Environmental economics and valuation: towards a practical investment framework for Catchment Management Authorities in New South Wales

Bob Farquharson[a], Christine Hill[b], Jeff Bennett[c], Jacqueline Tracey[d]

[a]NSW Department of Primary Industries, Tamworth Agricultural Institute,
bob.farquharson@dpi.nsw.gov.au
[b]NSW Department of Natural Resources, Wagga Wagga
[c]Australian National University, Canberra
[d]NSW Department of Natural Resources, Sydney

Abstract

The Catchment Management Authorities in New South Wales have programs that are collectively investing $436 million over four years to achieve catchment-wide natural resource/environmental improvements. In this paper, we consider the question of how to best allocate these resources so as to increase the well-being of the public within catchments and the state. We consider the current approaches used by CMAs and make a case for Benefit-Cost Analysis as an alternative means of assessing *ex ante* questions of priority setting at the catchment level and for project appraisal. A major issue for BCA is the estimation of potential benefits from project investments, particularly the estimation of values that catchment communities and those living outside the catchments place on the non-use benefits associated with environmental improvements. We discuss alternative means of eliciting such values and propose the stated-preference method of Choice Modelling as a means of overcoming this Benefit-Cost Analysis shortcoming, because it incorporates advances in non-market valuation.

Key words: environmental, economics, choice modelling, non-use values, investment framework

51st Annual Conference of the Australian Agricultural and Resource Economics Society, Queenstown, New Zealand, 13 – 16 February 2007

Environmental economics and valuation: a practical investment framework for Catchment Management Authorities in New South Wales

1. Introduction

The Catchment Management Authorities (CMAs) in New South Wales (NSW) have programs that are collectively investing $436 million over four years to achieve catchment-wide natural resource management (NRM)/environmental improvements. Given the size of this budget, we are concerned that the allocation of these funds should be managed to create as great a net impact on community well-being as possible.

Ultimately the objectives of these programs are anthropomorphic; the CMAs are interested in the human-socio-economic outcomes from an improved natural environment. Freeman (1994) views both natural and environmental resources as assets that yield a variety of valuable services to human society. These include (1) consumptive goods (material inputs including fuel, wood, minerals, water and fish that are concerned either directly or indirectly via a production process), (2) life-support services (breathable atmosphere and liveable climate), (3) amenity services (recreation, wildlife observation, scenic views, and non-use or existence values), and (4) the basis for dispersing, transforming and storing the residuals of economic activity. These service flows are valuable to society and contribute to socio-economic outcomes, so we are interested in including them in the NRM decision making process.

It seems self-evident that the application of taxpayer funds to works for public NRM benefit should aim to obtain as great a net impact as possible on social well being. In light of this, a decision-making process is required and an investment framework is appropriate since investments of public funds are being made with the objective of achieving desirable public outcomes. We consider whether and how existing CMA decision-making processes might be improved given this consideration.

In this paper we discuss developing a practical investment evaluation process and decision-making framework for NRM to meet the public policy objectives of NSW and Australian governments. We use the terms ‘natural resource’ and ‘environmental’ interchangeably in this paper although each has a specific meaning. The CMAs address issues of soils, vegetation, biodiversity and riverine ecosystem quality, which include both types of impact. These are natural resource use choices that affect public environmental assets (Bennett 2005).

Some CMAs currently use scoring and weighting methods to develop an Environmental Benefit Index (EBI) or an Environmental Services Ratio (ESR) as proxies for environmental benefits, which are then compared with project costs. Other CMAs use a cost-effectiveness approach (public cost per unit of environmental benefit), some consider cost shares (public versus private) and some don’t have any formal processes to rank proposals. None of these approaches put a value on environmental outcomes in economic terms and are deficient in terms of an investment framework that considers socio-economic outcomes.

We propose BCA as an alternative framework to the current methods because of the need to make the most of the public funds invested in NRM for socio-economic purposes. BCA requires that the non-use benefits from environmental improvements be valued, and we propose the economic stated-preference method of Choice Experimentation or Choice Modelling (CM) for estimating non-use values as part of the investment appraisal process. This method of environmental valuation, together with bio-physical modelling of the impacts of on-ground changes can be used to make improvements in an investment framework for NRM decision making.

2. What are the public policy requirements for NRM decisions?
At the Australian Government level, the National Heritage Trust (NHT) (see http://www.nht.gov.au/about-nht.html) and the National Action Plan for Salinity and Water Quality (NAP) (see http://www.napswq.gov.au/) are programs that focus on funding at the national, state and local levels to address NRM issues. Evaluations (see http://www.nrm.gov.au/monitoring/national-evaluations/index.html) of these programs have been conducted and it is noted that there are no requirements for prioritisation between investments in terms of their expected financial benefits in the planning stages of these programs. The Australian Government has recently announced continuation of funding for the NHT and the NAP programs beyond 2008 when the current funding finishes (Campbell and McGauran 2006). Campbell and McGauran state that the Government 'has a central role in ensuring the maximum return on this significant investment'.

At the NSW State Government level, the Natural Resources Commission (NRC) was established to provide the government with independent advice on a range of NRM issues. The NRC has developed a set of standards and targets for NRM within the state. The state-wide targets 'focus on state-wide NRM investments and provide a means of tracking progress on NRM issues within NSW' (see http://www.nrc.nsw.gov.au/). Target 12 relates to 'community' and requires that natural resource decisions contribute to improving or maintaining economic sustainability and social well-being. The NRC standard for quality NRM relates to quality assurance that will, among other things, 'maximise the efficiency and effectiveness of their investments in natural resources' (see http://www.nrc.nsw.gov.au/).

In the NSW State Plan (NSW Government 2006) the priority for better outcomes for native vegetation, biodiversity, land, rivers and coastal waterways includes targeting 'resources to the activities and places with the greatest potential for improvement', and in 'applying new scientific information, tools and market based programs to promote better natural resource management on both public and private land' (p. 121).

Thus the rhetoric of Governments in Australia for NRM is of 'maximising returns', 'maximising the efficiency and effectiveness of investments in natural resources', and 'targeting resources to the activities and places with the greatest potential for improvement'. However, the processes of achieving these 'goals' are not clearly specified or determined. The CMAs are aware of this rhetoric but do not have guidelines on what constitutes 'maximum efficiency', 'better NRM' or 'maximum return'. The aim of this paper is to suggest a sound practical approach to making these CMA goals operational. We propose the development of an investment framework that can be used in a planning or *ex ante* process utilised before the NRM investment decisions are made.

3. A decision framework for NRM decision making

3.1 NRM policy and assessment

As well as the large-scale investments mentioned above, there are also currently new regulatory regimes being imposed for native vegetation planning and water management. There are also 'market-based instruments' being implemented (Grafton 2005), which include investigation of auctions, offsets and cap and trade approaches. These issues and processes together potentially involve large transfers of wealth and/or well being.

Different needs are being expressed by NRM decision makers within the CMAs in NSW. One set of needs relates to priority-setting processes for allocation of funds within CMA budgets. Such priorities consider catchment-wide issues and can be utilised (with other information) in developing and refining CAPs used as a basis for specific NRM decisions.

Once the CAPs are in place funds disbursement processes are required, and decisions need to be made about the most appropriate activities to be undertaken. The 'most appropriate' requirement can include issues of efficiency and effectiveness in investing and administering funds for public NRM gains. Currently there is a range of methods possible, including MBIs.

A general classification of the decision making needs of the CMAs is shown in Figure 1. In this classification the higher-order needs are first determined and these priorities used as an input to setting or refining the CAPs. Then the mechanisms or instruments are considered in how to best meet each priority area. In the latter process it may be that issues of cost or information requirements preclude work in a specific NRM area. This decision may then lead to a further iteration of priority determination.

The specification of society's goals in making these investments is complex – there are political, social, financial, environmental and economic elements involved. The policy process is currently informed by 'expert advice' (internal and external to the public sector) and influenced by lobby groups. Rent-seeking in the political process suggests that this process is unlikely to improve society's overall well being (McKenzie and Tullock 1981). A superior assessment of policy (*ex post* and *ex ante*) would integrate all elements of change and NRM policy assessment needs to consider how to integrate the divergent impacts of the above elements.

3.2 A case for economic appraisal of NRM decisions

Even though there appears to be no specific current administrative requirements for the process used to make NRM decisions, there is a need for CMAs to assess broad priorities to direct NRM investments. The CMAs also need to decide on funding for individual projects for on-ground activities, and there are investment issues in those decisions. In general, the CMAs in NSW need to place or direct their investments into the most appropriate areas within the catchment, i.e. to optimise their investments. While *ex post* evaluations can be undertaken after a relevant time period to assess performance, there is a need for a prioritisation and investment framework to be used *ex ante* to develop structure and rigour in making NRM investments for catchment communities.

3.3 Alternative decision frameworks
Analytical tools (including bio-physical models) are valuable in predicting the outcomes of NRM investments. Such predictions indicate the quantity of NRM change arising from alternative proposals. The NRM improvement then must be valued in some way. Common units are required for comparative purposes and an important question for decision making is whether the units should be monetary or some other metric.

Economic approaches value NRM improvements in dollars worth of social well-being so that they can be offset against input costs or investments, and compared directly between proposals and against investments available across society. Non-economic approaches use scoring and weighting methods to develop an index of NRM improvement (Hajkowicz *et al*. 2007). An important issue in comparing these approaches is the feasibility (including accuracy of predictions), practicality and cost associated with measures developed from alternative approaches.

3.4 Current CMA approaches to decision making
The CMAs in NSW currently use a variety of non-economic methods to rank and evaluate bids for on-ground NRM works (Black *et al*. 2006). These include measures of environmental output based on an EBI and an ESR, and measures of input (public and private funds proposed, in-kind contributions by landholders). Bids are ranked as 'benefit-cost' (eg EBI or ESR/public dollar), 'cost-benefit' (dollar cost/unit benefit), cost sharing (public versus private) according to pre-defined ratios for different types of works, scoring and ranking systems in association with cost shares, and no bid ranking in two cases[1].

A summary of the key common needs identified in consultation with the CMAs includes, among others (Black *et al*. 2006):

- Prioritisation of investments at catchment scale for major themes based on prediction of outcomes, preferably, but even ruled-based prioritisation would be of value;
- Ability to assess benefits across multiple themes, and to distinguish private from public benefits; and
- Investment decisions based on outcomes, rather than outputs or inputs.

These needs imply a consistent and rigorous investment approach for their decision making purposes.

4. Scoring, ranking and indexing approaches
In this section existing CMA approaches to quantify environmental benefits are reviewed. Descriptions of EBIs and ESRs are based largely on personal communications from Brent Jacobs (NSW Department of Natural Resources) and Lester Lynch (then of the NSW Department of Infrastructure, Planning and Natural Resources and involved in the TARGET project). Hajkowicz *et al*. (2007) also discussed techniques for the selection of conservation contracts under competitive tendering programs. Under these programs purchasing decisions are often based on the benefits score and cost for the proposed projects.

---
[1] Note that even where no rankings are assigned, the process of fund allocation provides a *de facto* ranking.

4.1 Descriptions of these approaches

The objective of these approaches is to allow projects to be rated for environmental benefit while also determining a cost sharing ratio or a reserve price for a tender-based approach. Using these approaches a field officer can negotiate with the landholder to obtain a higher environmental benefit while providing the landholder with an improved cost-sharing ratio.

The aim of both EBIs and ESRs is to be: simple to use, transparent, easily understood by landholders, readily disaggregated, robust but adaptable and capable of accommodating changes, adapted so that the measurement scale will be wide enough to accommodate the range of variability of condition in the State, designed to use the full scale (not clumped around central values), suitable for use within the context of agricultural enterprises, and repeatable over time, scientifically credible, verifiable and cost–effective.

4.1.1 The EBI approach

Mathematically an EBI is a weighted sum of changes in component index scores for different environmental services. A number of prerequisites exist for calculating an EBI. First, the likely environmental service changes arising from on-ground works need to be measured or predicted in a consistent manner based on current scientific knowledge and experience of NRM. Then these changes must be expressed as a score for use in the weighting formula. Changes for different environmental services (eg water quality versus soil quality versus biodiversity) need to be considered for comparability. The scores for component indexes need to be normalised on a consistent scale (eg 0-1) so that different changes can be included in the EBI formula.

Further, weights must be developed to reflect the relative value of each service to the organisation using an index, so if a Government uses an EBI the weights should reflect the relative value the community places on each of the environmental services. As environmental services vary in importance around the state (eg salinity) it is not appropriate to set State-wide weights for every landscape. Generally weights should be set at the catchment scale to reflect the priorities in that catchment. Once the scores and weights for each proposal are set the EBI is calculated and compared with other proposals.

The EBI is proposed as one of a suite of decision-support tools for use in NRM. It is used to provide information about the relative value of environmental services generated by certain on-ground actions. It can be used in combination with other techniques, such as BCA and social impact assessment, to assist decision makers.

4.1.2 The ESR approach

ESRs are used to prioritise applications for on-ground works and to set cost-sharing ratios. The process involves developing a rating table, conducting an incentive funding assessment, and making incentive calculations. A salinity example from the Central West region of NSW is presented for illustration.

For each proposal dealing with an environmental issue (eg salinity) a rating table is developed with:

- criteria as rows (eg area of recharge treated, impact on deep drainage in recharge area, area of discharge treated, soil EC level in discharge area); and
- levels of criteria as columns (termed low, medium, high and very high).

For each criteria, each level has a range of values (eg for area of recharge treated 1-5 ha = low, 5-20 ha = medium, 20-50 ha = high, and >50 ha = very high, for area of discharge treated the relevant numbers are <1, 1-2, 2-5, and >5 ha respectively). For each criterion there is an associated rating in the range (0-1), eg the rating for area of recharge treated is 0.7, for impact on deep drainage in recharge area 0.8 in this example. These ratings are set by the funding agency, and are equivalent to the weights in the EBI.

For each proposal the incentive funding assessment involves determining an appropriate level for each criterion. The values associated with each level for each criterion were 2 for low, 4 for medium, 6 for high and 8 for very high in this example. These values are multiplied by the appropriate rating to determine a total score for the project. In this salinity example the total project score was 36.2, and the maximum possible total score was 83.2.

The incentive calculations are as follows. If the total indicative treatment cost per ha was $450, then the ESR is the project score divided by the total possible score, or 0.44. This ratio is applied to the indicative cost to determine the private contribution of $252/ha and the indicative incentive or reserve of $198/ha. In this way the ESR provides a ratio for ranking projects and a means of determining cost shares.

4.2 Issues for these approaches

There are a number of issues associated with these approaches. A major issue is that they are not based on any theoretical construct of society’s objective function. The choice of criteria to score or rate projects is in the hands of technical experts. Public money is being spent to achieve public benefit but there is no input from the public in these assessment processes.

In the scoring or rating processes there are issues of cardinal and ordinal ranking that can compromise the accuracy of final outcome. In addition, the translation of physical effects to the impact on people assumes a linear transformation process, but this ignores diminishing marginal utility. In addition, scoring impacts at different points in time do not seem to be consistently treated.

The weighting process appears to be imposed by the analyst, perhaps in conjunction with the decision maker. These weights can potentially be manipulated in the political process, a weakness of these approaches in making consistent public NRM policy decisions.

These processes utilise discussions between a small number of people (project applicants, analysts and decision makers) in developing the scores and weights. The processes do not appear to be able to derive values for a larger population or even a representative sample, as would be required for establishing social values as a basis for investing public funds.

These issues indicate substantial possible problems for ranking NRM projects in a social context. They are also unable to contribute to an economic BCA approach, as outlined in sections 2 and 3.

5. Benefit-Cost Analysis

5.1 Advantages of BCA

BCA has strong and consistent foundations in welfare economics (Just, Hueth and Schmidt, 1982, Freeman 1994, p. 10-12, Sinden and Thampapillai 1995, p. 20-3, Grafton *et al*. 2004, section 8.4). It has a tightly defined objective function for society, being the maximisation of total economic surplus based on production costs, exchange and consumer sovereignty (willingness to pay). It is concerned with the efficiency of resource allocation to ensure that policy changes yield marginal benefits greater than the associated marginal costs. Benefits and costs are closely defined in terms of contribution to or detraction from society's well being.

Because of its consistent formulation, BCA allows comparison across different policies. With respect to the values held by individuals, the objective is to assess these according to their own perception of what matters, i.e. based on rational choice. Time effects are embedded through the discounting process to calculate present values. A single numeraire is used to facilitate comparison.

5.2 Challenges for BCA

BCA requires that all impacts be valued in monetary terms. All benefits and costs must be valued in terms of their effects (broadly defined) on humanity (Tietenberg 2003). This does not imply that ecosystem effects are ignored unless they directly affect humans. Many people donate and contribute to causes that improve the environment; hence they express a value of willingness to pay for outcomes for which they receive no direct benefit.

This valuation requirement for NRM benefits represents a challenge when markets are not present to provide a 'window' into the well being of individuals. This is especially the case when policy changes focus on environmental impacts – which is pertinent for NRM policy as mentioned above. Environmental economists have developed methods for non-market valuation which can be utilised for NRM policy evaluations.

5.3 Issues in Economic Valuation of Environmental Benefits

The application of economic valuation techniques to environmental changes is by no means uncontroversial. There are several reasons for this, some of which stem from a misunderstanding of monetisation. The use of money as a standard is sometimes a barrier to wider acceptance. Many people believe that some environmental assets are 'priceless' in the sense that they cannot accept trade-offs involving these assets, or they consider it immoral to place a value on goods such as clean air or water, which are generally seen as a right for all (Ackerman and Heinzerling 2006). However, trade-offs are made all the time with regard to environmental resources, all valuation does is to make the extent of the trade-offs explicit.

Economic approaches express the relative values that society places on different uses of resources in monetary terms, as a convenience. We stress that valuation is about marginal changes, it is not attempting to consider the total loss of a species.

Another concern is that the preferences of individuals, expressed in terms of their willingness to pay, reflect only self-interest, while social decisions should be made out of concern for the public interest. However, in reality, preferences may have all kinds of motives, including a concern for others, for future generations, for different species, etc.

In addition to these philosophical concerns regarding the appropriateness of environmental valuation techniques, more substantive issues have been raised concerning valuation methodology particularly in relation to stated preference techniques and benefit transfer.

5.3.1 Methodological concerns with stated preference techniques and benefit transfer
A number of methodological concerns have been identified with the Contingent Valuation (CV) method which has been the predominant stated preference technique to date. A primary concern is the potential for survey respondents to give biased answers. Tietenberg (2003) summarises four types of potential bias that have been the focus of a large amount of research. These are strategic bias, information bias, starting point bias and hypothetical bias. An expert panel (National Oceanic and Atmospheric Administration (NOAA) 1993) considered that suitably designed surveys could eliminate or reduce these biases to acceptable levels and it provided specific guidelines for determining whether studies are suitably designed.

5.4 Cost of environmental valuations
The cost of undertaking original environmental valuations using CM is of the order of $100,000 to $140,000 depending on the type of survey methodology used (Dr Bob Dumsday, URS Australia, personal communication). Only highly contentious cases where large values are involved will warrant direct data collection exercises. The question is whether this amount is justified to obtain realistic and reliable value estimates. There is potential for relevant environmental values to be adopted from other studies (Rolfe and Bennett 2006). An alternative is for CM studies to be conducted in a representative sample of catchments for key environmental services and then benefit transfer to be used for all CMAs in NSW. An example is the report of URS Australia (2006) (see section 6.4).

6. Economic approaches to revealing values for environmental attributes
Freeman (1994) depicts natural resource assets as providing economic value to individuals in society in various ways. In Figure 2, the total economic value of these assets is divided into personal use and non-use values (OECD 1995). Non-use values include benefits (option, bequest and existence) from environmental assets such as biodiversity, conserved habitats and endangered species.

For traded goods, values are derived from markets with regard to observed relationships between price and quantities supplied and demanded. Natural resource goods and services are, however, often not traded in this manner. One way of determining prices for environmental services is to establish the conditions necessary for a functioning market. This can be done via natural resource pricing reforms and specifying property rights, as well as allowing and facilitating trade.

However, there are constraints on markets for many of these goods and services. These relate in general to information, property rights and environmental thresholds.

While these remain, the challenge is to ensure that the full costs and benefits of natural resource use and non-use are taken into account in decision making. Techniques that attach economic value to the stock as well as the flow of services from them can assist policy makers in meeting this challenge.

Note that valuation in BCA is centred on marginal costs and benefits. Hence it is a question of estimating change in the value of a stock or a flow depending on what is affected by the proposal under consideration.

Figure 3 illustrates the various techniques for monetary valuation of natural resource use and non-use values. Dose-response or production functions are relationships that relate a dose or input (eg fencing riparian zones) to some outcome (eg biodiversity). Valuation is applied to the outcome of the production function. Production functions are required for all valuation procedures, because before values are estimated we need to know the extent of the change being valued. The discussion below distinguishes between revealed and stated preference methods of economic valuation.

6.1 Revealed Preference Methods

Revealed preference methods infer prices for environmental services from observed market behaviour. Some of these techniques measure reasonably direct market impacts associated with changes in natural resource condition. For instance, productivity techniques assess the impacts on agricultural yields of changes in natural resource inputs (eg Magrath and Arens (1989) assessed the effect of soil erosion on crop yields in Java, Indonesia). Cost-based techniques such as defensive and replacement/repair expenditure, and opportunity cost also measure the direct impacts of changes in natural resource condition or use. Abdalla et al. (1989) valued the benefits and costs of groundwater contamination in Pennsylvania using the averting expenditure method.

Other revealed preference methods attempt to value environmental costs and benefits through more indirect means. In these cases preferences are revealed in markets that are in some way related to the good/service in question. For instance, these include travel cost and the value of a recreational site, and labour markets and the issue of environmentally-induced health risks. Navrud and Mungatana (1994) used the travel cost and CV methods to calculate the use value of visits to the Lake Nakuru National Park in Kenya.

6.2 Stated Preference Methods

For non-use environmental assets there is no relevant market behaviour to observe. In such cases a hypothetical or contingent market must be constructed using questionnaires. This is the basis for the stated preference methods.

Drawing on advances in market research and cognitive psychology, the stated preference methods have been applied widely in environmental economics over the past three decades. These techniques are used to determine willingness to pay for a good, even though the respondent does not currently use it directly, nor intends to use it in the future.

Two of the main categories of stated preference methods that are used to estimate the willingness to pay for non-use environmental assets and services are CV and CM.

6.2.1 Contingent Valuation Method

The CV method is a survey technique that attempts direct elicitation of individuals' (or households') preferences for a good or service. It does this by asking the respondents in the survey a question or a series of questions about how much they value the good or service. People are asked directly to state or reveal what they are willing to pay in order to gain or avoid some change in provision of a good or service.

A contingent market defines the good itself, the institutional context in which it would be provided and the way it would be financed. The situation the respondent is asked to value is hypothetical (hence, 'contingent'), although respondents are assumed to behave as if they were in a real market. Structured questions and various forms of 'bidding game' can be devised involving yes/no answers to questions regarding maximum willingness to pay. Econometric techniques are then used on the survey results to find the mean bid values of willingness to pay. Carson (2000) provides a guide to the use of CV.

6.2.2 Attribute Based Stated Choice methods

A recently-emerged alternative to CV is Attribute Based Stated Choice (ABSC) methods (Grafton *et al*. 2004). These methods present a set of alternatives which are defined by attributes, including the price or payment. The choice sets of alternatives are developed from experimental designs which allow the attributes to be uncorrelated and yield un-confounded estimates of the parameters of the conditional indirect utility function (Grafton *et al*. 2004).

Applications of ABSC methods generally follow 7 steps (Grafton *et al*. 2004):

1. Characterise the decision problem: identify the problem and decide how to frame the decision problem;
2. Attribute-level selection: define the number of attributes and determine the levels for each attribute, these must be understandable by the respondent;
3. Experimental design development: construct the choice tasks, alternatives or profiles that will be presented to the respondents;
4. Questionnaire development: determine the format of survey, pre-test the questionnaire;
5. Sample size and data collection: determine sample size based on considerations of data accuracy and survey cost;
6. Model estimation: these methods are based on random utility theory. Determine the most appropriate estimation method;
7. Policy analysis and decision support: use the model results to generate welfare measures, or predictions of behaviour, or both, for policy analysis or part of decision support.

These methods are useful in the valuation of the attributes of a scenario, or where the decision involves choosing from a set of alternatives. The design and analysis using these methods is based on random utility theory and is consistent with the theoretical underpinnings of CV (Grafton *et al*. 2004).

6.2.3 Choice Modelling

CM (see Bennett and Blamey 2001,) is perhaps the main ABSC method used for environmental valuation. The elements of CM that are common with CV are that the attribute scenarios are hypothetical choice sets. The questionnaire formats are also broadly similar. The key difference is that under CM willingness to pay is only elicited indirectly through a process of observed trade-offs made by respondents. Thus whereas CV directly asks for willingness to pay CM infers it from choices made by respondents across a sequence of options.

CM is based around the idea that any good can be described in terms of its attributes and the levels that these take. A forest can be described in terms of its species diversity, age structure, recreation facilities and an entry price or transport cost. Changing attribute levels will essentially result in a different "good" being produced and it is on the value of such changes in attributes that CM focuses. By choosing over these different "goods" including the implicit price attribute, respondents reveal the value of the other attributes indirectly. A well structured CM questionnaire is designed to ensure that there is no correlation between attributes to enable the model to determine the importance of each attribute.

CM conveys four pieces of information that may be of use in a policy context:

- the attributes that are significant determinants of the values that people place on non-market goods;
- the implied ranking of these attributes amongst the relevant populations. For example, in forests the relative rankings of different types of trees and how these rank relative to improved access;
- the value of changing more than one of the attributes at once (for instance, if a management plan results in a given increase in wildlife protection but reduction in recreation access);
- as an extension of this the total economic value of a resource or a good.

Morrison *et al*. (1999) examined the trade-off values of a sample of non-users for a bundle of socio-economic and environmental attributes associated with conservation and use of the Macquarie Wetland System in NSW. Options included for respondents were to continue the current system and to increase the water to the Macquarie Marshes, with the associated attributes being an increase in water rates for households (one-off increase), a change in irrigation-related employment, a change in wetlands area, a change in waterbirds breeding, and a change in the number of endangered and protected species present. A summary of the results was that increasing the breeding frequency of waterbirds by 1 year was equivalent to 154 jobs, which was equivalent to 545 km^2 of extra wetland area, which was equivalent to 5 endangered or protected species present.

These trade-off values are the strength of CM compared to CV, which provides an aggregated willingness to pay value but rarely more detailed information on the values of specific parts of the whole package. This latter information is far more relevant in a policy context.

6.3 Benefit Transfer

Benefit transfer is not strictly a valuation technique, but it involves 'borrowing' an estimate of willingness to pay from one site (the study site) and applying it to another (the policy site). What is borrowed may be a mean value which is not adjusted or a mean value which is modified to 'suit' the new site. Or it may be a whole benefit function that is transferred.

The attraction of benefit transfer is that it avoids the cost of engaging in primary studies and saves time. However substantial care must be taken to ensure the validity of transferring values from one site to another. The OECD (1995) noted that whilst benefit transfer studies are common the validity of these transfers is rarely tested.

One elementary procedure is to borrow an estimate of willingness to pay from the study site and apply it to the policy site. However, such transfers are easily invalidated by differences in the:

- socio-economic characteristics of the relevant populations;
- physical characteristics of the study and policy sites;
- proposed change in provision between the sites of the good to be valued; and
- market conditions applying to the sites for instance the availability of substitutes.

There are a number of ways to adjust benefit transfer values:

1. expert judgement, i.e. experts make a judgement about how the willingness to pay will vary between sites;
2. re-analysis of existing study samples to identify sub-samples of data suitable for transfer;
3. meta-analysis of numbers of estimates permitting the estimation of cross study benefit functions applicable to policy sites.

As an example of the latter, Walsh *et al*. (1992) conducted an analysis of outdoor recreational demand studies in the United States. They surveyed 287 estimates of net economic value per day from 1968 to 1988 of outdoor recreation. They tested a large number of variables to explain differences in recreation value estimates to develop a statistically valid measure that can be used in benefit transfer.

Windle and Rolfe (2007) report how a series of valuation studies were specifically performed to build a reference database of values for benefit transfer purposes. The CM technique was used to estimate community values for protection of soil, water and vegetation stocks in Queensland, where both state and regional populations were surveyed to generate value estimates in a variety of contexts. The results provide a database where government and natural resource management agencies can access generic estimates of environmental values.

Morison and Bennett (2004) and van Beuren and Bennett (2004) provide other examples of valuation studies for the environmental health of rivers in Australia.

6.4 A valuation approach for CMAs in NSW

CM has a number of advantages over existing methods used by CMAs to derive estimates of benefits from NRM projects for investment decision making. However, as discussed there can be substantial costs associated with CM studies. In proposing a practical approach for CMA decision making, two alternatives are possible using CM and benefit transfer.

One approach is to consult pre-existing studies and transfer an appropriate estimate to the target area, i.e. benefit transfer (van Beuren and Bennett 2004). The ENVALUE database developed by the NSW Environment Protection Authority is a source of values for Australian conditions, and there are similar databases in other countries. Rolfe and Windle (2007) report the development of a database for environmental values on Queensland. The main issue with adaptation of these values to current needs is representativeness and possible errors with the process, an issue that van Beuren and Bennett (2004) addressed.

The second possibility is to conduct specific studies for particular purposes on a representative sample of catchments and use benefit transfer to utilise the values on a broader context. The study by URS Australia (2006) is an example of this approach. If a large amount of information is required in a relatively consistent framework (eg NRM values for the 13 CMAs in NSW), then such an approach could be cost-effective. A brief review of the URS Australia (2006) study follows.

7. Application of Choice Modelling – Victorian River Health

A pilot study (URS Australia 2006) aimed to estimate the non-market values associated with improved environmental health in a representative selection of Victorian rivers. Its purpose was to provide a source of value estimates for use in benefit transfer to inform cost-benefit analyses of river health investments. The study valued attributes for three rivers with potentially seven more to be done. These 10 representative river studies can then be used to provide river health/environmental values for the 50 rivers in Victoria.

The research design involved choosing a number of rivers representative of river types, and then selecting representative people both inside and outside the catchments (urban and rural) to develop values. The results presented here are for to the Goulburn, Moorabool and Gellibrand rivers, representing large regulated (irrigation), regulated peri-urban, and large unregulated (coastal) river classes, respectively.

Population sample sizes were 1000 within each catchment plus further outside-catchment (rural) (1000 for Goulburn) and outside-catchment (urban) (1000 for each of Moorabool and Goulburn). Questionnaire development involved a generic design into which catchment-specific details were added for the three case study rivers. Expert opinion was used to refine an initial, broad list of attributes. Focus groups were then used to ensure compatibility of experts' attributes with respondents' understandings and comprehension (Table 1). These meetings were held in Melbourne and the catchments.

Given the attributes and levels shown in Table 1, a subset of all possible combinations of attributes was selected for questionnaire presentation to respondents in the choice sets. The experimental design involved a fraction of the full factorial of possible combinations of attribute levels. The main effects chosen included 30 pairs of river management outcomes with 5 'blocks' of these pairs each with the no-change option. This resulted in 15 versions of the questionnaire.

Two pamphlets were developed – one with information and one with the questions. Symbols were used to represent attribute levels rather than numbers. Further access was provided to further information through web addresses and phone contacts. A framing statement was prepared and a cheap talk script included.

A mail-out – mail-back format was used with survey areas defined by post codes. Random samples were drawn from a composite population database (1000/sub-sample). A letter of invitation was sent on 31 October 2005 with the questionnaire and information booklet. A reminder postcard (prior to Christmas) and a second reminder/re-mail of questionnaire package were sent mid-January 2006.

The survey response rate was 17%, this low rate was attributed to problems with the population database and survey timing. There were some inadequacies in sample coverage: 57% of responses were male, the average age of respondents was 52 years, 37% had tertiary education, and the mean income per fortnight was $2142.

Logit analysis was used to predict the probability of a respondent choosing an alternative as a function of the level of attributes in the alternative and the socio-economic characteristics of the respondent. Table 2 contains results for the Goulburn catchment. The attributes are consistently significant explanatory variables of choice. The signs of coefficients are as expected *a priori*. An alternative specific constant (ASC) was tested and found to be not significant, therefore there appeared to be no inherent bias toward the status quo.

The socio-economic variables were also largely consistent with *a priori* expectations. The education level was positively correlated to choosing change alternatives. Those not revealing their incomes held lower values. These results were consistent and support model validity.

Attribute value estimates for Goulburn are shown in Table 3. These are values ($/attribute level/household) derived from the survey results and a consistent and statistically significant pattern of values is observed. These numbers can be used to estimate the aggregate value from an investment in, say, fencing to exclude livestock from a stretch of river.

Based on predictions (from consultations with ecologists familiar with this river) of the changes in levels of river condition attributes, per-household values can be derived by multiplying the per unit implicit prices for each attribute (Table 3) by the number of units of change. The next step involves extrapolation of per-household values to the relevant populations. Australian Bureau of Statistics data can be used to indicate the total and household population of Victoria (Melbourne and the regions). Extrapolation across the whole of these sub-populations is unwise given that the value estimates relate only to the proportion of the sample that responded to the questionnaire. Hence the extrapolation is performed as the household population x sample response rate x household value. From this information the total value across the state of the environmental health improvements generated by the proposed riparian fencing project can be estimated. The logic of BCA suggests that if the cost of the fencing initiative is less than this aggregate value (taking into account all costs including direct fencing and opportunity costs) then the project should be undertaken.

This study is the first of its type in Victoria dealing with unpriced values associated with improvements in river health. These difficult-to-quantify values can be large in comparison with market-based values for improvement, and are often ignored in policy decisions. Ignoring these values can lead to serious underestimation of the returns to investment in river health. In policy terms, the results can be incorporated into BCA and provide support for decisions on funding of projects and programs in river health.

8. Conclusions

This paper highlights that while Government rhetoric for NRM decisions on funding and priorities is to make the most of these funds and maximise return on investment, the CMAs in NSW have no way of addressing this issue with their current tools and capacities. Current non-economic approaches used by the CMAs were reviewed and compared with economic (BCA) approaches in terms of the above objectives. Non-economic approaches currently used by the CMAs have a number of problems with the accuracy and consistency of the estimates, and they are not suitable for an investment framework. BCA is capable of providing such a framework so long as it incorporates estimates arising from NRM investments. This includes non-market environmental benefits. We argue that such benefits can be estimated using the CM technique, and that there are a number of existing studies and databases that can be adapted for these purposes. CM represents the most advanced economic technique for non-market valuation and is suitable for deriving marginal values associated with attributes of environmental services. A judicious approach to CM valuation and the appropriate use of benefit transfer will allow a practical approach to NRM decisions making in NSW.

References

Abdalla, Charles W., Roach, Brian A. and Epp, Donald, J. (1989), 'Valuing environmental quality changes using averting expenditure: an application to groundwater contamination', *Land Economics* 68(2): 163-169.

Ackerman, Frank, and Heinzerling, Lisa (2004), *Priceless: On Knowing the Price of Everything and the Value of Nothing*, The New Press, New York.

Bennett, J. (2005), 'Australasian environmental economics: contributions, conflicts and cop-outs', *The Australian Journal of Agricultural and Resource Economics* 49: 243-261.

Bennett, J. and Blamey, R. (eds) (2001), *The Choice Modelling Approach to Environmental Valuation*, Edward Elgar, Northampton.

van Beuren, M. and Bennett, J. (2004), 'Towards the development of a transferable set of value estimates for environmental attributes', *Australian Journal of Agricultural and Resource Economics*, 48(1): 1-32.

Black, Dugald, Grieve, Alastair, Herron, Natasha, Rawson, Andrew and Russell, Kylie (2006), 'Outcomes Report on CMA Consultations February-March 2006', Decision Support Tools (TOOLS2) Project, mimeo.

Campbell, Ian and McGauran, Peter (2006), 'Ongoing investment in a more sustainable Australia', Australian Government Press Release, Canberra, 3 October.

Carson, Richard T. (2000), 'Contingent Valuation: a user's guide', *Environmental Science and Technology* 34(8): 1413-18.

Freeman, A. Myrick III (1994), *The Measurement of Environmental and Resource Values: Theory and Methods*, Resources for the Future, Washington, D.C.

Grafton, R. Quentin (2005), *Evaluation of Round One of the Market Based Instrument pilot Program*, A Report to the National MBI Working Group, [available online at http://www.napswq.gov.au/mbi/pubs/round1-evaluation.pdf].

Grafton, R. Quentin, Adamowicz, Wiktor, Dupont, Diane, Nelson, Harry, Hill, Robert J., and Renzetti, Steven (2004), *The Economics of the Environment and Natural Resources*, Blackwell Publishing, Oxford.

Hajkowicz, S., Higgins, A., Williams, K., Faith, D., and Burton, M. (2007), 'Optimisation and the selection of conservation contracts', *The Australian Journal of Agricultural and Resource Economics* 51: 39-56.

Just, R., Hueth, D. and Schmidt, A. (1982), *Applied Welfare Economics*, Prentice-Hall, New York.

McKenzie, Richard B. and Tullock, Gordon (1981), 'Ch. 15, Rent Seeking', *New World of Economics*, 5th ed., McGraw-Hill.

Magrath, W. and Arens, P. (1989), ‘The costs of soil erosion on Java: a natural resource accounting approach’, Environment Department Working Paper 18, The World Bank, Washington D.C.

Morison, M. and Bennett, J. (2004), ‘Valuing New South Wales rivers for use in benefit transfer’, *The Australian Journal of Agricultural and Resource Economics* 48(4): 591-611.

Morison, M., J. Bennett and R. Blamey (1999). "Valuing Improved Wetland Quality Using Choice Modelling" *Water Resources Research*, 35(9): 2805-2814.

Navrud, Stale and Mungatana, E.D. (1994), ‘Environmental Valuation in Developing Countries: The Recreational Viewing of Wildlife’, *Ecological Economics* 11: 135-151.

NOAA (1993), ‘Report of the NOAA Panel on Contingent Valuation’, *Federal Register* 58(10), 4602-4614.

NSW Government (2006), *State Plan: A New Direction for NSW*, NSW Premiers Department, November.

OECD (1995), *The Economic Appraisal of Environmental Projects and Policies: A practical Guide*, OECD, Paris.

Rolfe, J. and Bennett, J. (Editors), (2006), *Choice Modeling and the Transfer of Environmental Values,* Edward Elgar, Cheltenham, (forthcoming).

Sinden, J.A. and Thampapillai, D.J. (1995), *Introduction to Benefit-Cost Analysis*, Longman, Melbourne.

Tietenberg, Tom (2003), *Environmental and Natural Resource Economics*, 6th edition, Addison Wesley, Boston.

URS Australia Pty Ltd (2006), ‘The Value of Improved Environmental Health in Victorian Rivers: Results from the Pilot Phase’, Report prepared for the Victorian Department of Sustainability and Environment, Corangamite Catchment Management Authority, Goulburn Broken Catchment Management Authority, and Melbourne Water Corporation, July.

Walsh, Richard G., Johnson, Donn M., and McKean, John R. (1992), ‘Benefit Transfer of Outdoor Recreation Demand Studies, 1968-1988’, *Water Resources Research* 28(3): 707-713.

Windle, J., and Rolfe, J. (2007), ‘Developing a benefit transfer database for environmental values on Queensland’, Contributed paper to the 51st Annual Australian Agricultural and Resource Economics Society, New Zealand, 13-16 February.

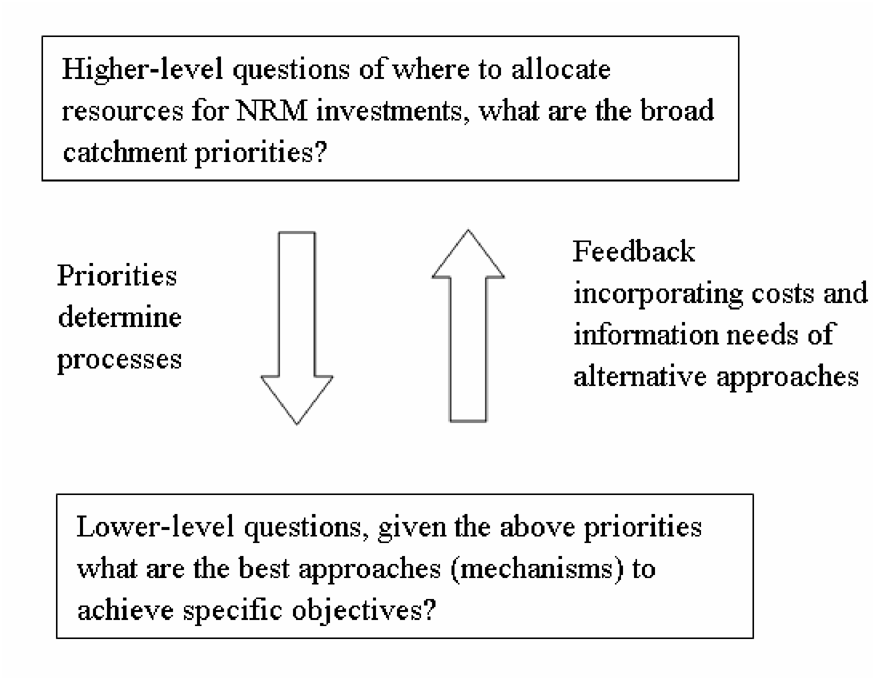

Figure 1. A general classification of CMA decision making needs for NRM

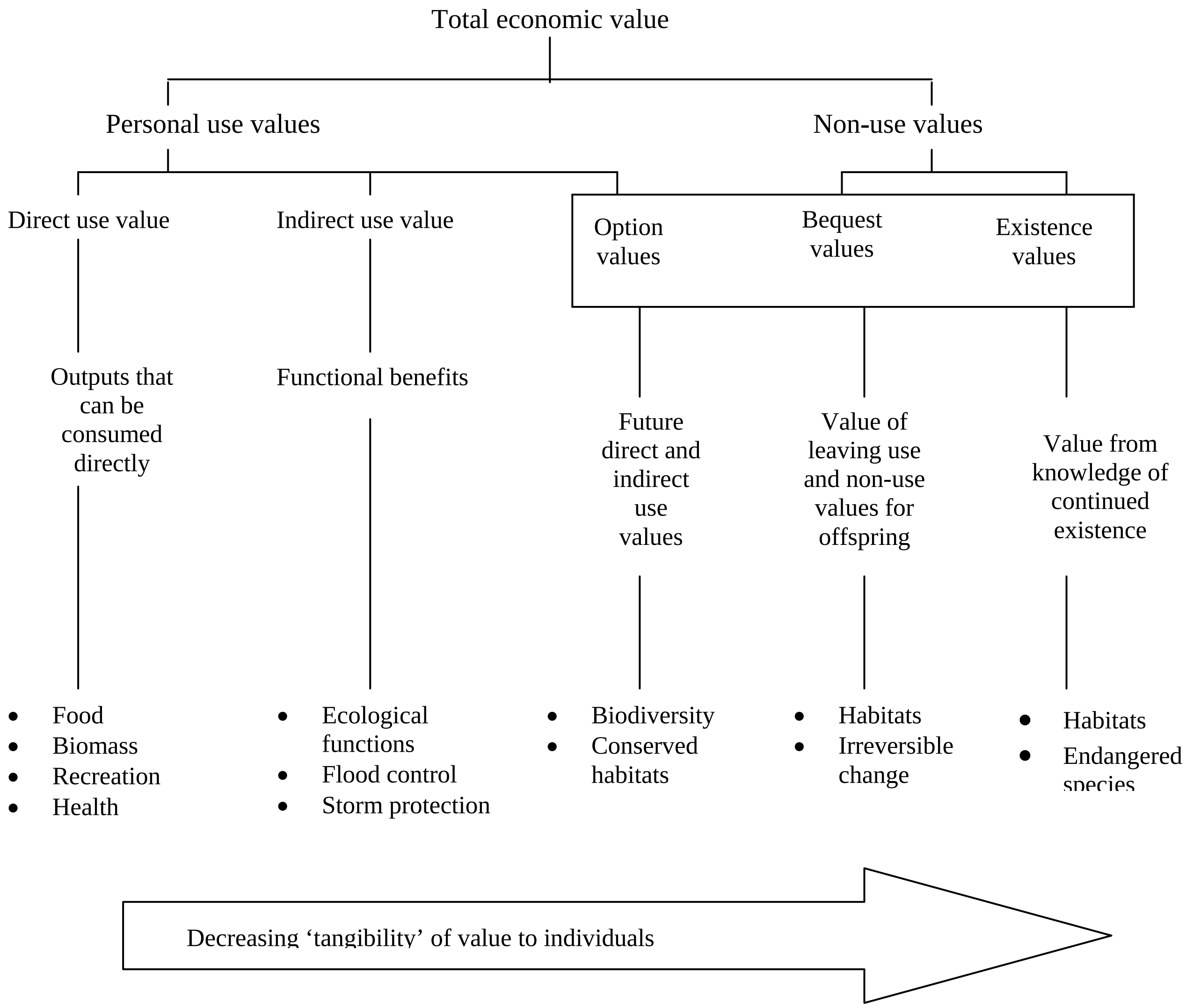

Figure 2: Categories of economic values attributed to environmental assets
Source: OECD (1995)

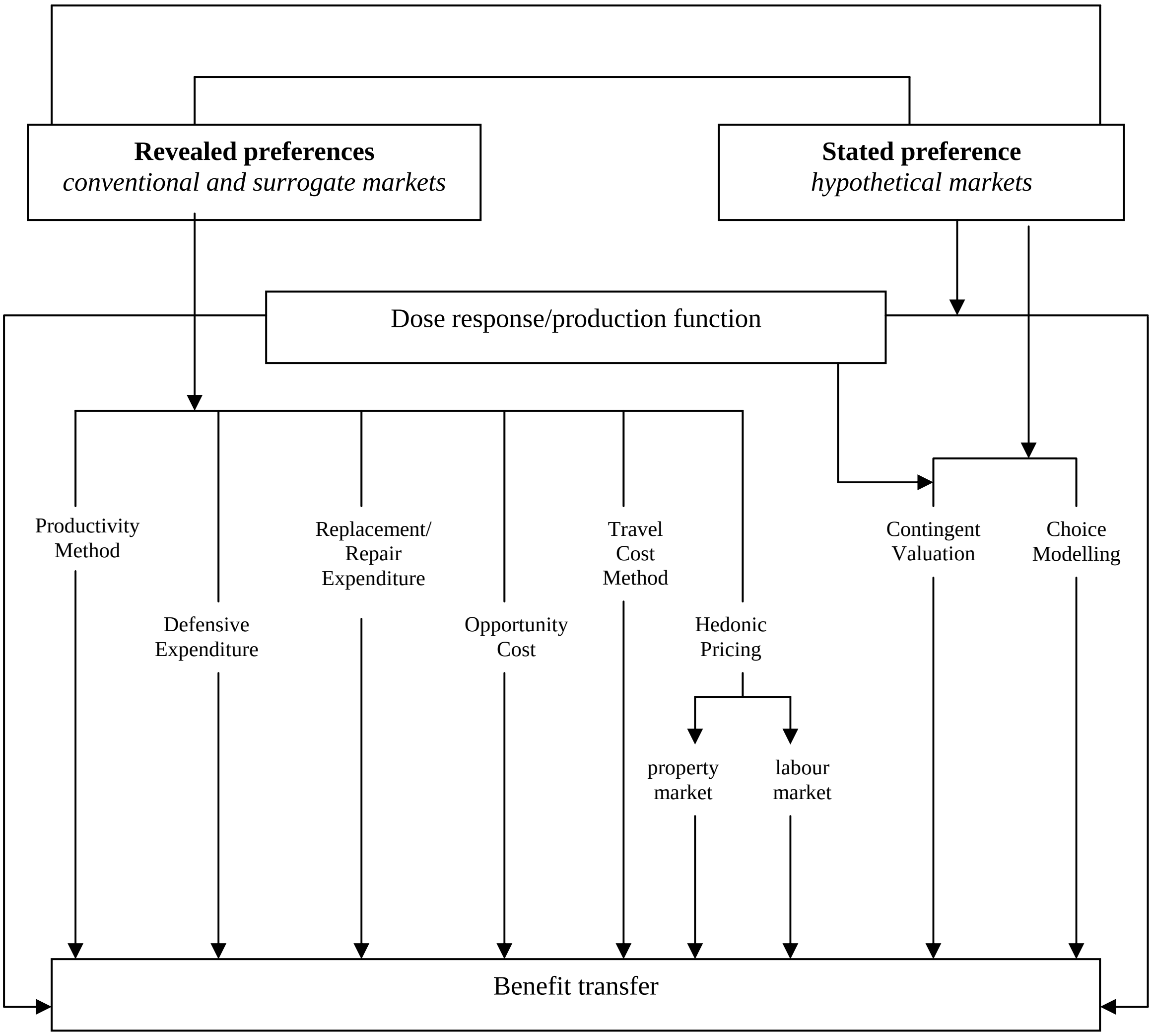

Figure 3: Environmental Valuation Techniques
Source: OECD (1995)

Table 1. Attribute distribution and levels, Victorian River Study

Attribute	Definition and unit	Attribute levels
Native fish	% pre-settlement species and population levels	Expert opinion to determine: • Current level • Level in 20 years time with no change in management • Level in 20 years time with 'best' management Levels set within that range
Riverside vegetation	% river length with healthy vegetation (both banks)	
Recreational opportunities	% river suitable for primary contact vegetation	
Native waterbirds and animals	Number of species with sustainable populations	

Table 2. Logit model results for Goulburn catchment, Victorian River Study

	Goulburn/ Gellibrand ($)	Goulburn/ In-catchment ($)	Goulburn/ Melbourne ($)
ASC (change)	6.736	6.011	2.679
Cost	-0.008*	-0.009*	0.011*
Fish	0.046*	0.041*	0.049*
Vegetation	0.038*	0.033*	0.061*
Birds	0.025*	0.037*	0.037*
Water qual.	-0.005	0.020*	0.018*
Age x ASC	-0.010	-0.035*	0.003
Inc x ASC	0.161	-0.153	0.312*
Ed x ASC	0.061	0.096*	0.179*
Gen x ASC	-0.031	0.672*	-0.055
Kids X ASC	-0.203	0.181	-0.881*
No age dum x ASC	0.106	-0.567*	0.064
No inc dum x ASC	-1.614*	-0.835*	-0.879*
No ed dum x ASC	0.909*	1.279*	17.953
IV	0.32*	0.576	0.42*

Table 3. Attribute value estimates Goulburn, Victorian River Study

	Goulburn/ Gellibrand ($)	Goulburn/ In-catchment ($)	Goulburn/ Melbourne ($)
Fish	5.56* (2.97-8.14)	4.39* (2.59-6.10)	4.47* (2.40-6.55)
Vegetation	4.65* (2.36-6.94)	3.56* (1.94-5.19)	5.53* (3.35-7.70)
Birds	3.04* (0.82-5.27)	3.90* (2.19-5.6)	3.35* (1.52-5.19)
Water quality	-0.59 (-2.57-1.38)	2.12* (0.60-3.63)	1.64* (-0.08-3.35)

* Significant at the 5% level