An overview of valuation techniques: Advantages and limitations

By Camille Bann

Introduction

Valuing biodiversity is of key policy interest. Economic values of non-marketed goods can draw attention to the economic importance of biodiversity in a country's development prospects, and can provide guidance for implementing appropriate conservation mechanisms (other uses are outlined in **Box 1**). However, estimating the monetary worth of biodiversity is perhaps the most challenging area of environmental resource valuation.

Fundamental to any discussion of the value of biodiversity is an understanding of what precisely the object of value is. It is necessary to distinguish between *biological resources* and *biological diversity*. A biological resource is a given example of a gene, species or ecosystem. Biological diversity refers to the *variability* of biological resources. Biodiversity is the 'variety of life' whereas biological resources are the manifestation or embodiment of that variety (OECD, 2002).

Because diversity valuation requires some idea of willingness to pay (WTP) for the range of species and habitats, it is hard to use the term 'biodiversity' as the object of valuation. In reality what economic studies normally measure is the economic value of 'biological resources' rather than biodiversity itself. *Biological resource* is a more anthropocentric term for biota such as forest and components of biodiversity that maintain current or potential human uses[1] .

There are other reasons why it is difficult to put a monetary estimate on biodiversity. There is a lack of consensus on the total number of living species (i.e., baseline measurements for biodiversity), rate of biodiversity loss, and biodiversity indicators fundamental to the valuation process (see **Box 2**). There is also a lack of knowledge of the true value and extent of current and potential future uses of biodiversity.

Criticisms of Economic Evaluation and Cost Benefit Analysis (CBA) include:

- Distributional Equity - Distributional concerns are rarely incorporated into the economic evaluation framework despite the fact that they are often of paramount concern, especially in poor countries.
- Discounting and Future Generation - Discounting does not satisfactorily deal with significant environmental costs and benefits occurring in the future (although these concerns can be dealt with by other means).

Box 1. Uses of Economic Valuation and Biodiversity Conservation

- Raise public and political awareness of the importance of biodiversity.
- Set conservation priorities given a limited budget.
- Facilitate land use decisions.
- Guide legal proceedings for determining damages where an agent is held liable for biodiversity loss.
- Limit or ban trade in endangered species.
- Prevent new invasions.
- Revise national income accounts.
- Design capture mechanisms (e.g., market creation, economic instruments, international transfers).
- Revise investment decisions (e.g., infrastructure development) that might otherwise ignore the impacts on biodiversity.

Source: OECD, 2002

Box 2. Biodiversity Indicators and Policy Assessment

Measurement of biodiversity is very complex because diversity is multi-dimensional. There are fundamental definitional problems relating to species and ecosystems. For example, discrete cut-off points for determining boundaries between species (Gaston and Spicer, 1998) or ecosystems is still subject to research and discussion. Even if this issue was resolved, the inventory task is monumental given the staggering number of microorganisms present at any location. The task is even more unmanageable at that genetic level. Furthermore, science has only a limited idea of the genetic dissimilarity between species.

Notions of species richness, evenness and distance are the most used expressions of diversity[1] . Clarification of these measures has important implications for conservation policy. Solow et al 1993 show that if the objective is to conserve diversity, an understanding of species distance is very important. Solow presents an example using the pairwise distance between cranes and their extinction probabilities. The conservation of the most endangered species does not in fact maximise diversity. The reason for this is that the genetic distance between the endangered species and at least one of the 'safe' species is small. Minimising the probability of the number of species lost is not the same as minimising the value of lost biodiversity. In practice conservation resources are largely allocated to 'exotic' species conservation (e.g., giant pandas and tigers) without any real consideration of the diversity issue. This focus might be because the difference between biological diversity and biological resources is unrecognised, or because conservation policy responds to the high values attached to scarce species. Nonetheless, if the stated aim is to conserve diversity, those policies may not be soundly based.

Source: OECD, 2002

[1] This anthropocentric view of biological resources is much more convenient for economic analysis compared to alternative value paradigms such as 'intrinsic values' (values in themselves and, nominally, unrelated to human use). Intrinsic values *are* relevant to conservation decisions, but they generally cannot be measured (Pearce and Moran, 1994).

- Intrinsic vs. Instrumental Value - There are different philosophical viewpoints on 'value'. CBA is founded on the instrumentalist view, whereas it is argued that the 'true' notion of biodiversity value is intrinsic.
- Relative vs. Absolute Value - CBA embodies the economist's notion that value is relative, i.e., the value of something is always relative to something else. Critics argue that biodiversity has absolute value in itself, and hence it cannot be measured relative to other things.
- Incremental vs. Total Values - CBA values discrete changes in the stock of biodiversity. It is argued that CBA might judge each small loss of biodiversity as being justified, while overlooking the fact that each small change contributes to the risk that the total stock will be lost (Norton, 1988).

Despite these drawbacks there is considerable scope for at least securing minimum values for biological diversity through the use of approaches focused on the market values of the sustainable uses of biodiversity (e.g., ecotourism, and the collection of medicinal plants and other non-timber forest products [NTFP]). Measuring these direct use values of biodiversity conservation is extremely important since biodiversity will be more prone to loss when these are not appreciated. Furthermore, estimates of direct use values provide an important benchmark for other, less easily quantified, uses. While most of these other uses are still associated with some particular current or future use (such as bioprospecting or amenity), the uncertainty associated with valuing these goods and services is often orders of magnitude greater than the uncertainty associated with the simple direct (but often untraded) uses. The availability of such baseline information is necessary, for example, to estimate 'option values' for future uses. Also, the baseline information allows setting of management and research priorities (Huber *et al*, 1997).

Box 3. Categories of Valuation Techniques

Approaches Based on Market Values

- Observed Market Value and the Related Goods Approach –market prices for environmental goods and services can be combined with quantity information to derive estimates of value. The related goods approach uses information on the relationship between a marketed and non-marketed good or service to estimate the value of the non-marketed good (e.g., barter exchange approach, direct substitute approach, indirect substitute approach).
- The Productivity Approach – uses market prices to value environmental services in situations where environmental damage or improvement shows up in changes in the quantity or price of marketed inputs or outputs.
- Cost-Based Methods – use some estimate of the costs of providing or replacing a good or service to approximate its benefit (e.g., opportunity cost, indirect opportunity cost, restoration cost, replacement cost, relocation cost, preventive expenditure). Cost-based methods are second best techniques and must be used with caution.

Revealed Preference Approaches - use information about a marketed commodity to infer the value of a related, non-marketed commodity (e.g., travel cost method, hedonic pricing method).

Stated Preference Approaches - elicit directly, through survey methods, consumers' willingness to pay for non-marketed environmental values (e.g. contingent valuation method).

An Overview of Valuation Techniques[2]

A range of techniques is available for the estimation of biological resource values (see **Box 3**). A comprehensive valuation would capture the Total Economic Value (TEV) of the resource (i.e., use and non-use values). Different valuation approaches are applicable to the different components of TEV. Direct use values are relatively straightforward to measure, and usually involve the market value of production gains. Since environmental functions are rarely exchanged in markets, measurement of indirect use values typically entails more complex techniques such as the change in productivity approach, travel cost method, and hedonic pricing method. Non-use values can only be defined from surveys of people's preference about their WTP (e.g., Contingent Valuation). Non-use values tend to be important in certain contexts, notably when the good in question has few substitutes. Since many biological resources are by definition unique, their non-use value is likely to be significant.

Valuation approaches can be broadly categorised according to market values, revealed preference approaches and stated preferences approaches (OECD, 2002)[3]. Valuation approaches based on market values rely on the availability of market price and quantity information to derive total values. Revealed preference valuation techniques seek to determine preferences for the environment from actual, observed market based information. Often, when no market price exists for an environmental good or service, peoples' preferences for the environment can be 'revealed' *indirectly* by examining their behaviour in markets that are *linked* to the environment. Some goods and services are complements to environmental quality, while others are proxies, surrogates or substitutes for it. Therefore, by examining the prices paid in environment-related markets, peoples' environmental preferences can be uncovered (Pearce and Moran, 1994). An advantage of these techniques is that they rely on actual choices rather than on the creation of a hypothetical market to uncover the value of the environmen-

[2] This paper provides a non-technical overview of valuation techniques. For a detailed account on methodologies, see Freeman, 1994; Johansson, 1994.

[3] Many authors categorise valuation techniques differently.

tal good or service in question as stated preference approaches do. The correct measure of value is an individual's maximum WTP to prevent environmental damage or realise an environmental benefit (represented by the area under the demand curve). Economic values comprise both the price paid in markets and the consumer surplus that users obtain. Consumer surplus indicates the excess of what the consumer would have been willing to pay over what he or she actually had to pay. This concept is particularly important when estimating the benefits of environmental goods and services that have a low, or no market price. In such cases, the entire area under the demand curve represents the benefit of the good. To estimate economic value, we therefore need to be able to derive the demand curve. Valuation approaches based on market values do not allow us to do this and so will always underestimate the true value of the resource.

Valuation Approaches

The following section provides a brief description of the individual valuation approaches. For each technique a Table is provided summarising its advantages and limitations, and its application to biodiversity valuation is outlined. In reality, decisions on what valuation approach to use will depend on the nature of the study plus the availability of resources (funds, time and expertise).

Approaches Based on Market Values

There are three valuation approaches based on market values:

- Observed market value and related goods approach
- Productivity approach
- Cost based methods including replacement cost.

Approaches using market prices offer the most pragmatic route to the monetisation of environmental use values. Therefore, economic values such as they exist in market values should be recorded and reported. Such information will contribute to priority setting.

Table 1. Observed Market Prices and Related Goods Approach – Advantages and Limitations

Advantages	Issues / Limitations
Relatively simple.	Market values tend to reflect actual use and hence ignore non-use values.
High intuitive appeal.	Does not capture consumer surplus.
	Likely to require the undertaking of market surveys and direct use surveys (However such surveys are simpler and less costly to conduct than those required by more sophisticated approaches).
	Large data requirements may be necessary to estimate theoretically correct values.

Observed Market prices

Where market prices exist they can be combined with quantity information to estimate the value of a resource. The use of market prices is undoubtedly the most straightforward of the valuation approaches and provides a relatively cheap and quick estimate of value. However, few studies report theoretically correct estimates due to data constraints. Strictly speaking efficient prices should be used, i.e., they should account for any distortions such as externalities, taxes and subsidies. Values used should be net of production costs. They should also be based on optimal harvesting levels, and account for seasonal changes in production and prices. Market analysis may also be necessary to understand the likely effects of market expansion, shifts in demand and international price fluctuations.

Related Goods Approach

The related goods approach consists of three similar valuation techniques: barter exchange, direct substitute, and indirect substitute approach. These relatively simple, intuitive approaches are often useful for estimating products in developing countries that are largely used by rural communities for subsistence purposes or traded informally. These approaches are based on the fact that often a non-marketed good or service is related to a marketed good or service. By using information about this relationship and the price of the marketed product, the analyst may be able to infer the value of the non-marketed product. For example, the direct substitute approach bases the value of a non-marketed good such as fuelwood, on the price of its closest marketed substitute (e.g., charcoal) and the rates of exchange between them.

Application to Biodiversity

Many natural resource products have market prices that can be used in the valuation exercise, for example, non-timber forest products, and genetic material for agricultural products and drugs. Empirical studies demonstrating the values of naturally occurring products are common (see Bann 1998, Pearce and Pearce, 2001 for review).

The Production Function Approach

The production function approach is a common economic technique, which relates output to different levels of inputs of the so-called factors of production (land, labour, capital, raw materials). It is often thought of as the most straightforward way to valuing the environment[4].

More formally, the production function for a single output may be given by:

$$y = F(X, Z)$$

[4]Variously called the change in production approach, the input-output or dose response approach. All involve an attempt to relate the incremental output of a marketed good or service to a measurable change in the quality and quantity of a natural resource.

where X is a set of inputs (e.g., land, capital) and Z is the input of the un-priced environmental resource. Let us assume that we can measure output *y* that has a market price. If prices of inputs X are not expected to change when supply of the environmental resource (Z) changes, then the economic value of the change in the supply of Z is the value of the production change associated with the change in Z at constant inputs of the other factors (X) (Pearce and Moran, 1994)[5].

For example, assume that an ecological function of a tropical forest is support for downstream fisheries by ensuring a regular flow of clean water to spawning grounds for fish and nurseries for fry. The forest area in the watershed (S) may therefore have a direct influence on the catch of some fish species dependant on the area, Q, which is independent from the standard inputs of commercial fishery, Xi...Xk. Including forest watershed area as a determinant of fish catch may therefore 'capture' some element of the economic contribution of this ecological support function (Barbier 1992).

$$Q = F(X_i \ldots X_k, S)$$

The approach is most appropriate where: the environmental change directly causes an increase or decrease in the output of a good (or service) which is marketed; the effect is clear and can be observed, or tested empirically; and, markets function well, so that price is a good indicator of economic value (OECD, 1995).

Specifying the physical effect of a change in environmental quality, and the resulting impact of the physical effect on the economic activities can be difficult and data intensive in practice. These functions may be estimated or derived from existing literature, but ideally expert scientific studies are required.

Where environmental change has a sizeable effect on markets, a more complex view needs to be taken of the market structure, elasticities, and supply and demand responses. Consumer and producer behaviour needs to be introduced into the analysis as behaviour may alter in response to changes in the environment. In addition, the impacts of market conditions and regulatory policies affecting production decisions need to be taken into account. Unless these factors are accounted for, the production function approach may produce unreliable information.

Application to Biodiversity Valuation

The production function approach has strong intuitive and practical appeal and has been used frequently in developing regions to estimate the indirect functions of ecosystems. For example, the impact of deforestation on soil erosion and water production and quality, and the impact of the loss of mangrove area on fish productivity.

Cost-Based Valuation

Cost-based valuation techniques assess the costs of different measures that would ensure the maintenance of the benefits provided by the environmental good or service being valued. These cost estimates are then used as proxies for the non-market environmental benefit in question. Cost-based valuation approaches include: opportunity cost-based approaches; approaches that measure environmental values by examining the costs of reproducing the original level of benefits (e.g., the replacement, restoration and relocation cost methods); and, the preventative expenditure approach, which examines the up front payments made to prevent environmental degradation.[6]

A practical difficulty is ensuring that the cost of maintenance will provide a benefit equivalent to the benefit of the original good. A potential cause of overestimation occurs if the benefits of maintenance do not exceed the costs of maintenance. If this is the case, then the investment is not a profitable use of economic resources and the cost of maintenance activities may be larger than the WTP for the original environmental benefits[7]. Conversely, if the benefits generated by the maintenance activity exceed that of the original environmental benefits, then the costs of maintenance activity may surpass the WTP for the

Table 2. Production Function Approach – Advantages and Limitations

Advantages	Issues / Limitations
Strong intuitive and practical appeal, therefore popular with policy/decision makers.	Specifying biophysical relationship can be complex and/or data intensive. Market values tend to reflect actual use and hence ignore non-use values. Does not capture consumer surplus. Market prices need to be corrected for market and policy distortions. Where the environmental change has a sizeable impact on the market, a more complex view of market structure is necessary.

[5] This approach can also be applied to output which is not marketed but where an actual market exists for similar substitutes or goods.

[6] The preventative expenditure approach is also referred to as the 'defensive expenditure approach' 'mitigation approach' or 'avertive behaviour approach'. There are two different approaches to this type of analysis and only one of them is truly a cost-based valuation technique. If estimates of what people are willing to pay to prevent damage to the environment or themselves are elicited through the use of constructed markets, or by the examination of past events in similar circumstances through the use of revealed preferences exhibited through actual or surrogate markets, *first based estimates* of value will be derived.

[7] In certain cases, such as estimating the costs of relocating communities affected by land use changes, satisfying this condition may not be critical. Concerns over equity (ensuring just compensation) may override any economic criteria being placed on the cost of relocation.

Table 3. Cost Based Valuation – Advantages and Limitations

Advantages	Issues / Limitations
A practical approach where resources (time, data, money) are lacking.	Considered to be second best techniques as they are likely to be inaccurate because they use costs as a measure of 'benefit'.
Less data intensive and time consuming than the more sophisticated approaches.	Market values tend to reflect actual use and hence ignore non-use values.
	Does not capture consumer surplus.

original environmental benefits. Further, because they bear no relation to demand or WTP for environmental goods and services, cost estimates fail to reflect consumer surplus (and may also underestimate producer surplus) thus tending to underestimate environmental values.

The replacement cost method has recently been used to estimate the values of ecosystem services (Costanza *et al* 1997; Pimentel *et al* 1997 and Ehrlich and Ehrlich 1996). However, the Costanza *et al* study is criticised on theoretical grounds (see Pearce, 1998). It is argued that the replacement cost is only valid if three conditions are met (Bockstael *et al* [2000]):

1) the human-engineered system provides functions that are equivalent in quality and magnitude to the natural function;
2) the human-engineered solution is the least cost alternative way of performing the function; and,
3) the individuals in aggregate would be willing to incur these costs if the natural function were no longer available.

These conditions are rarely achieved hence use of replacement costs is rarely accurate.

Due to the inaccuracies inherent in cost-based valuation approaches, they are generally regarded as *second best valuation techniques*. However, they can be extremely useful when there are limitations on the time and resources for detailed research or when data sets are so questionable as to reduce the advantages of using more exact but costly techniques.

Application to Biodiversity Valuation

Despite their theoretical shortcomings, such approaches are widely used. The replacement or restoration cost is, for example, used to value various ecosystem services and is implicit in the 'public trust' doctrine in the USA as it relates to certain natural resource damage costs.

Revealed Preference Approaches

Revealed preference methods include traditional travel cost models of recreational use, random utility models, hedonic models, and averting behaviour models. These methods rely on a surrogate market that provides a 'behavioural trail' to identify the environmental value of interest. They may be considered 'true' valuation approaches in the sense that they facilitate estimation of demand curves and hence consumer surplus. Generally, these approaches are favoured over stated preference approaches by many economists and policy makers because these values are revealed in real, rather than hypothetical, markets. However, they are limited in the sense that they are unable to account for non-use values and have large data requirements.

Travel Cost Method

With the travel cost method (TCM), it is assumed that travel costs to a site can be regarded as a proxy for the value of the non-market asset. The TCM is commonly applied to recreational areas and national parks. Two perspectives are possible. Simple travel cost models attempt to estimate the number of trips visited to a site or sites over some period of time, perhaps a season. Random utility models consider the specific decision of whether to visit a recreational site, and if so, which one (see Freeman, 1994).

The TCM is applicable when: the study site is accessible for at least part of the time; there is no direct charge or entry fee for the good or service in question, or where such charges are very low; and, where people spend a significant time, or incur other costs, to travel to the site.

The TCM techniques have improved considerably since the earliest studies were carried out but a number of reservations as to its use remain. Of particular concern is the large amount of data required, which is expensive to collect and process. Furthermore difficulties with estimation and data analysis remain. The method is likely to work best when applied to the valuation of a single site, its characteristics and those of other sites remaining constant. The method has limited use for valuing anything other than parks and charismatic species that can provoke travel behaviour. The most credible applications to date have involved national parks, recreational sites and international travel behaviour when visiting wildlife parks and reserves (Tobais and Mendelsohn, 1991; Maille and Mendelsohn 1993; Hanley and Ruffell 1993).

Application to Biodiversity

Where feasible, TCM is important when evaluating the demand for recreational facilities. The information derived from a TCM study can be used to: set appropriate entrance fees to national parks and reserve areas; allocate national recreation and conservation budgets between different sites; and inform land use decisions – for example whether it is worth preserving a site for recreational use or a rival land use.

Table 4. Travel Cost Method – Advantages and Limitations

Advantages	Issues / Limitations
Provides estimate of demand curve therefore possible to estimate consumer surplus. Where feasible, can provide estimates of value of parks and recreational facilities.	**General** The method has limited use for valuing anything other than parks and charismatic species that can provoke travel behaviour. Does not account for non-users, off-site benefits and non-use values. **Theoretical** Time Costs – determining the value to be attached to travel time. Dealing with multi-purpose visits. How to deal with substitute sites. Treatment of utility or dis-utility from travelling. Truncation or sample selection bias in dealing with site visitors, and neglecting non-visitors. Difficulties with the estimation and data analysis techniques. **Practical** Survey based and large amounts of data required, therefore expensive and time consuming. Requires trained interviewers to carry out survey work and statisticians and/or econometricians to carry out analysis.

Table 5. Hedonic Pricing – Advantages and Limitations

Advantages	Issues / Limitations
The hedonic approach is founded upon a sound economic theory base and is capable of producing valid estimates of economic benefits.	It relies on the assumption of a freely functioning and efficient property market. Huge data requirements. The approach only reflects impacts to the extent that individuals are aware of them. A number of statistical problems may hinder its feasibility. It is essentially an *ex post* valuation and does not capture non-use value.

Hedonic Pricing Method

The Hedonic Price Method (HPM) is another revealed value technique that relies on market prices (typically property prices or wages) to embody the value of the environmental attribute (or job risk) of interest. The property value approach, for example, is based on the assumption that the value of land is related to the stream of benefits derived from it. The value of a house, for example, is affected by many variables including size, construction, location and the quality of the environment (air quality and noise pollution). With sufficient data on property values, it is in theory possible to tease out the value of the environmental feature holding other things constant. In other words, the value is revealed from within the value of the property. The method is data demanding and there are few applications available in the published literature.

Application to Biodiversity Valuation

The application of HPM to biodiversity is extremely limited. Few biodiversity-related attributes are likely to show up systematically in the complementary market prices - the WTP for housing in most cases, and even when they do, accurate data to describe them is rarely available to undertake robust analysis.

Studies relating to the value of forestry, shoreline and landscape have relied on these attributes being significant in local property markets (e.g., Garrod and Willis 1992).

A closely related application is the valuation of plant genetic resources for agriculture – e.g., plant breeding and crop improvement (Evenson 1990; Gollin and Evenson 1998). The steps for conducting this research are similar to its analogue in the housing sector although the data requirements are just as onerous. In this context the 'external' value of interest is a naturally occurring material germplasm or genetic trait, which is an attribute of an original crop landrace prior to crop improvement. The original raw material or trait is ultimately one attribute of a final product. If the contribution of that trait can be isolated from the other production factors, then its resource value can be estimated. The steps necessary for undertaking such an analysis are summarised in **Box 4**.

Clearly this methodology has important implications for the issues of benefit sharing and intel-

Box 4. Estimating the Contribution of germplasm of original landraces to Rice Productivity

Gollin and Evenson (1998) show how the HPM can be applied to the analysis of the productivity of alternative categories of rice germplasm in India. The key steps are:

- For a crop – e.g., rice, divide gains in output into gains from yield and gains from increased area under cultivation.
- Disaggregate rice yield gains into gains attributable to varietal improvement, other technological advances and other sources of change.
- Assume varietal improvement is dependent on stocks of advanced crossing material from different sources and other research resources.
- Stocks of advanced material depend on the existence of traditional landraces and wild species.
- Link productivity to original germplasm, its origins and ownership.
- Note finally that the data requirements are onerous. In short detailed information is required on the productivity of all factor inputs in all the above stages.

lectual property rights. In theory, the methodology offers the potential for the identification of key germplasm contributions to crop development by countries and communities within countries. It can therefore serve as a basis for estimating returns to indigenous communities as part of a benefit sharing agreement. In practice, data sources will prevent identification of inputs for many crops.

This approach can also help to determine the value added at each production stage by informal and formal breeding inputs that have led the crop to its current status. This is particularly important information for the CGIAR[8] group when information on the returns to publicly funded research is at issue.

Stated Preference Approaches

Stated preference techniques (SP) refer here to any questionnaire-based technique that seeks to discover individuals' preferences. The most well-known approach under this category is Contingent Valuation Method (CVM)[9] although Choice Modelling (CM) is becoming increasingly popular[10].

The CVM uses survey techniques to ask people directly what their environmental preferences are. It is therefore a form of market research, where the 'product' in question is a change in environment quality. A hypothetical market is constructed and consumers are asked what they would be WTP for a hypothetical environmental improvement or to prevent a deterioration, or what they would be willing to accept (WTA) in compensation to tolerate a loss. A hypothetical market is taken to include not just the good itself (an improved view, better water quality, etc), but also the institutional context in which it would be provided, and the way in which it would be financed. Answers to questionnaires are intended to *simulate* the behaviour of individuals in the market place. A great deal of care needs to be taken to ensure that questionnaires mimic the relevant features of the market place, and that potential biases in responses are controlled.

Table 6. Stated Preferences – Advantages and Limitations

Advantages	Issues / Limitations
An important feature of SP methods is that they can help reveal values that are not revealed using other methods. In particular SP can uncover non-use values.	SP methods require carefully designed survey and sampling procedures and the employment of sophisticated data analysis (econometric modelling). Obtaining reliable information therefore requires a substantial investment of time and resources, which makes SP techniques very expensive.

The SP techniques become necessary when the WTP information that is needed cannot be inferred from markets. They are then extremely applicable to the valuation of public goods for which no markets exist. CVM is technically applicable to all circumstances and is the only practical method for uncovering existence value (e.g., preservation of rare species, biodiversity for its own sake) that generally does not pass through markets and do not have substitutes or complements that pass through markets.[11]

Choice Modelling involves a rating or ranking of options each of which contains a varying set of characteristics (e.g., a forest can be described in terms of species diversity, age structure and recreational facilities), including a money price or cost. Respondents are not asked any WTP questions. Rather the willingness to pay is inferred from the stated choices (Louviere *et al*, 2000),

CM differs from CVM in that it solicits rankings or ratings rather than monetary values. Arguably, this can reduce protest votes since people may find it easier to rank or rate alternatives without having to directly think in money terms. However this depends on the amount of background information provided in what is already (for the respondent) a cognitively burdensome task. At present there is no strong reason to choose one of these technique in preference to the other.

Application to Biodiversity

Contingent valuation has been used extensively in the valuation of biological resources including rare and endangered species, habitats and landscapes.

CVM is likely to be most reliable for valuing environmental gains, particularly when familiar goods are considered, such as local recreational amenities. The most reliable studies (i.e. those that have passed the most stringent validity tests and avoided severe 'embedding' whereby values are not sensitive to the quantity of the good being offered) are those valuing high profile species or elements that are familiar to respondents. In other cases, the need to provide information to elicit reliable values is a limit both to CV and other attribute-based choice models.

There is a small body of studies testing the applicability of CM to biological resources. It is argued that the constrained attribute design requirement makes CM even more limiting than CVM. Moreover, the selection and representation of these attributes and their levels simply adds to the design problems already associated with hy-

[8] Consultative Group on International Agricultural Research.

[9] See OECD, 1995; Bann, 1998; Mitchell and Carson, 1989 for more details on methodology

[10] Choice modelling approaches include - choice experiments, contingent ranking, contingent rating and paired comparisons.

[11] Other valuation techniques are not aimed at capturing non-use values. While it may be possible to infer estimates of existence values from market behaviour - such as donations to philanthropic pursuits - it is almost impossible to separate out use and existence values revealed in such markets.

Table 7. Benefit Transfer – Advantages and Limitations

Advantages	Issues / Limitations
Avoids the cost/time of engaging in 'primary studies'	Reliability? How can the transferred values be validated? The literature that tests for validity of benefits transfer is a long way from supporting such procedures. Therefore, at present there appears to be no substitute for high quality original studies.

pothetical surveys. A strong advantage of the CM over CVM is that it can reveal something about the sum of the parts of a resource rather than the total value. In many circumstances, the policy question to be answered by a valuation study concerns the improvement of a specific attribute.

Benefits Transfer

A final valuation technique is known as benefits transfer, which could be based on any of the valuation techniques described above. Benefits transfer (BT) involves 'transferring' economic benefit estimates from a site where a study has already been done (the 'study site') to the site of policy interest (the 'policy site'). If BT is a valid procedure, then the need for 'primary' studies is greatly reduced. However, the 'interim' consensus, based on ongoing research, appears to be that BT is unreliable (Brower, 1988; Bateman *et al*, 1999a). Results tend to differ by up to 75% if outliers are excluded, and by up to 450% if they are included. This margin of error may be acceptable for some project and policy applications, and uncertainty of the final results can be dealt with through sensitivity analysis.

Benefits transfer is most appropriate when: funds, time, or personnel are insufficient to undertake a satisfactory new study; the study site is similar to the policy site; the issues (e.g., proposed policy change, or nature of the project) are similar in the two cases; and, the original valuation procedures are theoretically sound (OECD, 1995). These 'borrowed' unit values can represent 'order of magnitude' estimates for the environmental goods and services of interest. However, primary data collection and analysis may be unavoidable for large projects, projects with potentially large (and irreversible) consequences, or for particularly complicated or politically sensitive projects.

The benefits value could have been measured using any one of the techniques summarised in **Box 3**. In benefits transfer, it is possible to transfer an average WTP estimate from one study site, or to transfer a WTP function from the study and apply it to the policy site, or to transfer WTP estimates from meta-analysis.[12]

If values are transferred 'unadjusted' the credibility of the policy site estimates are questionable. Possible differences that should be accounted for include: differences in baseline conditions and/or the magnitude of the economic impact (i.e., change from baseline), variations in study methodology, researchers judgement in the selection of sample size, socio-economic characteristics of the relevant population, determinants of WTP, differences in market conditions applying to the sites (e.g. variations in the availability of substitutes), and econometric specifications.■

[12] ***Meta-analysis*** explains the variations in WTP taken from a number of studies. This should enable better transfer of values since we can find out what WTP depends on. In the meta-analysis case, whole functions, based on the collected studies, are transferred rather than average values.

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