hill. Imber et al. (1990, p.6) state that the intended measure was of willingness to pay ‘... to avoid any damage to the Zone and the Park from the proposed Coronation Hill mine’. However, the questions asked of survey respondents concerned the value of inclusion of the Conservation Zone in the Kakadu National Park and consequent protection of the Zone and Park from any effects of mining. Thus it appears that the survey participants could be expected to respond to a broader set of concerns than those about the Coronation Hill mine.

Participants were provided with some background information and asked some questions about their attitudes and personal characteristics. They were then presented with one or other of two scenarios of possible adverse effects of mining, and were asked (in two stages, as described in section 4.2) to express their willingness to pay given amounts to avoid these effects by inclusion of the Conservation Zone in Kakadu National Park. While the orientation of the study is toward existence value, the nature of the survey question appears to cover on-site values as well.

The methods used in setting up and carrying out the survey closely follow the recommendations of leading practitioners, and steps were taken to deal with all of the sources of bias discussed in the contingent valuation literature. However, there are some serious questions about the survey participants’ ability to make the valuations asked of them. Imber et al. argue that the willingness-to-pay questions were framed in a context in which the costs, in terms of opportunities lost to carry out other conservation or private consumption, were clear to the participants. First, the general context of the questions asked about attitudes to the environment and conservation may have provided some context. Second, participants were given specific warnings that not developing the Coronation Hill mine could result in higher taxes and that the Conservation Zone was only one possible call on their funds for conservation.

Smith’s (1991) concerns about the extent of the market seem relevant. It is not clear
that it would be possible for those surveyed, in general, to separate their concerns about the Conservation Zone from those about Kakadu National Park as a whole or from conservation issues more broadly. Several aspects of the information provided as background to the questions would be likely to elicit something of people's concern for Kakadu National Park, rather than providing a value for preservation of the proposed mine area and for a low probability event leading to off-site damage. Second, the presumption that the total Australian population is the relevant market is questionable. It may be that only some Australians value the Conservation Zone but that others are willing to offer values, when interviewed, in order to express broader concerns about conservation. The replies of the latter group will lead to mismeasurement of the target value.

Further, the presumption that non-respondents (those who were asked but did not give replies) have the same demands for conservation of the Zone as do respondents is questionable. As Smith (1991, p. 29) points out, 'Nonresponse to valuation surveys is rarely treated as zero valuation', yet failing to respond may be a more rational action for those who do not value the good than for those who do. As is noted in appendix A, non-response rates were variable between centres but quite substantial in most cases (the highest being 48 per cent, in Sydney). Any significant difference between the demand characteristics of those cooperating in the survey and those refusing could make a large difference to the validity of the results. Other aspects of the analysis are discussed in appendix A.

It also seems likely that, if the survey had been carried out after the Commission had the results of assessments of the risks associated with mining, both scenarios presented in the survey would have involved less environmental damage than in the actual survey. Statements about risks in the draft report (Resource Assessment Commission 1991) indicate less apparent risk than the scene-setting statements in the survey.

5.2 Alternative interpretations of the survey data

Imber et al. (1990) interpret the results of the Commission's contingent valuation survey as indicating that Australians would, in aggregate, be willing to pay $647 million a year to avoid the possible environmental damage from mining in the Conservation Zone. This estimate has already been compared in the media with the ABARE estimate of net present value of $82 million from proceeding with the Coronation Mill mine.

Aside from the questions of the difficulty respondents may have had in providing meaningful answers to survey questions, there are several reasons for suspecting that the results of the Commission's survey may not provide any enlightenment about the willingness of Australians to pay for the preservation of the Conservation Zone. In the first place, the value estimate would seem to imply a willingness to totally reorient Australian consumption patterns. If the whole area of Kakadu National Park had a similar value, on an area basis, to that imputed to protecting a very small part of the 47 km² Conservation Zone, that would mean that Australians would be willing to pay $276 billion to conserve the whole park. Yet total private consumption expenditure by Australians in 1989-90 was only $195 billion (Australian Bureau of Statistics 1990).

Of course it is not necessarily valid to extrapolate the implied value per square kilometre from the Conservation Zone to conservation areas on a wider scale. However, the order of magnitude of value implied by such an extension provides...
some idea of the budgetary reality of the contingent valuation estimates. A further relevant observation is that Kakadu is only one of a large number of World Heritage listed national parks in Australia. In addition to that large group of internationally significant parks there are hundreds of small national parks, nature reserves, public and private forests, beaches, streams and other areas of some conservation value. Preservation of Kakadu as a whole — not just the Conservation Zone — was volunteered by only 2 per cent of the people interviewed as one of the two or three ‘environmental matters most important to Australia’. The relative magnitudes of expressed willingness to pay and available funds for conservation expenditure are inconsistent. Although survey participants were told that failure to develop the mine and inclusion of the Zone in the National Park might have some influence on their incomes or taxes, it is unlikely that they considered their answers in any real budgetary context. As is indicated in chapter 3, the budgetary context in which public decisions are made is complex. Reference to the respondents’ budget constraints was made in a single statement that their taxes might increase and that the Conservation Zone could be one of many calls on their funds for conservation. In view of the magnitude of the willingness-to-pay estimates, it seems that participants in the survey did not respond as if they were considering a problem of allocating scarce funds among competing uses. There are a number of possible interpretations of the Commission’s survey data. That presented by Imber et al. is based on an implicit assumption that all respondents actually had the ability to make, and attempted to provide, meaningful monetary estimates of the value of preservation to themselves. Examination of this interpretation on the basis of the results of the Commission’s survey is rendered difficult by the statistical methods used: the problems are discussed in some detail in appendix A. An alternative interpretation would be based on the view that at least some respondents were unable, or unwilling, to provide meaningful estimates of monetary value, and interpreted the questions as an opinion poll on whether the relevant areas of Kakadu should be preserved. This second interpretation is discussed informally in the following section, and in some technical detail in appendix B.

5.3 An opinion poll interpretation of the survey data

A noteworthy feature of the estimates derived from the Commission’s survey is that the net present value for estimated median willingness to pay for preservation to avoid the scenario of minor damage (assuming a 7 per cent real discount rate and assuming that responses were in terms of real payments over ten years) is approximately $4.5 billion, or about 55 times as large as the net present value of returns estimated from mining by ABARE (1990b). If the estimate is correct, it seems unlikely that preservation of Kakadu could be a subject of political controversy. Even given severe failures of the political system, it seems unlikely that projects with a benefit–cost ratio of 55:1 could be rejected or seriously questioned. The alternative hypothesis to be entertained is that the reported estimates of willingness to pay are invalid.

It may therefore be useful to consider an alternative interpretation of the survey data in which respondents base their answers primarily on prior beliefs. Since survey participants were first asked if they would be willing to pay a specified amount and then asked their willingness to pay another amount (the second amount depending on their answer to the first
Responses to the Conservation Zone contingent valuation questions

<table>
<thead>
<tr>
<th>Money values a</th>
<th>Number of people interviewed</th>
<th>Sequence of answers b</th>
</tr>
</thead>
<tbody>
<tr>
<td>First question</td>
<td>Second question</td>
<td>Yes–Yes</td>
</tr>
<tr>
<td>$/y</td>
<td>$/y</td>
<td></td>
</tr>
<tr>
<td>Major damage scenario</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>250/50</td>
<td>258</td>
</tr>
<tr>
<td>(43.4)</td>
<td>(27.5)</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>100/20</td>
<td>249</td>
</tr>
<tr>
<td>(57.4)</td>
<td>(11.6)</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>50/5</td>
<td>257</td>
</tr>
<tr>
<td>(57.2)</td>
<td>(9.7)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>20/2</td>
<td>254</td>
</tr>
<tr>
<td>(70.9)</td>
<td>(7.5)</td>
<td></td>
</tr>
</tbody>
</table>

Minor damage scenario

| 100            | 250/50                       | 252      | 105     | 30      | 17     | 100    |
| (41.7)         | (11.9)                       |          | (6.7)   | (39.7)  |
| 50             | 100/20                       | 235      | 124     | 23      | 15     | 93     |
| (48.6)         | (9.0)                        |          | (5.9)   | (36.5)  |
| 20             | 50/5                         | 252      | 136     | 20      | 11     | 85     |
| (54.0)         | (7.9)                        |          | (4.4)   | (33.7)  |
| 5              | 20/2                         | 252      | 149     | 17      | 7      | 79     |
| (59.1)         | (6.7)                        |          | (2.8)   | (31.3)  |

a The money value asked in the second question was dependent on the respondent's answer to the first question. For example, for the major damage scenario, of the 258 people asked if they were willing to pay $100, 170 said yes. Those 170 were then asked if they would be willing to pay $250 and 112 said yes. Figures in parentheses are percentages of those asked about the first money value indicated.


question), their responses under this interpretation could be characterised as follows:

- Yes–Yes = 'Definitely preserve.'
- Yes–No = 'Preserve unless it turns out to be a lot more expensive than is now supposed.'
- No–Yes = 'Don't preserve unless it turns out to be a lot cheaper than is now supposed.'
- No–No = 'Definitely don't preserve.'

There are three key predictions that arise from this interpretation of the survey results.

- First, since respondents are only expressing preferences for or against a conservation option, the percentages of Yes–Yes and No–No responses should be insensitive to the money values used in the questioning process.
- Second, responses should be insensitive to income, except insofar as this is correlated with the general cluster of attitudinal variables analysed in the survey. (Since the respondents are not considering the allocation of values, their budget constraints have no meaning.)
- Finally, if the issue has already been debated extensively, as in this case, it is likely that responses will also be insensitive to changes in the scenario presented.

Imber et al. state that income has a positive but insignificant effect on estimated willingness to pay for the national sample, and a negative but insignificant effect for the Northern Territory sample.

Valuing conservation in Kakadu
Concerning the first and third predictions, it is apparent from the data presented in table 2 that, although the money values used in the survey have some effect on responses, the effect is not very large, particularly for the minor impact scenario. For this scenario, the proportion of Yes–Yes responses goes from 42 per cent when the figures are $100 and $250 to 59 per cent when the figures are $5 and $20. The proportion of No–No responses goes from 40 per cent to 31 per cent over the same range. For the major impact scenario, the proportion of Yes–Yes responses goes from 43 per cent when the figures are $100 and $250 to 71 per cent when the figures are $5 and $20. The proportion of No–No responses goes from 31 per cent to 21 per cent over the same range.

These results suggest that, under this alternative interpretation of the survey data, about 70 per cent of the responding sample may have expressed views which are robust to changes in either the scenario or the dollar values used: namely, 42 per cent pro-preservation, 21 per cent anti-preservation and 6 per cent moderately pro-preservation. The remaining 30 per cent are apparently sensitive to changes in the scenario and/or the dollar values.

Of course, the analysis described above is not rigorous, and is aimed at suggesting the plausibility that the survey data were drawn from a mixed group of respondents, expressing both pro-preservation and anti-preservation opinions as well as considered valuations of the specific preservation option presented. A more detailed technical analysis of such a 'mixed' willingness-to-pay/voting model for the national sample data collected in the survey is presented in appendix B. This analysis substantially refutes the assumption of Imber et al. that the survey respondents were all able to make meaningful monetary assessments of preservation values for the Kakadu Conservation Zone. An estimated 53 per cent of the respondents effectively treated the survey as an opinion poll on preservation or development of the zone or perhaps on some broader set of issues.
6. Conclusions

It seems quite clear from the above analysis that the monetary estimates of willingness to pay produced from the Commission's contingent valuation survey have little relevance for policy. In the first place, the order of magnitude of the estimates is out of proportion to the Conservation Zone's place in overall conservation priorities, to income and to the concern about Kakadu National Park volunteered by the survey respondents. Second, there is at least one more plausible explanation of the observed behaviour of the respondents — that is, that a majority of the respondents treated the survey as an opinion poll, rather than a valuation exercise.

There are other serious questions about the likelihood of the survey providing useful results. These centre around, first, the question of what Smith (1991) refers to as 'the extent of the market' for existence values and, second, the range of application of the concept of existence values. Regarding the 'extent of the market' for existence values, there are several unanswered questions about the validity of the expansion of individual survey respondents' answers to estimates of national value. In the first place it is not clear that all of the Australian population would attach existence values specifically to the Zone (as distinct from other conserved environments). Further, it is not clear that, in the context in which the questions were asked, the answers provide individual results which can be added up and which relate purely to the Conservation Zone. Finally, it is not clear that the quite large group of non-respondents can be assumed to have the same demand for conservation as the respondents.

The other set of questions, about the scope of the concept of existence values, concerns the extent to which it is valid to consider existence values for conservation and not those that may exist for mining or other development projects. It is far from clear that considering only the positive existence values from conservation is valid.

It is clear that the estimates of willingness to pay derived from the survey should not be used in any comparison with market values for goods or with estimates of value, such as the ABARE estimate of the net present value of the Coronation Hill mine, which are based on market values. The data resulting from the Commission's survey are best interpreted as the results of a survey of public opinion, rather than as providing a numerical estimate of willingness to pay for preservation of the Kakadu Conservation Zone. On the basis of these data, there is some evidence that a majority of Australians favour incorporation of the Conservation Zone into Kakadu National Park. However, it is not clear that those surveyed had a full appreciation of the costs of not developing the Coronation Hill mine or of the low risks of substantial environmental damage associated with the proposed mine.
Appendix A  An assessment of the Resource Assessment Commission analysis of the survey data

The design used in the contingent valuation survey involved multiple stages of selection (region, census collector district, dwelling and individual), the final stage of selection of individuals being on a quota basis. In addition, the survey suffered from considerable non-response, ranging from a 48 per cent refusal rate in Sydney to 24 per cent refusal rates in non-metropolitan Victoria and South Australia. The final sample of individuals recruited into the study therefore was a disproportionately stratified and heavily clustered quota sample from the Australian population.

A comparison of the demographics of the survey sample with available Australian Bureau of Statistics data shows an overrepresentation of people aged between 25 and 44 and white collar workers, and an underrepresentation of people not in the labour force and people in private sector tertiary industry.

Imber et al. (1990) in their analysis appear to ignore this non-representativeness and complexity of the sample structure, treating the final sample as a representative random sample of the Australian population. In particular, no attempt seems to have been made to allow for the effect of sample structure on the statistical significance of the various results quoted in the report. This effect can lead to exaggerated claims of 'significant' results if not properly compensated for in analysis (Skinner, Holt and Smith 1989).

The willingness-to-pay estimates derived by Imber et al. were based on the application of two slightly different modelling approaches (parametric and non-parametric) to the willingness-to-pay values obtained in the survey. First, the values measured in the survey were obtained within a two-stage discrete choice framework. This resulted in the occurrence of both right and left censored values in the survey data set. However, the Kaplan-Meier estimator underlying the Imber et al. (preferred) non-parametric estimates is appropriate only for right censored data, and is therefore biased. A more appropriate approach (assuming that the complex nature of the sampling procedure could be ignored), would have been maximum likelihood estimation based on grouped multinomial data (Cox and Oakes 1984, section 11.5). Second, the parametric modelling of the willingness-to-pay values was based on an inappropriate application of a likelihood criterion to a non-nested set of competing parametric hypotheses, and the Weibull distribution eventually selected appears not to have been examined for goodness of fit to the survey data. The Weibull is a right-skewed unimodal distribution, while the values observed in the survey appear left-skewed and bimodal. Consequently, the use of a Weibull model for parametric analysis of these data is likely to be misleading.
Appendix B  A statistical analysis based on a mixed voting/willingness-to-pay model

The discussion in chapter 5 indicated that the referendum method underlying the willingness-to-pay estimates reported in Imber et al. (1990) does not provide a satisfactory explanation of the data obtained in the Commission's contingent valuation survey. In particular, the alternative voting model described there appears to provide a more satisfactory explanation of these data.

In this appendix an analysis of the Commission's national sample data, as reported in Imber et al. (1990), is provided. This enables a comparison to be made between the willingness-to-pay model and a model which includes voting behaviour, as they apply to these data. For the purpose of this particular analysis it was assumed that these data were obtained from a simple random sample of the population. Extension of the analysis to take account of the complex nature of the Commission’s survey sample is theoretically feasible, given access to the individual record data.

In order to provide a reasonable comparison between these two interpretations, it is necessary at least to take account of anchoring. Anchoring is the tendency for respondents in surveys or related activities to make their responses to a sequence of questions relative to some starting point, such as an initial value given in the survey or their own responses to the first question (Tversky and Kahneman 1974). The second possibility — the one examined here — suggests that, under the two-stage discrete choice model used to measure willingness to pay in the survey, second-stage responses (that is, responses to questions 8b and 8c in the survey) should be modelled as dependent on whether the first-stage answer (to question 8a) was ‘Yes’ (in which case the amount proposed in question 8b is larger than the corresponding amount in 8a) or ‘No’ (in which case the amount in question 8c is smaller than the corresponding amount in 8a).

First, a willingness-to-pay model is presented. Let YY, YN, NY and NN denote the four possible response patterns generated under the two-stage measurement procedure used in the survey. In what follows, it is assumed that a logistic model applies to both the first-stage response probabilities and to the probabilities of the second-stage responses given the first-stage response. That is, a model is assumed which yields the following probabilities for the four response patterns observed in the survey:

\[
P(YY) = \frac{1}{1 + \exp(\alpha_0 + \alpha_1 SCEN + \alpha_2 M_1)}
\]

\[
P(YN) = \frac{1}{1 + \exp(\beta_0 + \beta_1 SCEN + \beta_2 M_2)}
\]

\[
P(NY) = 1 - \frac{1}{1 + \exp(\alpha_0 + \alpha_1 SCEN + \alpha_2 M_1)}
\]

\[
P(NN) = 1 - \frac{1}{1 + \exp(\beta_0 + \beta_1 SCEN + \beta_2 M_2)}
\]

where

- \(M_1\) is the amount initially proposed;
- \(M_2\) is the amount asked second if the initial answer is ‘Yes’;
- \(M_2\) is the amount asked second if the initial answer is ‘No’; and
- \(SCEN\) is a dummy variable which takes the value 1 if the minor impact scenario is the one presented.

The logistic model above serves as a convenient way of expressing the idea underlying the willingness-to-pay approach. That is, an individual possesses...
an internal valuation of the resource of interest, and therefore responds 'Yes' or 'No' to a willingness-to-pay question by comparing the amount suggested with this valuation. It is not the only model that has been suggested for responses dependent on such 'latent' variables (an alternative is the probit) but is by far the most widely used model for these situations. The second type of anchoring effect mentioned above is represented by $\beta_0$ and $\gamma_0$, which will be equal in the absence of anchoring. (The first type is not represented.)

A more general framework includes the possibility that some respondents act in the manner specified by the voting model. Under this mixed voting/willingness-to-pay model, it is assumed that a proportion $\theta_1$ of respondents answer 'Yes' regardless of the money values put to them, a proportion $\theta_2$ answer 'No', also regardless of money values, while the remainder follow the (possibly anchored) willingness-to-pay model specified above. Under this framework the probabilities of the four possible response patterns are given by

$$
\begin{align*}
pr(YY) &= \theta_1 + (1 - \theta_1 - \theta_2)P(YY) \\
pr(YN) &= (1 - \theta_1 - \theta_2)P(YN) \\
pr(NY) &= (1 - \theta_1 - \theta_2)P(NY) \\
pr(NN) &= \theta_2 + (1 - \theta_1 - \theta_2)P(NN)
\end{align*}
$$

where $P(YY)$, $P(YN)$, $P(NY)$ and $P(NN)$ denote the logistic based probabilities defined earlier.

This general model was fitted to the national sample data of the Commission's survey by maximising the associated likelihood function under a simple random sampling assumption. A likelihood ratio statistic was used to test various possible restrictions on the model.

The first line of table 3 shows the results from fitting the unrestricted model. A number of features of the estimated parameter set are of interest. First, 53 per cent of respondents ($\theta_1 + \theta_2$) are estimated to follow the voting model. This group is large enough to undermine the results of any interpretation of the national sample data in terms of willingness to pay. In particular, the existence of 39 per cent of committed 'Yes' voters means that the median estimate of willingness to pay will be determined by the point at which an additional 11 per cent of respondents answer 'Yes'. Mean estimates of willingness to pay are even more strongly influenced.

Second, there is a sharp difference in second-stage responses depending on whether the first answer was 'Yes' or 'No'. The value for $\beta_0$ is negative, while that for $\gamma_0$ is positive. This indicates that even excluding the group covered by the voting model, a 'Yes' answer is likely to be followed by another 'Yes' and similarly for 'No'. For example, a respondent who is asked about willingness to pay $50 in order to avoid the major impact scenario after previously answering 'Yes' to paying $20 has an estimated 72 per cent probability of answering 'Yes' again; and a respondent who had previously answered 'No' to paying $100 to avoid the major impact scenario has a 77 per cent probability of answering 'No' to paying $50 for the same purpose.

Third, which of the two scenarios is presented has a greater effect at the first stage of questioning than at the second stage. In fact, scenario is almost irrelevant to the second-stage responses of people who answered 'No' at the first stage.

In summary, over 50 per cent of respondents act in accordance with the voting model, without being influenced by the suggested money amounts. Furthermore, the behaviour of the remaining respondents is inconsistent with a strict application of the willingness-to-pay model, and may be best interpreted as a mixture of the two types of response. This conclusion is corroborated below.

The second line of table 3 reports the results of imposing the restriction $\theta_1 = \theta_2 = 0$ (reducing the model to a pure willingness-to-pay model). The results show a more extreme version of the
Results from fitting a mixed voting/willingness-to-pay model to the survey data

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>$\theta_1$</th>
<th>$\theta_2$</th>
<th>$\alpha_0$</th>
<th>$\beta_0$</th>
<th>$\gamma_0$</th>
<th>$\alpha_1$</th>
<th>$\beta_1$</th>
<th>$\gamma_1$</th>
<th>$\alpha_2$</th>
<th>$\beta_2$</th>
<th>$\gamma_2$</th>
<th>log $L$</th>
</tr>
</thead>
<tbody>
<tr>
<td>No constraints</td>
<td>0.39</td>
<td>0.14</td>
<td>-1.13</td>
<td>-1.56</td>
<td>1.17</td>
<td>0.94</td>
<td>0.23</td>
<td>0.28</td>
<td>0.010</td>
<td>0.012</td>
<td>0.001</td>
<td>-2133.9</td>
</tr>
<tr>
<td>$\theta_1 = \theta_1 = 0$</td>
<td>0</td>
<td>0</td>
<td>-1.06</td>
<td>-2.09</td>
<td>2.03</td>
<td>0.46</td>
<td>-0.24</td>
<td>0.02</td>
<td>0.005</td>
<td>0.005</td>
<td>-0.003</td>
<td>-2135.2</td>
</tr>
<tr>
<td>$\alpha_2 = \beta_2 = \gamma_2$</td>
<td>0.38</td>
<td>0.20</td>
<td>-1.72</td>
<td>-1.54</td>
<td>0.24</td>
<td>1.13</td>
<td>0.19</td>
<td>0.62</td>
<td>0.011</td>
<td>0.011</td>
<td>0.011</td>
<td>-2134.4</td>
</tr>
<tr>
<td>$\alpha_2 = \beta_2 = \gamma_2$</td>
<td>0.40</td>
<td>0.20</td>
<td>-1.50</td>
<td>-1.74</td>
<td>0.13</td>
<td>0.74</td>
<td>0.74</td>
<td>0.74</td>
<td>0.013</td>
<td>0.013</td>
<td>0.013</td>
<td>-2140.5</td>
</tr>
<tr>
<td>$\alpha_2 = \beta_2 = \gamma_2$</td>
<td>0</td>
<td>0</td>
<td>-0.96</td>
<td>-2.28</td>
<td>1.73</td>
<td>0.24</td>
<td>0.24</td>
<td>0.24</td>
<td>0.005</td>
<td>0.005</td>
<td>0.005</td>
<td>-2144.6</td>
</tr>
<tr>
<td>$\alpha_1 = \beta_1 = \gamma_1$</td>
<td>0.38</td>
<td>0.20</td>
<td>-1.72</td>
<td>-1.54</td>
<td>0.24</td>
<td>1.13</td>
<td>0.19</td>
<td>0.62</td>
<td>0.011</td>
<td>0.011</td>
<td>0.011</td>
<td>-2134.4</td>
</tr>
<tr>
<td>$\alpha_1 = \beta_1 = \gamma_1$</td>
<td>0.40</td>
<td>0.20</td>
<td>-1.50</td>
<td>-1.74</td>
<td>0.13</td>
<td>0.74</td>
<td>0.74</td>
<td>0.74</td>
<td>0.013</td>
<td>0.013</td>
<td>0.013</td>
<td>-2140.5</td>
</tr>
</tbody>
</table>

pattern seen in the general model. The conditional probabilities for a 'Yes' response to $50$ at the second stage under the major impact scenario have now moved out to 86 per cent following 'Yes' to $20$ at the first stage, and 13 per cent following 'No' to $100$ at the first stage. Furthermore, the coefficients on $\beta_1$ (the scenario effect) and $\gamma_2$ (the money effect after an initial 'No') are incorrectly signed. Although the imposition of these restrictions cannot be rejected by the likelihood ratio test, the fitted behaviour of the respondents is clearly inconsistent with the willingness-to-pay model.

The third line of table 3 reports the results of imposing the restriction $\alpha_2 = \beta_2 = \gamma_2$, so that the response to any given money value is assumed to be independent of the stage of questioning or the previous response. This would be expected under a referendum based willingness-to-pay interpretation of the responses of those survey participants who did not treat the survey as an opinion poll. (It is still assumed that others of the subjects are, instead, voting.) This hypothesis cannot be rejected by the likelihood ratio test. The effect is to increase the estimated proportion of respondents following the voting model to 58 per cent.

The fourth line reports the results of imposing the restriction $\alpha_1 = \beta_1 = \gamma_1$ in addition to $\alpha_2 = \beta_2 = \gamma_2$. This means that the effect of which scenario is presented is also independent of the stage of questioning or the previous response. Again, this would be expected under a referendum based willingness-to-pay interpretation of the 'non-voting' survey responses. The proportion of respondents modelled as 'voters' rises to 60 per cent, but this additional restriction is rejected by the likelihood ratio test.

The final line indicates the results of imposing all three of the above restrictions: $\alpha_1 = \beta_1 = \gamma_1$, $\alpha_2 = \beta_2 = \gamma_2$ and $\theta_1 = \theta_2 = 0$. This represents a model broadly consistent with a strict application of a referendum based willingness-to-pay interpretation of the survey data. This set of restrictions is rejected relative both to the unconstrained model and to the model of line 4.

In summary, if the population is partitioned into a group which behaves in accordance with the voting model and a group which accords with the referendum based willingness-to-pay model, between 50 per cent and 60 per cent are found to follow the voting model, about 40 per cent favouring preservation. It is thus apparent that a majority of those respondents who follow the voting model support preservation rather than development. This vote appears to dominate most of the results reported by Imber et al. (1990).
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