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Valuing Our Natural Environment

Final Report
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eftec, 16 Percy Street, London W1T 1DT; tel: 0207 580 5383; fax: 0207 580 5385; eftec@eftec.co.uk; www.eftec.co.uk

This report has been prepared by:

Ece Ozdemiroglu, eftec
Robert Tinch, EFL
Helen Johns, eftec
Allan Provins, eftec
Jane C Powell, EFL
Clare Twigger-Ross, Collingwood Environmental Planning

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Executive Summary

E1 Introduction

Defra's recent Five Year Strategy identified natural resource protection as one of its five strategic priorities. A systematic approach to developing an evidence base for the natural environment - including valuation evidence - is one of the research programmes that underlie the implementation of the strategy.

Social scientists from various disciplines, and in particular environmental economists, collate different kinds of evidence on the value to people of the natural environment. This information is increasingly used by policy makers at Defra, the Environment Agency for England and Wales, other public sector organisations such as the Forestry Commission and English Nature and even NGOs such as the Royal Society for the Protection of Birds (RSPB).

This study aims to present an outline of such evidence and the choice of methods that can be used to collate this evidence. In particular, the objectives of the study are to: collate existing valuation research; evaluate different valuation methods; identify how they compliment and conflict with each other; to examine how they can be and are used in decision making; and to review different measures of prosperity. In addition to the work undertaken by the study team, the report also contains the findings of expert and policy maker consultations.

E2 Concepts of Value

"Value" is not one, but several related concepts. While many people might consider the natural environment and its component resources to have "intrinsic" value – or value in their own right – the concept of an asset's value which is the most relevant to policy-making is of *contribution to human welfare relative to other assets*. In addition, the value concept of interest here is not the value of the entire natural environment but relatively small changes in its quality or quantity.

Exchanging goods and services in markets provides a ready-made indicator of value, in the form of price, which also signals how much of input resources should be allocated to production of different types of goods and services. But there are many types of resources which contribute hugely to human welfare which cannot be traded in markets – many environmental resources (such as clean air) and ecosystem services (such as water filtration and flood prevention) are amongst the foremost examples of such "non-market" goods and services.

E3 Valuation Methods and Evidence: Literature and Use

Valuation methods fall broadly into two camps: methods attempting to express individuals' preferences for changes in the state of the environment in monetary terms ("economic methods"), and methods which are more centred upon seeking and exploring how opinions are formed or expressing preferences in units other than money ("deliberative and participatory methods").

Amongst the economic methods are techniques which attempt to calculate value based on: the input of the natural environment to agricultural production; the effects of environmental amenity on property prices; the factors affecting the choices people make between recreational sites; and asking individuals to choose between different environmental outcomes with different price tags. Deliberative and participatory methods range from discussion groups

and processes where members of the public are presented with expert opinion and asked to consider a verdict, to means for synthesising expert opinion on specialised subjects.

In the policy-making process, two ways in which valuation evidence is or could be used are: within decisions support methods (such as cost-benefit, cost-effectiveness and multi-criteria analyses); and in alternative measures of prosperity to GDP (such as Green Net National Product). Methodological and literature overviews of each valuation method are provided in the report.

E4 Expert and Policy-Maker Consultation

The study undertook three consultation exercises: a questionnaire for academic experts; a questionnaire of policy-makers and a pair of workshops for policy-makers.

The academic experts' questionnaire was primarily a verification exercise to ensure that our descriptions of the different methods were correct. This final report incorporates their comments and references. The policy-makers' questionnaire and workshops yielded some useful discussions of how those who are tasked with using and processing valuation information view the process and how it could better suit their needs.

Policy maker consultees were very much aware of gaps in valuation evidence, but maintained that these data gaps could not prevent decisions from being made. The main reason given for data gaps was the expense and difficulty of commissioning original valuation work. Some noted gaps were a lack of evidence for how to deal with risk and uncertainty and difficulties in combining the outputs of different valuation methods. Most respondents felt that the use of valuation evidence is likely to increase in the future, due to increased pressure to deliver environmental public goods and to scrutinise and justify investments, regulation and resource requests.

E5 Conclusions

One of the key advantages of valuation methods is the explicit and relatively transparent way in which they bring values into the decision-making process. Of course this can be overstated: it is possible to manipulate both economic and deliberative and participatory valuation methods. Nevertheless, if the alternative to using valuation methods is for priorities to be set with only a rough idea of what others' values are, then some form of valuation effort appears to be an improvement on none at all.

The overall role of valuation evidence is to support rather than to make decisions, and the choice is not a case of either economic or deliberative and participatory methods, but using a combination of these as the context of the decision requires.

More work is required in making better use of existing evidence by training policy makers in the use of different types of evidence; by improving their access to valuation literature and by improving the communication between those who commission and those who undertake research.

Work to fill the current gaps in the literature and update the existing evidence to better reflect the current environmental conditions (rather than the conditions when the studies took place) needs to continue.

Finally, more work is required in developing decision support tools for combining different types of value evidence with a view to present as much information as possible rather than aiming to come up with a single number at the end of the analysis.

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1. Introduction

1.1 Policy Background

Defra's recent Five Year Strategy (Defra, 2004a) identified natural resource protection as one of its five strategic priorities, and the recent Sustainable Development Strategy (SDU, 2005) identified natural resource protection and environmental enhancement as one of four priority areas for immediate Government action.

Defra is developing this strategic priority for natural resource protection, and made the commitment in the Sustainable Development Strategy to undertake a process of active engagement with stakeholders to "develop a clear vision and approach for the UK to the protection and enhancement of natural resources by the end of 2005".

This has been broken down into three areas of work:

- Creating a UK vision for the natural environment;
- Taking a systematic approach to developing an evidence base for the natural environment; and
- Developing a more strategic UK approach to the protection and enhancement of the natural environment.

This study is part of the second area of work[1]. Social scientists from various disciplines, and in particular environmental economists, collate different kinds of evidence on the value to people of the natural environment. This work is often conducted in collaboration with natural scientists, and generally involves some interaction with the public. The information is increasingly used by policy makers and advisors at Defra, the Environment Agency for England and Wales, other public sector organisations such as the Forestry Commission and English Nature and even NGOs such as the Royal Society for the Protection of Birds (RSPB). This study aims to present an outline of such evidence and the choice of methods that can be used to collate this evidence.

1.2 Objectives of the Study

The Terms of Reference list the objectives of the study as follows:

- Collate and assess existing research on the value of the natural environment;
- Identify and evaluate different methodologies for valuing the natural environment;
- Assess the current state of economic and deliberative and participatory methods of valuing the natural environment;
- Identify and assess the conflicts and complementarities of using economic and deliberative and participatory methods of valuation; and
- Identify and evaluate different measures of prosperity.

These objectives are achieved through the implementation of the following tasks which are presented in terms of key questions relating to the value of our natural environment:

[1] More information is available at http://www.defra.gov.uk/wildlife-countryside/natres/index.htm

- Task 1: What is the evidence on valuation? What is the literature like to date?
- Task 2: What is the menu of methodologies available? What can they achieve? What purpose do they serve?
- Task 3: What is actually done / taken into account by decision-makers? What is needed?
- Task 4: What can be recommended for the future for the different purposes identified?
- Task 5: Which of the above are specifically applicable to the case of 'measuring prosperity'?

Given the study objectives and tasks, consultation with experts and policy makers was seen as a crucial research stage. Section 1.4 below outlines how the report is organised to describe the outputs of these five study tasks, including the process and results of expert and policy maker consultations

1.3 Scope of the Study

There are five determinants of the scope of a wide ranging study such as this:

- Definition of the natural environment;
- Geographical boundaries;
- Type of value;
- The decision-making context; and
- Coverage of valuation methodologies.

The Terms of Reference include the following within the definition of 'natural environment':

- Biodiversity (including habitats and ecosystems);
- Water quality, supply and demand;
- The marine environment;
- The soil environment;
- Landscapes;
- Air quality; and
- Recreation and access to the natural environment

While these are distinct categories in terms of ecological and geographical definitions and the way people may make use of them, they are not necessarily covered separately in the relevant valuation literature. For example, literature could assess the impacts of a given human activity on more than one of the above categories (e.g. the effect of energy use on air quality and the effect of changes in air quality on habitats and ecosystems). Several of the above categories of natural environment may contribute to human welfare together in a way that they cannot always be valued separately (e.g. recreational benefits depend on level of access, landscape, biodiversity, water quality and so on). Therefore, while the above list is useful for determining the overall scope of the study, it does not imply that separate values for each item in the list are possible to provide for different decision-making contexts. On the contrary, using value evidence to understand the linkages between the components of the natural environment is likely to lead to more efficient and effective policy decisions.

The geographical scope of the study is "all UK water, air, land and sea" to quote from the Terms of Reference. The study also looks at the value given to global and regional natural resources which are affected by UK domestic policy. This does not refer to the literature on the relationship between trade and environment, but to the question of how the regional and global environment is valued by the UK population, and any record of the evidence of this value. Therefore, the natural resources listed above are analysed in local, national, regional and global contexts.

The type of values addressed in the study relate to: (i) those that are attached to the goods and services provided by the natural environment; and (ii) the consequences of a negative impact on the ability of the natural environment to provide these goods and services. For example, both the values associated with good water quality and the damage caused by poor water quality are included in the scope. Thus, a final category (pollution and degradation) is added to the above list defining the term 'natural environment' and included in the literature overview in Section 3 and Annex 2.

Economic and deliberative and participatory methods[2] for valuing the environment included in the study are:

- Economic valuation methods
  - Market data approaches
  - Revealed preference approaches
  - Stated preference approaches
- Deliberative and participatory methods
  - Group based approaches
  - Health-based approaches
  - Survey approaches

Both groups of methods aim to collect qualitative or quantitative evidence on the value of the natural environment. Distinctions between economic and deliberative and participatory methods principally stem from their conceptual and theoretical foundations. These distinctions are explored throughout this report.

Information on the value of the natural environment can be used in a variety of ways (e.g. demonstrating value in appraisal of projects, programmes and policies; design of policies such as economic instruments; calculating compensation for environmental liability, and so on). Therefore, the study covers all types of evidence that can be used in all possible decision-making contexts, which were also explored through consultation with policy makers.

There is also some discussion on the decision support methods that can be used for appraisal. The following methods, which process this information and compare different options for a given decision, are considered in the study:

- Cost-effectiveness (and least cost) analysis
- Cost-benefit analysis
- Multi-criteria analysis
- Life cycle analysis

Note that the above list does not include other methods such as Strategic Environmental Assessment or Environmental Impact Assessment since these collect (and may process) information on impacts but do not directly compare alternative outcomes. Further detail on the distinction between different valuation and decision support methods is provided in Section 3 and Annex 1.

The relevance of economic valuation for monitoring sustainable development is also included within the scope. Here the definition of sustainable development follows from Pearce and Barbier (2000): "ensuring that future generations have at least the same economic opportunities as the current generation"; i.e. that per-capita welfare should not decline over time. Four alternative measures of prosperity to Gross National Product are reviewed:

[2] "Deliberative and participatory" is perhaps not the best term to represent this group of methods since health-based and survey approaches are neither deliberative nor participatory. However, in the absence of a widely accepted term and in order to avoid using the term 'non-economic', this term is used.

- The United Nations Human Development Index;
- The Index of Sustainable Economic Welfare (Daly and Cobb, 1990);
- Green Net National Product (and an extension, Genuine Savings); and
- The UK National Sustainable Development indicators.

On the basis of the above factors determining its scope, the study is essentially one of methodological review and overview of the available evidence. The overview of the available evidence is not meant to generate 'off-the-shelf' values for the natural environment but to demonstrate which valuation methods may be and have been used in which contexts.

1.4 Report Structure

The report consists of four further sections, structured as follows:

- **Section 2** answers a number of policy-relevant questions surrounding the concept of value;
- **Section 3** reports our primarily literature-based findings on Tasks 1, 2 and 5;
- **Section 4** summarises the policy maker consultation process with regards to the current practice of using valuation information (Tasks 1-3) and future expectations and needs (Task 4); and
- **Section 5** presents our conclusions and recommendations for future (Task 4).

Three annexes accompany the report:

- **Annex 1** summarises each of the economic and deliberative and participatory valuation methods and associated decision-making methods. The summaries cover each method's objectives, value concept encapsulated, theoretical basis, process of implementation, data needs, other practical issues for implementation, principal outputs, transferability of outputs, key uses, consideration of distributional impacts, advantages and disadvantages, and conflicts and synergies with other methods;
- **Annex 2** expands on Section 3 in providing a more detailed summary of the valuation by natural environment category, as well as the list of references included in the literature overview for the different valuation methods; and
- **Annex 3** provides an in-depth report of the expert and policy maker consultations and policy maker workshops.

2. Concepts of Value

This section sets out the conceptual basis for the subsequent presentation of the evidence on the value of the natural environment. The section is organised in five sub-sections, each attempting to answer a fundamental question within the context of valuing the natural environment.

2.1 Why Value the Natural Environment?

This question is best considered in four parts. Firstly, the natural environment is "valuable" as:

- It underpins and supports all human activity, and in this sense is of immeasurable total value;
- More pertinently for policy, small changes in environmental goods and services will have consequences for human activities; affecting welfare both through markets and externally to markets, i.e. market and non-market impacts;
- Humans may ascribe value to possible states of the natural environment over and above any personal or societal human use that may be made of those environments; and
- There may be senses in which environments are of intrinsic value over and above any value they have for human welfare (notwithstanding the associated impossibility of measuring this).

These reasons are hard to disagree with but can have highly complex implications. Table 2.1 shows the complex ways in which the natural environment provides goods and services that benefit human life. The classification is taken from Defra (2005), and while that report refers to 'ecosystem goods and services', this is a term used to classify the *processes* through which the natural environment contributes to human welfare. Thus, the terms 'natural environment' and 'ecosystem (goods and) services are used somewhat interchangeably throughout this report.

Table 2.1: Some ways in which natural goods and services contribute towards welfare (categories of ecosystem goods and services)

Purification and Detoxification	*filtration, purification and detoxification of air, water and soils*
Cycling Processes	*nutrient cycling, nitrogen fixation, carbon sequestration, soil formation*
Regulation and Stabilisation	*pest and disease control, climate regulation, mitigation of storms and floods, erosion control, regulation of rainfall and water supply*
Habitat Provision	*refuge for animals and plants, storehouse for genetic material*
Regeneration and Production	*production of biomass providing raw materials and food, pollination and seed dispersal*
Information/Life-fulfilling	*aesthetic, recreational, cultural and spiritual role, education and research*

Source: Defra (2005). For details on each of these services, see that report. Note that the Millennium Ecosystem Assessment also uses a slightly different classification, which ultimately has the same scope and purpose.

The second part of the answer contends that the continued functioning of a healthy ecosystem is worth more than the sum of its individual functions. In particular, natural environments can

often be considered as providing resilience of function; the capacity to recover from and absorb external shocks and stresses. This resilience is itself valuable, in the same way that insurance against adverse impacts is valuable, and one goal of management can be to enhance resilience values. Resilience may be a particularly important concept in the case of biodiversity loss, where the concept of "functional redundancy" arises: the idea that some species which seem to provide little or no important contribution to ecosystem function under current conditions may become very important or "keystone" species under changed conditions. Thus they may be of great value simply through their *potential* to provide key functions if conditions change, or to ensure continuity of functions as conditions change.

However, the fact that something is "valuable" does not in itself justify the decision to attempt to value it. The need to value the natural environment arises from the need to better integrate natural and social sciences in managing the natural environment and helping the policy-making process. Thus, valuation aims to provide means by which the contributions that the natural environment makes to human welfare can be better taken into account in decision-making procedures so that more efficient, effective and/or equitable decisions can be made. This provides the third part of the answer to the question 'why value the environment?'. In the context of modern industrial democracies, this implies shifting the emphasis from financial or market-based evidence towards a wider information set including costs, benefits and values which are not (fully) represented in existing markets. Depending on one's stance on what constitutes social welfare, this may imply assessing the attitudes and opinions that citizens hold concerning the natural environment. In monitoring progress towards sustainable development it is also necessary to gather information on how loss of natural resources now might impact upon the welfare of future generations.

Finally, against these possible gains from knowing values must be set the costs involved in calculating them. Thus the final part in the justification for valuing natural environments is that methods are available which are sufficiently reliable, and sufficiently inexpensive, to inform decisions on the natural environment. Inexpensive is a relative term and hence decisions on whether to estimate the value of the natural environment (and if so how) should be taken by comparing the cost of doing so to the value of any expected reduction in inaccuracy as an input to policy-making (Allen and Loomis, 2004). This value is calculated by assuming that improved accuracy would reduce the likelihood of making a 'wrong' decision and hence save the cost of such a wrong decision. Much of the substance of our work here is concerned with precisely this: establishing which methods, or combinations of methods, are best suited to carrying out valuation in a cost-effective, reliable and useful way.

2.2 What is Value?

Here we attempt to answer this question in terms of the philosophical basis of the concept, links between value, welfare and wellbeing, the typology of total economic value and the measure of what can be valued.

2.2.1 Philosophical basis

There is a great deal of philosophical and ethical complexity (not to mention literature) underlying this question, partly because "value" is not one, but several related concepts. At the most fundamental level, value is related to the philosophical idea of "the good", and there is a crucial distinction between intrinsic and extrinsic value, which may be roughly presented as follows:

"That which is intrinsically good is nonderivatively good; it is good for its own *sake. That which is not intrinsically good but extrinsically good is derivatively good; it is good, not … for*

its own sake, but for the sake of something else that is good and to which it is related in some way" (Zimmerman, 2004).

This leaves the problem of deciding what it is that is "intrinsically good". Much of economics, following in the utilitarian tradition of Bentham, Mill and others, assumes that pleasure is intrinsically good (and pain intrinsically bad), generally narrowing this to an anthropocentric (human-centred) focus on human pleasure and pain. It also assumes that human preferences are a reliable indicator of the relative pleasure of different outcomes. Thus, the natural environment is viewed as valuable because it provides environmental goods and services which support human life and satisfy human preferences as mentioned in Section 2.1.

The framework outlined in Table 2.2 can help in adapting this philosophical idea to the context of valuing the natural environment. Only the two shaded boxes, i.e. anthropocentric values, are commonly taken into account in value assessments following the utilitarian tradition, and most often only the upper one of these is considered.

Table 2.2: Classification of environmental values

	Anthropocentric	Non-anthropocentric
Instrumental	*Total Economic Value: personal use and non-use (inc. existence value related to others' use)*	*The values of other animals, species, ecosystems etc. (independent of humans)*
Intrinsic	*"Stewardship" value (unrelated to any human use)*	*Value an entity possesses independently of any valuer*

Source: adapted from Turner et al. *2005.*

Of course, the "instrumental" values in this framework are themselves related to underlying intrinsic values: here, the pleasure or self-worth of individual entities. It is possible to hold other opinions on what is intrinsically valuable ("beauty", "truth", "the greater glory of God" and so on). It is possible to believe that more than one thing is intrinsically valuable, which brings potential problems regarding how to proceed if these things are in conflict. There are philosophical issues here which are not within the scope of this study, but it is important to note two ideas which crop up frequently in debate about environmental policy.

One is the suggestion that other entities, in particular animals, but sometimes also plants, and even ecosystems have their own values. It is clear, for example, that many animals can feel pain. The second is that the environment possesses "intrinsic value". Those who make this claim mean that the natural environment is 'worth' something *in itself* and independently of any being who may value it. Whether or not this is a meaningful concept, i.e. whether there can be 'value' independently of a 'valuer', is an issue we do not dwell on here.

It is, however, relevant to ask what the policy implications of such notions are. It is not clear that humans collectively have any moral obligation to take non-anthropocentric instrumental values directly into account over and above any human preferences bearing on other entities' welfare (which fall into the anthropocentric boxes in Table 2.2). In any case, non-anthropocentric intrinsic value is, by definition, beyond our knowledge. Therefore, this study restricts its focus on those forms of value which are realistically possible to measure, i.e. anthropocentric values. Of course, individual humans' values may well include preferences relating to the well-being of non-human entities. We flag up the possibility that others may hold quite different ethical views which may be incompatible with the framework we outline here. Nevertheless, we would argue that for contemporary, mainstream UK society, our approach is broadly acceptable for evaluating human activities within the bounds of some ethical limits.

2.2.2 Valuation, welfare and wellbeing

In conventional economic thinking, then, value is considered a 'signal' for the contribution which a resource makes in contributing towards human welfare. Usually this signal takes the form of a market price; if markets are sufficiently competitive, then a high price will indicate that demand for a good is high relative to supply. This not only signals that producing additional units of the good will contribute to welfare, but signals that other resources should be directed towards its production. However, it should be remembered that market prices represent only a lower range estimate of value; some people may in fact be prepared to pay much more than the market price for the goods and services they buy. The difference between price paid and maximum willingness to pay is referred to as *consumer surplus*.

There are many practical reasons why a high price might be a distortion of this signal (e.g. monopoly power in a particular market). There are also obviously very many goods which people value – and which contribute to their welfare in very real direct ways – but which cannot be traded in markets. Of these goods, the natural environment (or ecosystem goods and services) are amongst the most notable.

There are several problems with the welfare economics framework which are widely recognised by economists. These include technical issues, beyond the scope of this report, related to comparing and summing utility across people, methods which assume people have identical preferences, the problems of linking preferences to welfare, and so on. In fact, these problems apply not only to monetary, consumption or output-based measures of welfare but to any single-valued welfare function (Gowdy, 2005). There is also well-known evidence that greater consumption does not necessarily imply greater happiness, that relative rather than absolute wealth may be important, and that a host of other factors come into play (heredity, relationships, intelligence, education and so on). It should be stressed that economists do not use monetary methods because they think welfare and preferences and monetary expressions of them are identical, but rather because, so far, money is found to be the most common unit to express the trade-offs between different factors (environmental and other) that contribute to human welfare. If direct, cardinal measures of welfare or utility were available, economists would use them instead; but there is currently no way of measuring welfare directly.

For this reason there has been some discussion in recent years of attempting to account for those factors that contribute to human welfare but are external to market-driven economic activity. Some economists have recently turned substantial attention to research into applying recent developments in anthropology, neuroscience, psychology and economics to provide different measures of utility or happiness (e.g. Layard, 2005). Some economic studies have already started to attempt environmental valuation on the basis of direct happiness measures rather than monetary measures (Welsch, 2002). Similar approaches are being promoted in the field of valuing health impacts (Dolan and Kahneman, 2006). It seems likely that there will be greater research effort in combining economic valuation methods and non-monetary indicators of happiness or wellbeing in the future.

The latest expression of this in government research is the work on 'wellbeing' being conducted by the Sustainable Development Research Network (McAllister, 2005). While this research has so far noted that there is no single concrete definition of wellbeing it also notes that the concept "accounts for elements of life satisfaction that cannot be defined, explained or primarily influenced by economic growth" (McAllister, 2005). It should however be noted that the term 'wellbeing' has been used interchangeably with 'welfare' in welfare economics for many years and that the concept of welfare also includes those aspects which do not derive from goods traded in markets. Because of this lack of a clear distinction between welfare and wellbeing, this study uses the term 'welfare' with the hope that the reader will conceptualise this term as including substantial non-market elements, as also shown by the concept of Total Economic Value in the next sub-section.

2.2.3 Total Economic Value

The concept of Total Economic Value (TEV) has proven useful as a conceptual framework for keeping track of the wide range of complex and interrelated physical and value flows involved in valuing the natural environment. It reflects the use humans make of the natural environment (both through markets or informally) and also the value they may attribute to it unrelated to their current or future use. In other words, TEV consists of *use value* and *non-use value* (Defra, 2005)[3].

Use value involves some interaction with the resource, either directly or indirectly:

Direct use value: Individuals make use of a resource in either a consumptive way (e.g. the fishing industry and agriculture) or a non-consumptive way (e.g. rambling).

Indirect use value: Individuals benefit from ecosystem services supported by a resource rather than actually using it (e.g. watershed protection for flood mitigation, cycling processes for agriculture or carbon sequestration).

Non-use value is associated with benefits derived simply from the knowledge that the natural environment is maintained. By definition, non-use value is not associated with any use of the resource or tangible benefit derived from it, although users of a resource might also attribute non-use value to it. Non-use value can be split into three basic components:

Altruistic value: Derived from knowing that contemporaries can enjoy the goods and services the natural environment provides.

Bequest value: Associated with the knowledge that the natural environment will be passed on to future generations.

Existence value: Derived simply from the satisfaction of knowing that ecosystems continue to exist, regardless of use made of them by oneself or others now or in future (also associated with 'intrinsic value').

Finally, two categories not immediately associated with the initial distinction between use value and non-use value are:

Option value: An individual derives benefit from keeping open the option to make use of some aspect of the natural environment in the future, even though he or she does not currently plan to make such use. It is "an additional value to any utility that may arise if and when the good is actually consumed" (Perman et al. 1999), and only exists because of uncertainty concerning future preferences and/or the availability of the good, and if the valuer is risk-averse. It can be regarded as a form of insurance to provide for possible future use.

Quasi-option value: A related value arising through avoiding or delaying irreversible decisions, where technological and knowledge improvements can alter the optimal management of a natural resource. It does not require risk aversion. It is particularly relevant to the precautionary principle. A

[3] 'Total' in the term refers to the sum of its components, not the total value of the natural environment. The value measured is individuals' preferences for or against changes in the quality and quantity of environmental goods and services. It is not the value of the entirety of the natural environment, without which we cannot contemplate human life on earth.

common example is the potential for genetic information in biodiversity to be used for creating pharmaceuticals or improved crop varieties.

The term 'benefit' is used in the description of TEV above to mean maintaining or increasing human welfare. A cost, on the other hand, would relate to a change in the natural environment (e.g. pollution) that leads to a decrease in human welfare. Some use values can be expressed in monetary terms using data from actual markets. Use values derived from environmental goods and services that are not traded in markets, i.e. are non-market, and non-use values in general, are not reflected in market transactions unless there has been a government intervention in the form of taxation or another policy that forces the market price to incorporate these values.

Ecosystem services, introduced in Section 2.1, are a way to categorise and understand the linkages in the ecosystems that ultimately contribute to human welfare both through the provision of goods and services (use value) and non-use value. Table 2.3 shows some examples of this.

The examples in the table are a simplification as the interaction between different ecosystem services is immensely complex and is covered elsewhere (Defra, 2005, English Nature, forthcoming, and Millennium Ecosystem Assessment, 2005) and is not rehearsed here. However, the crucial point to make here is that understanding ecosystem services is necessary to understand how the natural environment works and how it contributes to human welfare so that they can be better managed. Quantifying the economic (or other) value of these services individually is likely to be impossible because their individual contributions are not always possible to identify in scientific analysis, let alone through economic or deliberative and participatory methods.

Table 2.3: Examples of how different ecosystem services contribute to different components of TEV

	Direct Use Value	**Indirect Use Value**	**Non-use Value**
Purification and Detoxification	-*	Clean air, water and soil	-*
Cycling Processes	Nutrient cycling, nitrogen fixation, carbon sequestration, soil formation – all of which contribute to all other ecosystem services		
Regulation and Stabilisation	Water supply	Pest and disease control, flood and coastal erosion mitigation	-*
Habitat Provision	Recreation in wild areas, food and other products	Ecological resilience	Existence of diverse species
Regeneration and Production	Renewable resources, raw materials and food	Pollination	Existence of habitats, e.g. rainforests
Information/Life-fulfilling	Samples for scientific research, possibility of individual research, use by media (e.g. nature programmes)	Readers of research and audiences of media coverage	Cultural heritage, sense of identity

**: These cells are left blank. However, these services still generate use and non-use values through their contribution to other services. For example, habitat provision cannot be thought of without purification and detoxification, cycling process and regulation and stabilisation services.*

2.2.4 Different measures of value

The preceding paragraphs have discussed the idea that the natural environment is valuable; and it surely is, but this is quite imprecise. We have discussed the valuable goods and services which are the *flows* provided by the *stock* of natural environments. This is analogous to the stock value of a capital asset and the flow or rent or interest that it provides. Essentially, stock and flow are different facets of the same phenomenon, and in some respects it does not matter which we use. But, it *is* important to be clear in any given analysis whether stock or flow values are being counted, because to mix them is to make a fundamental error.

The stock and flow distinction also gives an insight to the management-dependent nature of the value of a natural resource. For example, the flow of value from an over-fished or degraded fishery might be much lower than it could be under "optimal" management. In fact, we can think of different types of stock values: in terms of the (net present value of) actual flows, or as the potential value of flows which could be gleaned under optimal management. Similarly, there might be high stock value with little flow value – as for example in a fishery which is being left to recover from overexploitation, or a growing timber crop. We can think of improvements in management which could result in improvements in stock and flow values, and indeed being able to think in these terms is part of the justification outlined above for valuing the natural environment.

A different distinction can be made between total and marginal values. We can have total and marginal flow values, and total and marginal stock values. Total, rather obviously, refers to the whole value of the flow in a period, or the whole value of a stock. Marginal values relate to the additional value gained or lost by a small change in provision of some flow (or of some stock).

Although it may seem natural to think in terms of the total stock or flow value of the natural environment, it is often the case that estimating total values is both very difficult and largely irrelevant. This is because the decisions we have to make generally involve relatively small changes (improvements or deteriorations) in the provision of environmental goods and services. But this is not inevitably true; and it is also often a question of scale. For example, on a national scale, society might view a hydropower decision in the marginal framing of whether or not to flood one valley out of all of the unflooded valleys in the country; at the local catchment level, a more "total" perspective is to be expected.

The key point, though, is that valuation methods might be reasonably good at picking up marginal values, where we are dealing with relatively small changes in provision; they might be completely unequipped for dealing with large changes, where people have severe problems imagining the change, or where there may be thresholds at which values change very rapidly. An example would be valuing fresh water provision where it is quite possible to think in terms of, and to value, small to middling changes in quality or quantity. The exercise starts to lose meaning the closer it approaches the extreme case of valuing the entirety of fresh water provision. Without fresh water, life would be impossible. So there are limits to the realm within which valuation techniques make sense – but such extreme cases do not occur in most decision-making contexts and practical (either economic *or* deliberative and participatory) valuation exercises.

2.3 Whose Values Should Count?

For both economic and deliberative and participatory methods, it is important to answer the question of who to include in the analysis. The distribution of costs and benefits among different groups at different time periods is a crucial factor when assessing the value of the natural environment. In terms of beneficiaries, we can think of individuals (the basic unit in

estimating total economic value), commercial entities and the public sector as forming broad categories. Table 2.4 identifies these beneficiaries across the local, regional/national and global scales. Often when decisions are made about the natural environment, the inclusion of the interests of the global community can tip the balance. This is especially the case when it comes to non-use and option values, and even more so when mechanisms to capture these values for local communities can be put in place (e.g. through pricing, environmental taxes, international agreements etc.).

Table 2.4: Beneficiaries of ecosystem services provided by the natural environment

	Local	**National/Regional**	**Global**
Individual	Local users (e.g. recreational users)	Tourists, consumers, students	Everyone (climate regulation, existence values)
Commercial entity	Local industry (e.g. entrepreneurs, farmers, traders, artisans)	Economic sectors, national and regional GDP	International enterprise (e.g. fishery and forestry industry)
Public sector	Local Government (e.g. tax revenue)	National Government (e.g. tax revenue, foreign revenue from sale of concessions)	International Community

The distribution presented in Table 2.4 brings forth the issue of conflict of interest between the different beneficiaries or users of the natural environment and its goods and services. Inter-temporal trade-offs also occur. Benefits and beneficiaries vary between short versus long term, and this variation is clearest when exploitation of the natural environment in the short term leads to a decline in the goods and services it can provide in the long term.

Thinking at the level of the individual, at least three questions come to mind in terms of deriving benefit based on individuals' expressions of their values (whether through economic or deliberative and participatory methods):

- Whose values are we trying to assess? Which entities are "inside" and which "outside"? Those "inside" will have their instrumental values (Table 2.2) counted directly, while those "outside" will feature only to the extent that those "inside" hold altruistic values for their welfare. This discussion may seem abstract, but in fact represents real practical problems for social choice. When we attempt to make social evaluations of possible decisions, the outcome of the question "whose values?" is of primary importance. Are all humans "inside"? Or only those in the region or country in which the assessment occurs?

  The quick answer to these questions is that we should count the values of all those affected by the changes (both users and non-users) in the natural environment. These include both those who gain from the change (e.g. those who gain financially from using a resource) and those who lose (e.g. those who suffer from the pollution generated by resource use activities). This definition of the 'affected population' is not limited by geographic or administrative boundaries. For example, given the UK's pledge to reduce its acidifying air-borne emissions and greenhouse gases, the damage caused by UK emissions should ideally be included in an assessment of air quality policy of the UK, regardless of whether the damage occurs inside or outside the UK. Other international impacts can be thought of in the same way.

- Should the preferences of future generations count? Consideration of the values which future generations might place on the natural environment is needed for consideration of sustainable development. There are obvious difficulties with accounting for the values of

future generations. Preferences for natural resource protection might alter over the course of generations: for example, value may increase with scarcity; economic growth may make people more affluent and hence less likely to favour environmentally destructive use of land for short-term income; or value may decrease if alternatives to the natural environment are preferred. However, generations overlap, and evidence of bequest values shows that the current generation does care about the wellbeing of future generations – even if what future generations may prefer is unknown to us now.

- Are there any values which we should *not* count? Consumer sovereignty is one of the most enshrined principles of economics. Thus, economic analysis simply observes or elicits preferences without making any judgement about the motives for these preferences (Carson, 2000). However, policy makers may care about these motives and hence deliberative and participatory methods seek to not only understand the motive (which is also considered within economic methods) but also allow participants to influence each others' motives through deliberative discourses.

Once it is decided what value is and whose values are to count, the next question concerns how to measure. In economic analysis, the value (or benefit or cost) for the society is the sum of value (or benefit or cost) as expressed or incurred by the individuals that make up that society. At least in some of the deliberative and participatory methods, the focus is more on finding a consensus among the affected population. More discussion on this is presented in the next two Sections.

2.4 How Do We Value the Natural Environment?

This study focuses on two approaches to valuing the natural environment: a group of methods referred to as 'economic valuation methods' and a group of methods referred to as 'deliberative and participatory methods'. Details of each method in each group are provided in the fiches in Annex 1 with summaries in Section 3. However, it is fitting to define these approaches here. How the value evidence can be used in decision-making is discussed in Section 2.5.

Economic valuation methods are based on economic theory and aim to quantify all or parts of the Total Economic Value of an environmental good or service. These methods assume that individuals have preferences for or against environmental change, and that these preferences are affected by a number of socio-economic and environmental factors and the different motivations classified within the TEV concept. It is also assumed that individuals can trade-off both between different environmental changes and between environmental changes and monetary amounts, and do so in order to maximise their welfare (or happiness, wellbeing or utility). Indeed the impossibility of not trading-off environmental assets with other resources or against money was pointed out by Thomas (1963). All decisions have costs (whether these are monetary or in terms of other resources) and hence all decisions to incur that cost imply that benefits exceed costs. All decisions not to incur the costs imply that cost exceed benefits. Economic valuation is always implicit or explicit, it cannot not exist at all.

The measure of individuals' preferences is either willingness to pay (WTP) for an improvement (or to avoid a degradation) or willingness to accept (WTA) compensation to forgo an improvement (or to tolerate a degradation). In addition to being the most common unit, using money also has the advantage of allowing comparison of non-financial benefits of the natural environment, non-financial costs of its degradation, and financial costs and benefits of using the natural environment. In other words, it allows a direct integration of environmental and social aspects of a decision with its financial aspects. Essentially, economic methods study choices or trade-off decisions, and from this the idea of preferences and values consistent with those decisions.

Deliberative and participatory methods may also examine the values underlying decisions, but do this by asking people to explain or discuss why they behave in a particular way, or hold a particular view. Often, these methods focus on what people think society should do – not on their personal actions, motivations or values. In this sense they can be (but are not necessarily) very different from economic methods, which focus on the individual level, and apply external value judgments about how individual values should be aggregated to reach a social welfare assessment.

Deliberative and participatory methods also focus on the *processes* of decision-making and management, for example in terms of procedures, without necessarily changing the *outcomes* of management decisions. This represents a move away from the "substantive" framework of standard economic analysis, which focuses on the outcomes of decisions, towards a more procedural rationality, which focuses as much (or more) on the ways in which society reaches decisions.

Clearly there is nothing to stop individuals' preferences (in the economic sense) including views on what the society should do, or what the common good is. Equally, people engaging in participatory exercises do not suddenly lose all of their individual preferences. On the other hand, differences do exist. Paavola (2005) argues that "*environmental governance is best understood as the resolution of environmental conflicts through the establishment, reaffirmation or change of environmental governance institutions*" and from this concludes that "*the choice of environmental governance institutions is a matter of social justice rather than economic efficiency, demanding greater emphasis on public participation as the foundation of their political legitimacy*". This is perhaps the key distinction to be made between some of the participatory methods covered in this study, and those other methods (both "economic" and based on data or evidence collection) which aim to extract information on values from people, but do not involve those people directly in assessing the information, or in controlling how the values are subsequently used.

Moreover, economic methods treat preferences as pre-existing and generally stable constructs (which is not to say they may not change overtime given experience, education and information concerning a particular issue), whereas the deliberative and participatory methods consider that preferences about complex environmental matters are only formed through a process of deliberation. As we shall discuss further, these different approaches are not necessarily incompatible (indeed there have been several promising moves to combine them) and there seems to be a place for both to be used in a wide range of different contexts under the general 'valuing the natural environment' umbrella.

A further issue is that the relationship between cause and effect for many complex ecosystem goods and services is not well understood, as mentioned above, and respondents in a valuation exercise might not fully appreciate the impact that an environmental good might have on their wellbeing. This is most commonly found in biodiversity valuation (see, for example, Christie et al., 2004). Most people might not imagine, for example, that they derive much utility from the existence of many species of soil fauna, but these play a crucial role in maintaining soil productivity. In such cases, the amount of information provided to participants can play an important role in the results of valuation.

Whether it is their behaviour as consumers or their consciously-expressed preferences, what people value is ultimately limited by what they know. On the one hand, through valuation, we can find out about the gaps in people's knowledge and try to rectify these. On the other hand, we need to be careful about the amount and accuracy of the information provided to individuals during surveys or discursive methods so as not to bias them in favour of one outcome or another. This, in turn, implies that valuation exercises often require inter-disciplinary teams preparing the necessary information (e.g. environmental impact

assessments, epidemiological findings about the effects of pollution on human health and so on). However, ultimately, the focus of valuation methods (of either kind) should be the changes in the outcomes that are likely to affect human welfare and not necessarily the processes behind these changes.

It should be noted here that studies that estimate the contribution of environment-related sectors (e.g. tourism, environmental technology, etc.) to the general economy in terms of revenues or job creation are not included in this study. In the case of tourism, the contribution of environmental benefits (as opposed to other attractions) to tourists' choice for visiting a region is not always clear from tourism revenue figures. In the case of environmental technology, these technologies usually exist to abate pollution; however money spent on them is not indicative of the contribution to welfare of environmental resources themselves and is highly dependent on the regulatory context. Finally, the number of jobs sustained by a sector is not an indicator of the value of the natural environment, as labour is a factor of production and spending on labour is not an indicator of welfare generated by that production.

2.5 How Can We Use the Value of the Natural Environment in Decision-Making?

As mentioned above, the ultimate aim of defining and measuring the value of the natural environment is to include this information in the decision-making process. Particular areas where valuation can assist include the determination of an appropriate level for environmental pricing and taxation; demonstration of the (economic) importance of an environmental good or service; policy, programme and project appraisal; setting priorities within a sector plan or across different sectors; green national and corporate accounting; and determining compensation in environmental litigation. The potential usefulness of economic and deliberative and participatory methods for each of these contexts differ. While, for example, economic methods are more relevant for pricing or taxation, both types of methods can contribute to appraisal. The focus of this study is on the decision-support methods which are generally used for appraisal and measures of prosperity. These are discussed in greater detail in Section 3. Here we provide an overview of how different valuation methods could be used for these two general purposes.

2.5.1 Decision support

The standard economic approach to social choice makes two fundamental assumptions. Firstly, that *"Society should make changes . . . only if the results are worth more in terms of individuals' welfare than what is given up by diverting resources and inputs from other uses"* (Freeman,1993). Secondly, welfare is to be assessed via preferences: "*preferences are treated as data of the most fundamental kind. Value, in the economic sense, is ultimately derived from individual preferences*" (Randall, 1981).

Within this framework, preferences are taken as given and welfare is to be measured in terms of the satisfaction of individual preferences. Total value (or benefit or cost) of an environmental change is the sum of all costs and benefits impacting the entirety of the affected population. The analysis takes the status quo distribution of factors such as income, and access and use of the natural environment as given. On this basis, the economic analysis would recommend the outcomes that generate more benefits on average for all of the affected population. Cost-benefit analysis (CBA - see Section 3.4.2) is based on the Kaldor-Hicks criterion, or potential Pareto Optimum (Kaldor, 1939; Hicks, 1939): that an outcome is preferable so long as the benefits for the winners are sufficiently greater than the costs of the losers so that the winners *could* compensate the losers and still be better off. Note that the

rule allows *hypothetical* compensation to be sufficient to satisfy this rule: there is no requirement for actual compensation of losers. Thus, economic analysis generally focuses on efficiency of allocating resources to meet needs and wants, and not on the equity or fairness of this allocation.

But, this is not obviously the "right" or the only way in which social welfare should be assessed. "*Why should preference — as distinct, e.g., from belief, argument, reason, or opinion — count in social decision-making? Why is it a good thing, all else being equal, that preferences be satisfied — preferences taken as they come, on a willingness-to-pay (WTP) basis, constrained by income and bounded by indifference between alternatives?*" (Sagoff, 2003).

One alternative to this approach which focuses on efficiency rather than equity is to introduce some accepted "fair" way of determining distributional questions. Another is to stop searching for "the best" alternative from an economic/cost-benefit framework, and instead attempt to develop social choice processes which are fair and/or democratic, or which meet some other ethical criterion. This approach is increasingly popular for example in ecological economics, which favours procedural rationality over substantive rationality (see e.g. Faucheux et al., 1997).

This discussion leads on naturally to considering the purpose of valuation. Should valuation be undertaken as purely a process to support decision-making or should it be part of the decision-making process? As the discussion below shows, the choice is not always a case of either economic or deliberative and participatory methods but possibly using a combination of these as the context of the decision requires. Economic valuation methods can be considered as a tool for helping decision-makers to make welfare-increasing decisions. On the other hand, deliberative and participatory techniques can be considered as part of the democratic process. So the goals of economic and deliberative and participatory valuation methods can be seen to be quite different, and in many senses are complementary. For example, they can be used in combination (e.g. monetary values and scores for measure of value); consecutively (e.g. options short-listed by a technical or scientific assessment as feasible can be prioritised using monetary values); and side-by-side (e.g. extensive participatory focus groups can be used as part of stated preference surveys and on their own).

Thus the key issue is not "which set of methods is better?" but rather "how can we best combine economic and deliberative/participatory valuation methods?". This is already seen in practice. For example, the guidance for implementing Regulatory Impact Assessment (Cabinet Office, 2003) requires that benefits and costs of each option are considered and quantified where possible, but also that distributional impacts are considered and the options and the assessment are subject to consultation. The importance of such regulatory guidance in commissioning and using the results of valuation studies is mentioned by policy maker consultees as summarised in Section 4.

Alongside this scope of assessing which combinations of techniques are best suited to particular cases comes a recognition that the answer must depend not only on the environmental goods and services in question, but also on the wider policy framework within which the valuation is attempted, including the ways in which values are to be used.

Where the purpose is to "correct" prices, by taxation or pricing of environmental goods and services, there is a clear *a priori* case for using economic valuation methods. The policy instrument presupposes the decision to draw the good or service into the market setting. Of course this begs the question of how the choice of instruments is made, and whether or not economic valuation methods are used there; but taking that decision as a given, there can be little objection to using economic valuation methods to inform the tax or price level. It should also be noted that the decision will entail some implicit (and possibly explicit) distribution of

property rights. Where there is no such intention to use economic instruments or pricing, and no intention to allocate property rights implicitly or explicitly, economic valuation remains one tool amongst many possible ways of attempting to take preferences into account.

2.5.2 Measures of prosperity

The above discussion about value evidence and valuation methods does not distinguish between the micro (e.g. an individual, a single project) and the macro (e.g. national sectoral and environmental policies) level decision-making. Measuring prosperity at the macro level is intended to guide public policy towards measures which will increase overall welfare. There has been much discussion over recent years amongst environmentalists and environmental economists about the shortcomings of Gross National and Domestic Products (GNP/GDP) as measures of national prosperity.

What's wrong with GNP?

GDP is the total value of final goods and services produced within a country's borders, while GNP is the total value of final goods and services produced by a country's nationals, i.e. adding returns from investments abroad, and subtracting returns to foreign investments in the country. Here we refer to GNP, although the differences between the two measures are typically small. Net National Product (NNP) is GNP minus the depreciation of man-made capital; this is less commonly used because accurate estimates of capital consumption are hard to make, and methods vary across countries, so comparison is harder.

While the use of GNP as an indicator of economic activity is not called into question, its use as a measure of aggregate welfare or wellbeing is. The principal criticisms of the use of GNP as an indicator of welfare are (see for example Daly and Cobb, 1990, Layard, 2005):

- The implication that an individual's level of consumption is *the* major determinant of his or her welfare;
- The omission from GNP of determinants of welfare which are not traded in markets;
- The omission from GNP of depletion of man-made and natural resources; whether traded in markets (fossil fuels, mineral ores) or not (fresh air, water and landscape);
- The fact that expenditures linked to economic activity, but which could be argued to be detrimental to welfare, such as commuting and advertising, are included in GNP; and
- The fact that expenditures to counteract and mitigate the environmental and health impacts of economic activity are included as contributing to welfare.

The third point is particularly important for the discussion here. While in national accounting GNP is adjusted to give NNP by subtracting an estimate for the depreciation of manmade capital, no estimate is made for the depletion of natural capital. Attempts to include natural capital depletion in national accounting (e.g. Hamilton and Clemens, 2000) have been made because of the concern that use of unreplenished natural resources is treated as a flow of income by standard accounting procedures, rather than consumption of capital.

However, it is not true to say that environmental assets are not included at all in traditional national accounts. According to Hamilton (1994): "*To the extent that there is a commercial activity associated with an environmental asset, such as tourism or hunting, then the value-added in this activity appears as part of the national product*." Environmental degradation itself may also show up in GNP in so far as it causes either a reduction in productivity (e.g. through lost agricultural productivity), or as an addition in a value-added activity (e.g. through defensive or mitigating expenditures, property insurance).

Alternative Measures of Prosperity

There is increasing research on measures of prosperity that are alternatives to GNP. These include adjustments to GNP which use economic value evidence to estimate the depletion of natural capital and the welfare-reducing impacts of economic activity such as pollution. Measures which attempt to do this include Green Net National Product (and the related indicator of Genuine Savings) and the Index of Sustainable Economic Welfare (ISEW). These are summarised in Section 3.4.3 and discussed in more detail in Annex 1. Two other measures of prosperity which do not attempt to monetise environmental costs and benefits – the UN Human Development Index and the UK Sustainable Development Indicators - are also reviewed.

Usefulness of Alternative Measures of Prosperity for Sustainable Development

It should be noted that a measure of progress towards sustainable development is different from a measure of welfare. The latter will measure the welfare of the current generation regardless of that of future generations. The former will take into account whether natural capital[4] which may be required to sustain the welfare of future generations is being depleted in the process of generating welfare for the current generation. A word of caution is needed, then, if using alternative measures of prosperity in conjunction with the definition of sustainable development given in Section 1.3 of per capita welfare which does not decline over time. According to Pearce (2004) the term 'sustainability indicators' can be *"misleading because while there are many indicators that are relevant to sustainability, an indicator of sustainability must measure sustainability, and very few indicators do that*".

Arguments for green national accounting are not just intended as an alternative way of measuring prosperity, but also a way of 'guiding' sustainable development. Solow (1993) wrote that a "*properly defined net national product… measures the maximum current level of consumer satisfaction that can be sustained forever*" and can therefore be regarded as "*this year's interest on society's total stock of capital*". According to Perman (1999), these two propositions give us "*the rule for sustainability:… to maintain society's total stock of capital intact, by consuming only the interest on that capital*".

If, therefore, the aim of alternative measures of prosperity is to improve our understanding of how we are performing against our goal of sustainable development, then the usefulness of these measures should be judged by assessing how clearly they present such progress (or lack thereof). It is also useful to be clear whether such indicators imply a *weak sustainability* or *strong sustainability* approach. An index which implies that natural and man-made capital are directly substitutable, such as Green Net National Product adopts a weak sustainability approach. A strong sustainability approach would imply that natural and man-made capital are not substitutable for one another, and would treat these components separately.

[4] While the focus here is on natural capital, human capital (education, skills and knowledge) and social capital (factors which 'bind' society together) should also ideally be included.

3. Valuation Methods and Evidence: Literature and Use

This section provides a summary of the economic valuation methods (Section 3.1) and deliberative and participatory methods (Section 3.2). The summary of the methods focuses on their most important characteristics. Other important details, such as the theoretical basis, data needs, practical issues, principal outputs, transferability of outputs, methodological discussion, consideration of distributional impacts, advantages, disadvantages, and conflicts and synergies with other methods, can be found in the fiches in Annex 1. The reader is encouraged to refer to Annex 1 for completeness.

The overview of literature of both groups of methods is presented in Section 3.3 and the full list of relevant references can be found in Annex 2. The uses of value evidence, i.e. decision support methods and measures of prosperity, are summarised in Section 3.4. The Section concludes with a discussion (Section 3.5) which incorporates a number of issues that arise in the context of undertaking valuation studies and interpreting their results.

As noted in Section 2.4, assessments of jobs created, income, revenues, GDP contributions of environmental industries such as tourism, pollution abatement technologies, mitigation investments and so on are not included in the review of literature.

3.1 Economic Valuation Methods

There are three main approaches of economic valuation methods depending on the type of preference data used: market price proxies (and the production function approach); revealed preference methods (hedonic property pricing, travel cost method and random utility models); and stated preference methods (contingent valuation and choice modelling).

3.1.1 Market price proxies

Definition
Market price approaches consider the costs that arise in relation to the provision of environmental goods and services which may be observed directly from actual markets. These costs can take the form of opportunity costs or the cost of alternative provision as well as mitigation costs or the costs of avertive behaviour and shadow project costs.

Value concept encapsulated
Market price approaches can be proxies for direct and indirect use value but not non-use values. This is because the price a consumer pays for a good or service is a minimum expression of their willingness to pay for it – they may in fact be willing to pay much more than the market price, i.e. consumer surplus is not accounted for.

Resource/Policy contexts
Market pricing approaches can only be used for environmental goods and services that are marketed, have clear market-based substitutes, or the degradation of which can be mitigated against. For example, this may include the market value of forest products or spending on improving water quality, storm or flood protection and so on. The opportunity cost approach is suited to assessing the creation or protection of environmental resources such as forests, which typically entails the loss of land for some other productive use (typically agriculture). An example of the cost of alternatives approach is estimating the economic value of coastal wetlands, in terms of storm protection value, on the basis of the cost of constructing equally effective man-made defences. Use of market price data is typically related to appraisal, for example in assessing minimum compensation requirements or estimating mitigation costs.

Practical limitations
It should always be borne in mind that market prices can be distorted through monopoly, oligopoly or oligopsony power, government intervention, taxes, subsidies, and so on. Note also that mitigation costs will typically only provide a partial assessment of the environmental impact of interest. For instance, the treatment cost to improve water quality will only account for the impact experienced by water companies and their customers, and will not account for water pollution damages to aquatic ecosystems and other users.

Use in combination with other methods
Some aspects of pricing approaches, such as mitigation costs, may actually serve as inputs into the production function approach framework (see below).

3.1.2 Production function

Definition
The production function approach focuses on the (indirect) relationship that may exist between a particular ecosystem service and the production of a marketed good. Here, environmental goods and services are considered as inputs to the production process and their value is inferred by considering the changes in production process of market goods that result from an environmental change.

Value concept encapsulated
The approach is capable of capturing the indirect use component of TEV. The function provides an explicit method for estimating the importance of environmental goods and services in the production of market goods and services, or conversely, the negative impact that pollution can have on production processes.

Resource/Policy contexts
In the main, the production function approach is limited to environmental inputs such as water, soil, raw materials, air quality and the ecosystem services that support these such as cycling and regeneration and production. A common example is in the assessment of air quality effects on agricultural and forestry production. The approach can also be used to assess the effect of water quality on agriculture, forestry, fisheries and to assess soil fertility (or soil erosion) as a factor input to agriculture. The results can be used to demonstrate the importance of environmental inputs, appraisal of pollution control options and setting minimum compensation amounts for liability. The approach can also feed into cost-benefit, cost-effectiveness and multi-criteria analyses.

Practical limitations
Estimating the value of environmental goods and service via this method requires a fair degree of analytical rigour, particularly in identifying and specifying the relationship between different factors in the production and/or cost functions. The approach requires a considerable amount of data concerning the final goods market and factor inputs, as well as econometric expertise. In practice it may be difficult to assess the response in production to changes in environmental factor inputs due to scientific uncertainty and lack of data associated with our understanding of how ecosystems services are provided and interact with each other.

Use in combination with other methods
Mitigation costs/averting expenditures and avoided costs may be included within the production function framework, since these actions will alter production and cost functions. Market prices (and even WTP or WTA estimates for non-market changes) can be incorporated to estimate the economic value of the change, where production function is used to estimate the physical change.

3.1.3 Hedonic property pricing

Definition
Hedonic property pricing is based on the notion that the price at which a property sells is determined, in part, by the environmental characteristics of the surrounding location. The economic value of the environmental characteristics is estimated by regressing the sale price against all factors thought to affect the price.

Value concept encapsulated
The method can estimate the environmental costs and benefits that property buyers and sellers are aware of and hence can reflect in their selling and buying behaviour. Within this scope, the value components that can be measured are limited to direct and indirect use values.

Resource/Policy contexts
The method is generally used for localised and site-specific impacts, including both 'goods' such as pleasant views (and related increases in property price) and 'bads' such as traffic noise, disamenity due to proximity of landfills, and so on (and related decreases in property price). The scope of these studies is limited to environmental characteristics which are observable by individuals and are likely to have an impact over the period of occupancy. This, by definition, excludes changes that are yet to occur. The method is less applicable to environmental goods/bads which are not typically perceived by the buyer, such as chemical hazard, radiation, etc. The method can be used to input into cost-benefit analysis (projects and policies), 'demonstration' of importance of an issue, establishing the basis for a tax and legal damage assessment. An example of actual practical use was in the revision of the UK Landfill Tax.

Practical limitations
Hedonic property pricing requires large amounts of data on property prices and property characteristics and a high level of expertise in data analysis. However, possibly the most limiting characteristic of the method is its ability to detect the welfare impact of only those changes in the environment that are perceivable by individuals.

Use in combination with other methods
The hedonic pricing method is principally a stand-alone method with relatively small scope for combination with other methods.

3.1.4 Travel cost method

Definition
The travel cost method is a survey based technique that uses the cost incurred by individuals travelling to and gaining access to a recreation site as a proxy for the recreational value of that site. Costs considered are travel expenditures, entrance fees, and the value of time.

Value concept encapsulated
The method differs from market pricing approaches in that it constructs demand curves for the site to estimate consumer surplus. However, it is still limited to measuring direct (non-consumptive) use value alone. Note that users, in this case, visitors to a site, could also hold non-use values but these cannot be estimated separately.

Resource/Policy contexts
The method is typically limited to valuing environmental goods and services that have explicit recreational uses, such as woodlands, wetlands, rivers and lakes, national parks and coastal areas. It is not able to account for environmental goods (or bads) that are imperceptible to visitors. Since the method is generally used to estimate recreational benefits, it can be used

for entry pricing for any environmental site open to recreation and demonstration of the importance of a site.

Practical limitations
The practical requirements of the method depend on the readily available information. If a survey is required to collect the visitation and cost data, the time and data requirements could be limiting. The method may under-estimate the use value derived by individuals, particularly if they move house to be near a site since travel costs incurred will not reflect actual recreational value, principally due to the fact that the cost of travelling to the site will likely be small. While the TCM is suited to explaining recreation demand over a given time period (e.g. the number of visits in a year), it is not suited to considering changes in site quality and this limits its use in cost-benefit analysis or other appraisal.

Use in combination with other methods
The travel cost method is closely related to the random utility model (see below). Additionally, the survey aspect of the method implies that it can be combined with stated preference methods, where it is possible to elicit information on travel costs and values for a simulated market involving the environmental good of interest.

3.1.5 Random utility model

Definition
This method is an extension of the travel cost method, but is used for testing the effect of changing the quality or quantity of an environmental characteristic at a particular site. Instead of estimating the overall demand for recreational trips, this method focuses on the choice an individual visitor makes when deciding which site to visit.

Value concept encapsulated
The component of TEV estimated is direct use value. Note that users - in this case, visitors to a site - could also hold non-use values but these cannot be estimated separately.

Resource/Policy contexts
As with the travel cost method, this method is suited to estimating the value of environmental goods and services associated with open-access recreation resources such as national parks, woodland, forest, rivers, lakes, wetlands and coastal areas. The random utility model can be applied to estimate the change in recreational use value which arises from a change in the characteristics of a recreational site. It can, therefore, be used for appraisal and site management planning, such as inputting to cost-benefit analysis of projects which may affect specific aspects of recreational sites.

Practical limitations
The method is subject to the same practical limitations as the travel cost method. In particular the ability to collect sufficient data may be limited.

Use in combination with other methods
The ability to explain choice among alternative sites comes at the expense of the ability to explain total demand for recreation. Hence the travel cost method and random utility model are complementary methods for estimating the value of environmental goods and service from travel cost surveys, and the decision as to apply which will depend on the required output. As with the travel cost method, the random utility model can also be used in conjunction with stated preference methods if a survey is used to collect the data.

3.1.6 Contingent valuation

Definition
The contingent valuation method is a survey-based approach to valuing environmental goods and services. The approach entails the construction of a hypothetical, or 'simulated', market via a questionnaire where respondents answer questions concerning what they are willing to pay (or willing to accept) for a specified environmental change. The approach defines the environmental goods and services as a bundle of different characteristics (quality, quantity, different services etc.) and seeks to elicit willingness to pay for the entirety of the bundle.

Value concept encapsulated
The method is able to estimate the total economic value of an environmental good or service, i.e. both use value and non-use value components (and values held by both users and non-users). However, separate valuation of all relevant ecosystem services within a single study is likely to be too onerous (and arguably not necessary), as is the separation of total economic value to its constituent parts. Stated preference techniques such as the CVM and choice modelling (see below) are the only approaches to estimate non-use value associated with environmental goods and services.

Resource/Policy contexts
The method is particularly flexible and facilitates the valuation of a wide range of environmental goods and services - including the changes that are yet to be experienced. The results can be inputted to cost-benefit analysis of projects, programmes and policies; demonstration of the importance of an issue; priority setting within a sector; determining marginal damages as the basis for an environmental tax or charge; and legal damage assessment (liability). A recent UK example is the use of contingent valuation to set the Aggregates Levy (see DETR, 1999).

Practical limitations
Reliable contingent valuation studies are not simple to implement. Time is required to develop the survey instrument and to ensure that the non-market good or service to be valued is clearly explained along with the constructed market and payment method. Analysis of the dataset requires econometric expertise. While in principle all aspects of the natural environment can be the subject of a contingent valuation study, in practice the appropriateness of the method is at least partially influenced by the familiarity and complexity of the issue. Ultimately, the preferences expressed by respondents are influenced by what respondents already know about the issue and what they can be told (in a neutral and straightforward way) during the questionnaire.

Use in combination with other methods
The method can be combined with deliberative and participatory methods. For instance, one-to-one in-depth interviews, focus groups and workshops could be used to investigate methodological issues such as consumer versus citizen preferences. Contingent valuation studies may also be carried out in conjunction with travel cost studies or avertive expenditure studies since data necessary for all these studies could be collected through a single questionnaire.

3.1.7 Choice modelling

Definition
Choice modelling is based around the notion that goods and services can be described in terms of characteristics (or 'attributes') and the levels that these characteristics take. For example, a lake may be described in terms of its ecological quality, chemical water quality, number and type of species it provides habitat for, and so on. A choice modelling questionnaire presents

respondents with different combinations of these attributes and asks them to choose their most preferred combination, or rank their preferences in order. As each combination has a 'price' attached, subsequent analysis of respondents' choices reveal their WTP or WTA for each of the characteristics (or attributes) presented to them.

Value concept encapsulated
As with contingent valuation, choice modelling is able to estimate the total economic value of an environmental good or service, i.e. both use value and non-use value components (and values held by both users and non-users). As goods and services are defined in terms of their attributes and as these are changed, choice modelling is more flexible in estimating individual values for different ecosystem services (subject to these being perceived by individuals). However, the separation of total economic value into its constituent parts is as difficult (and arguably unnecessary) for choice modelling as it is for contingent valuation.

Resource/Policy contexts
Choice modelling, which was initially developed in marketing and transport policy contexts, facilitates the valuation of a wide range of environmental goods and services – including changes yet to be experienced. In this respect, it is more flexible than contingent valuation, as many more potential combinations of environmental change can be presented. This allows for a better incorporation of uncertainty surrounding environmental impacts than can be afforded by contingent valuation. Choice modelling can input into cost-benefit analysis of projects, programmes and policies, or into decision-making contexts concerning the demonstration of importance of an issue, priority setting within a sector, determining marginal damages as the basis for an environmental tax or charge; or legal damage assessment (liability).

Practical limitations
The practical limitations are similar to those of contingent valuation. In addition, more complex choice modelling designs may cause problems for respondents leading to an increased degree of random error in responses. Therefore it should be expected that as the number of attributes (or rankings increase) the likelihood of inconsistent responses will also increase due to limits in cognitive ability unless sample sizes are increased to reduce number of choices each respondent is asked to make.

Use in combination with other methods
The potential for combination is similar to that of contingent valuation.

3.2 Deliberative and Participatory Valuation Methods

A wide range of deliberative and participatory methods are available and used in environmental valuation and decision support. Although we consider these methods under the general framework of "valuing the natural environment", the precise way they contribute to this varies substantially. Some of the methods we call deliberative or participatory here are designed for problem-specific participatory democracy; some are based on data collection and analysis (and these are not really participatory at all); some may be used for supporting economic valuation techniques (e.g. use of focus groups in stated preference studies). Some may be combined with decision support methods such as multi-criteria assessment (MCA) (e.g. using MCA within a focus groups or citizens' juries), or even cost-benefit analysis. This can give rise to conflict between the ease of use and comfort offered to decision-makers and the needs of the participants who are intended to be empowered and included through the participatory techniques. Several of the methods can be used for more than one of these functions. While there is likely to be some disagreement amongst experts and practitioners regarding precisely what the proper utilisation of any given method is, below are the summaries of the way we defined these methods in this study.

3.2.1 Survey approaches

Definition
Surveys and interviews need little definition - there are thousands of examples. Surveys are very useful for eliciting broad, baseline data about public attitudes, views and (reported) behaviour and the reasons behind these. They do not give scope for discussion and deep exploration of issues, but do allow for large, statistically significant samples. A key interest in questionnaire research is often the ability to analyse correlations between demographic and attitudinal factors, and to explore links between responses to different questions using statistical tests and regression analysis.

Value concept encapsulated
In theory, any concept of value can be captured via questionnaires and interviews, from general statements of ethical principles through to choices between specific conflicting options. Questions can cover monetary values, including stated monetary values, values as revealed through (stated) behaviour, or verbal expressions of value.

Resource/Policy contexts
Questionnaires can be applied to cover any natural resource or policy issue. However, the technique is best suited to "taking the pulse" of existing attitudes on environmental issues and behaviours, rather than engaging the public in complex reflection on new and challenging topics. Questions can also be directed at estimating policy impacts/effectiveness, for example trying to find out how respondents might alter their behaviour under a particular policy (however, there is always a problem here going from stated intentions to actual responses).

Practical limitations
Typically at least a month or two will elapse between handing over the questions and receiving the data. It is possible to carry out very quick surveys with just one or two questions, but these are of limited interest for serious research purposes. Because of time/attention constraints, there is a limit on the number of questions and therefore the number/depth of topics covered. One way of reducing this problem can be to use split sample designs, where different questionnaires are used for each sub-sample.

Use in combination with other methods
Questionnaires and interviews have clear synergies with economic valuation methods, where a survey is often an essential part of the method (e.g. travel cost method, stated preference techniques). More generally, questionnaires can provide useful background data for decision-making and deliberative processes of all sorts.

3.2.2 Focus groups

Definition
Focus groups have developed as a market research tool, and involve small groups holding a structured discussion on a particular topic led by a facilitator. Often the interest is in how the group discusses a topic, for example revealing how people think about an issue and how groups develop a discourse on complex environmental issues and trade-offs. Focus groups aim to discover the positions of participants regarding, and/or explore how participants interact when discussing, a pre-defined issue or set of related issues.

Value concept encapsulated
In theory focus groups can consider any concept of value. Generally, monetary valuation of an environmental good or service is not the objective of the exercise. More likely, the group will focus on how to choose between conflicting objectives, or on what decision should be made in

a particular circumstance, or on the reasons underlying particular behaviours or responses to policy.

Resource/Policy contexts
Conceptually there are no limits to the issues that may be covered in focus groups and in-depth groups. However, highly contentious issues may give rise to difficult group dynamics. Hence focus groups might not be suitable for exploring difficult local issues with highly entrenched positions on different sides. Focus groups have a broad range of applications, from stand-alone research, to initial scoping and framing phases in questionnaire research.

Practical limitations
In terms of participants, groups will usually have at least six members (plus facilitators) and at most 15 or so. Groups with larger numbers of participants may be difficult to manage as a single group. The representativeness of the views expressed in the groups of the overall affected population would be determined by the number of groups and the representativeness of participants.

Use in combination with other methods
Focus groups can serve as a pre-testing and initial design stage for questionnaire and stated preference approaches, and as a forum in which to elicit weights for MCA approaches. They are particularly useful for understanding how respondents interpret questions and information presented.

3.2.3 Citizens' juries

Definition
Citizens' juries are intended to obtain carefully considered public opinion on a particular issue or set of social choices, where a sample of citizens has had chance to consider evidence from experts and other stakeholders and hold group discussions on the issue at hand. They have developed specifically to elicit opinions that factor in or express a public interest, rather than only individual interest or preferences. Participants are charged with acting in what they perceive to be the public interest.

Value concept encapsulated
Potentially citizens' juries can capture all values in a framework of deliberative choice. Generally the emphasis is on citizen values rather than private values, although values are not expressed quantitatively or directly.

Resource/Policy contexts
The citizens' jury process can be applied to any resources, but they are particularly suitable where there are fundamental issues at stake. There have been applications to nuclear waste storage, GM crops, nanotechnology, wind farm siting, fisheries policy, national park creation, coastal protection, flood management and so on. Citizens' juries may be implemented for decision-making where there are fundamental and/or complex social choices at stake. When the context is specific and local, the jurors may be selected as key stakeholders/representatives of different points of view, rather than randomly.

Practical limitations
Typically citizens' juries are very labour intensive. For researchers, facilitators, jurors and witnesses expenses and compensation for time must be allowed for as well as the costs of meeting facilities and support. Ensuring representativeness of the affected population (if desired) could also be a limiting factor.

Use in combination with other methods
Notionally the outputs from citizens' juries can be used as evidence with other valuation methods. Alternatively questionnaire and focus group approaches may be used as scoping exercises prior to setting up citizens' juries. Recent work has started to look at using juries as part of stated preference methods, with the advantage of an improved understanding of the object of valuation.

3.2.4 Health-based approaches

Definition
There exist several types of health-based approaches: quality, utility and disability-adjusted life years or life expectancy and healthy-year equivalents. These are based on measuring the value of health impacts in terms of the health-based impacts and not the willingness of individuals to pay to avoid them (though they can also be combined with monetary valuation).

Value concept encapsulated
A quality-adjusted life year (QALY) combines two key dimensions of health outcomes: the degree of improvement/deterioration in health, and the time interval over which this occurs, including any increase/decrease in the duration of life itself. Disability-adjusted life years (DALY) have similar grounding, but aim not to measure the degree of improvement arising from an intervention, but rather to measure the total amount of healthy life lost, whether from premature mortality or from some degree of disability during a period of time (or indeed both). Healthy-years equivalent (HYE) differs by involving valuation of whole-life sequences of health states which can change over time.

Resource/Policy contexts
QALYs or similar measures might be applied to any setting where there are human health impacts associated with the natural environment, or use or pollution of it. Generally QALYs are used in the cost-effectiveness context of ranking alternative health interventions. In environmental applications they are more likely to be used as a measure of one of many different impacts.

Practical limitations
The calculations of health effects in environmental settings may be complex and uncertain. For example, calculating HYE involves valuation of whole-life sequences of health states, which requires fewer restrictive assumptions than QALYs, however this also makes them much less practical to implement, to the extent that they can be considered a theoretical innovation with very limited practical significance.

3.2.5 Q Methodology

Definition
Q-methodology aims at identifying typical ways in which people think about environmental (or other) issues. The key difference of the Q methodology from standard survey analysis is that rather than focusing on why individuals hold certain attitudes (e.g. as affected by age, gender, race, income), Q focus on patterns of attitudes, or discourses, shared perceptions, developing "typical" sets of views (which need not exactly represent the views of any specific individual).

Value concept encapsulated
Whilst Q-methodology can potentially capture any kind of value, the process is not explicitly focused on 'quantifying' or distilling these values. Instead it is concerned with how individuals understand, think and feel about environmental problems and their possible solutions.

Resource/Policy contexts
Q-methodology was introduced to psychology over 70 years ago and can potentially be applied to any resource or issue. More recently it has been used in other disciplines including health, political science and ecological economics. The Q-methodology approach is useful for initial analysis flagging up common issues or views amongst the public. This can help establish which policies are likely to meet with wide support or resistance.

Practical limitations
Implementing Q-methodology is typically quite labour intensive and requires a reasonably long time frame. The two separate stages of interviewing will normally need a significant time gap in-between to allow for analysis of initial results and creation of the statements for the Q-sorting stage.

Use in combination with other methods
Q-methodology might be useful in initial stages of larger-scale group work (citizens' juries and the like) as a means of helping participants to understand the different points of view they may represent.

3.2.6 Delphi surveys and systematic reviews

Definition
The intention of Delphi surveys and systematic reviews is to produce summaries of expert opinion or scientific evidence relating to particular questions. Delphi surveys are essentially a means of synthesising expert opinion rather than a way of uncovering public values or attitudes. Systematic reviews are a technique for robust and systematic literature search and review of evidence, pioneered in health research and more recently applied in the environmental field.

Value concept encapsulated
Both approaches are means of summarising knowledge and hence a survey or review can be conducted to ascertain what is known about any type of values for a given type of good.

Resource/Policy contexts
Both Delphi and systematic reviews can be applied to any issue, and both have been used extensively in health. Generally, the issue will be a fairly precise question; a recent example by the Centre for Evidence Based Conservation at the University of Birmingham is whether wind turbines have an impact on bird abundance (CEBC, 2005). Delphi and systematic reviews may be particularly useful for situations in which the issues are complex and/or specialised, and where there is a perceived need to draw together and summarise a wide range of literature or expert opinion. Where an issue is uncertain and contested, these methods can help decision-makers to understand why the scientific community is divided, and how the current balance of opinion appears to lie.

Practical limitations
Both Delphi and systematic reviews are likely to be time consuming. Delphi may require several weeks to months depending on how quickly experts can reply and how many iterations are required.

Use in combination with other methods
Many other methods require background scientific information as an input, and Delphi/systematic review are suitably "neutral" ways of producing this information. Some applications combine systematic reviews and Delphi, and other methods such as focus groups and interviews, in order to achieve a comprehensive assessment of published evidence and expert opinion. While Delphi and systematic review are not methods of public consultation,

they can be integrated within participatory deliberative methods as a robust and even-handed way of summarising expert knowledge on the issue. For example, the output could be provided to a citizens' jury as background information and as an aid to deciding which expert witnesses should be cross-examined.

3.3 Literature Overview Valuation Methods

This section presents the methodology adapted to provide the overview of the currently available evidence (Section 3.3.1) and the main findings on the basis of this overview (Section 3.3.2). More detailed summaries of the literature for each natural environment or policy context category and the list of references found are presented in Annex 2.

3.3.1 Methodology

The purpose of the literature overview was to discover the extent to which economic valuation methods have been used in practice. The overview does not aim to be exhaustive, since the literature is diverse and fast growing, but instead to illustrate which methods have been applied in the UK and how frequently. In order to make the task of such an overview manageable, the following selection criteria were adopted:

- Literature produced mostly in the last 10 years is covered. Some references that are older than this have been selected where they are seminal examples of a particular application.
- Studies that undertake primary research using the valuation methods are given priority. Some studies that use a mix of methods, meta-analysis[5] or benefits transfer are also included when these add variety or are the only examples in a particular natural environment category in the UK.
- The geographical limit was selected as the UK. Some non-UK studies are included in the overview of the deliberative and participatory methods literature especially when there are no UK applications of a method.
- With regards to the literature on economic valuation methods, studies that estimate the contribution of environment-related sectors (e.g. tourism, abatement technology, etc.) to the general economy in terms of revenues or job creation are not included in this study (as also mentioned above). Moreover, this literature is covered extensively by Defra (2004b).
- Finally, studies that estimate the cost of implementing an environmental policy (e.g. costs of Biodiversity Action Plans) are not included as cost of implementation is not a direct measure of value[6].

Adhering to these selection criteria, both academic literature and grey literature of studies commissioned by policy makers or private companies were reviewed through:

- Online databases such as EVRI (Environmental Valuation Reference Index[7]) and Research in Agricultural and Applied Economics[8] and internet searches;

[5] Meta-analysis is a form of systematic review, which collates research undertaken on a particular topic or issue. For example, it may be applied in an economic valuation context, where estimates of WTP for the same (or similar) good are collected from a number of separate studies in order to derive general relationships between WTP for the good and a number of common explanatory factors.
[6] Note that the cost here is financial cost alone, not the opportunity cost, shadow project or mitigation cost (see Annex 1 for details).
[7] See: www.evri.ca
[8] See: www.agecon.lib.umn.edu/cgi-bin/view.pl

- Eftec's in-house databases constructed for earlier studies including the Benefits Assessment Guidance for the Environment Agency (EA 2002a), recreational studies for the Environment Agency (EA, 2002b), land use studies for the then DTLR (DTLR, 2002) and the Environmental Landscape Features database by IERM and SAC (1999) for Defra;
- Public agency websites including Defra (Economics & Statistics); Office of National Statistics; Environment Agency for England and Wales; Scottish Environmental Protection Agency; Countryside Agency;
- University / department websites including, *inter alia*, the Universities of Cambridge, Reading and Birmingham; and
- Additional references provided during the expert consultation process.

3.3.2 Summary of findings

Economic valuation methods

The vast majority of the economic valuation studies in the literature use stated preference methods; particularly the contingent valuation method as it has been applied for a longer time than choice modelling. The fact that stated preference studies are able to capture all elements of TEV and can incorporate environmental changes yet to occur as well as those already experienced, is probably the major reason for their wider use. Considering the main use of valuation evidence is to assess the value of the potential future changes in current quality and quantity of the natural environment, these advantages of stated preference methods are crucial. There are also a few studies using revealed preference methods and market price proxies. Unsurprisingly, studies using hedonic property pricing are limited to transport and waste management policy areas; those using the travel cost method are limited to valuing aspects of recreation and landscape and those using market prices are limited to marketed goods.

In terms of resource coverage, the literature to some extent seems to reflect academic interests, but is also influenced by policy (particularly landscape and water bodies due to land use and water management policies). The most covered natural environment category is biodiversity (including habitats and species), followed by recreation, air, water quality, landscape, pollution and degradation, the marine environment and soil. This initially seems surprising since biodiversity is a rather complex category, the valuation of which suffers from the limited knowledge and understanding of individuals affected (regardless of what the valuation method is). However, a closer look at the literature reveals that what can be counted under the 'biodiversity' category is largely valuation of habitats and their use and non-use values. There are fewer studies that explore the value of 'diversity' per se (for example, Christie et al., 2004).

In general, economic valuation methods seem to be most widely used when the impact has already been experienced, or when the likely future impacts are known and scientifically well-understood (even if the probability of a particular impact happening is not known, the impact itself can be defined).

Finally, there is a tendency to apply economic valuation methods that rely heavily on analysis of market prices or revealed preferences when the topic is a controversial local issue such as siting of new waste management facilities. While there are also examples of stated preference being used in such contexts, this tendency can be explained by the likelihood of individual respondents reflecting locally politicised and hence strategic views during a survey.

Deliberative and participatory methods

Unlike for the economic valuation methods, the overview of these methods included studies from outside the UK, especially for those methods that have not been widely used in the UK. There is a fair-sized literature on participatory approaches in the management of technological risk, including applications to genetically modified organisms, nuclear waste disposal, and recently nanotechnology. Obviously there are important environmental aspects to all such examples. Indeed, it is characteristic of participatory approaches that they are directed at specific decision contexts which may cross-cut a number of environmental and other areas. Participatory approaches are not well suited to "valuing" a single environmental function independent of context, in the way that economic methods might be applied to estimate values for, say, a specific reduction in air pollutants. Rather, they are applied to holistic questions such as "how should we deal with radioactive wastes?".

The advantage of these methods is most evident when the topic of valuation is an emerging trend in science and policy, where the need for value evidence is for shaping policy before its impacts can be assessed through economic valuation methods.

3.4 Using Value Evidence for Decision Support and Measuring Prosperity

This section briefly describes how the valuation methods outlined in Sections 3.1 and 3.2 are used in decision support methods and as components of alternative measures of prosperity[9]. As with the valuation methodologies, full details of the decision support tools and alternative measures of prosperity are given in Annex 1. Since the most popular approach for using economic value evidence for both of these purposes is benefits transfer, this section starts with a summary of it, with more detail provided, again, in Annex 1.

Table 3.1 summarises the scope for using each economic valuation method in terms of the affected population they cover, their value basis and application in terms of categories of natural environment and ecosystem services. The table is not specific in its coverage of ecosystem services since, as mentioned above, they contribute to the types of goods and services provided by the natural environment categories covered in this study. This also implies the difficulty of valuing ecosystem services separately, again as mentioned above. Finally, while the scope summarised in the table is potentially applicable, the scope of a given valuation study would be determined by the context of the study (e.g. policy question, characteristics of the environment of concern, its current and potential uses etc.) and the availability of (mostly scientific) information about the environmental change in question.

The table excludes deliberative and participatory methods as these could cover the relevant aspects of any natural environment category or ecosystem service. The relevance is determined by the policy question posed. The exception to this are the health-based approaches which, as their title implies, are limited to estimating the health impacts of environmental change.

[9] In fact, only two of the alternative measures of prosperity reviewed use the results of economic valuation in their components – the Index of Sustainable Economic Welfare and Green Net National Product. But Section 3.4.3 holds generalities applicable to other potential alternative measures of prosperity.

Table 3.1: Scope of using economic valuation methods			
Valuation method	**Affected population captured**	**Value basis**	**Natural environment / ecosystem service**
Market price proxies*	Users only	TEV – use values	Marketed products from the natural environment or their market substitutes; all ecosystem services but limited to their contribution to marketed products (e.g. agriculture, forestry, fisheries, genetic information); estimating avoided damage (e.g. from flooding, coastal erosion); their marketed substitutes (e.g. cost of coastal defences, cost of water treatment) and tangible impacts (e.g. cost of illness)
Revealed preference methods			
Hedonic property pricing	Users only	TEV – use values	Landscape, amenities, air quality, peace and quiet, and hence all ecosystem services that provide these
Travel cost	Users only	TEV – use values	Recreation and all hence all ecosystem services that contribute to recreational opportunities
Random utility model	Users only	TEV – use values	Recreation and all hence all ecosystem services that contribute to recreational opportunities
Stated preference methods			
Contingent valuation	Users and non-users	TEV – use and non-use	All natural environment categories and hence all ecosystem services that contribute to these
Choice modelling	Users and non-users	TEV – use and non-use	All natural environment categories and hence all ecosystem services that contribute to these

**: including production function.*

3.4.1 Benefits transfer

Although not an economic valuation method *per se*, benefits transfer (or value transfer) is important since it has the advantage of being quicker and cheaper than undertaking original primary economic valuation research. It is a process whereby information regarding economic value (use and non-use) in one (study) context is applied to a new (policy) context for which an estimate of economic value is required. The simplest type of benefits transfer, unit transfer, refers to using an average value found in one context to another. A more sophisticated approach uses WTP functions and applies the coefficients describing the relationship between WTP and factors influencing it estimated in the study site to data from the policy site. However, most examples of benefits transfer are of the simpler type.

In general, the resource and policy application of benefits transfer is naturally defined by the coverage of prior studies. It is useful especially in the initial stages of planning for appraisal, compensation/liability, economic instruments, and so on, in order to help estimate the magnitude of the value. It has also been widely used to appraise programmes of large numbers of similar projects as seen in the case of water supply schemes within the periodic review process[10].

Finally, note that while, in general as well as in this study, benefits transfer refers to monetary expressions of economic value, the practice of borrowing from previous research to answer the current question is widespread and can also be involve deliberative and participatory methods.

[10] This is a process by which water companies in England and Wales submit business plan containing water supply and quality related schemes to Ofwat, Defra and Environment Agency every five years. The plans are reviewed on the basis of their implications for the environment and water bills.

3.4.2 Decision support methods

Cost-benefit analysis (CBA) is a decision support method which compares, in monetary terms, as many benefits and costs of an option (project, policy or programme) as feasible, including impacts on environmental goods and services. It can, in principle, be applied both ex ante and ex post. Its application to any natural environment category is limited by the availability of the necessary data. The use of CBA for public sector decision-making is recommended by HM Treasury in the Green Book, which provides overall guidance for appraisal of public projects, programmes and policies (HM Treasury, 2003). Perhaps the most important advantage of CBA is that it is designed to target two of the most crucial appraisal questions: "Is a given objective worth achieving?" and if so, "What is the most efficient way of doing this?".

Cost-effectiveness analysis (CEA) is a decision support method which relates the costs of alternative ways of producing the same or similar outcomes to a measure of those resulting outcomes. Notably CEA is equivalent to one dimension of CBA in that it can answer the question of the most efficient way of achieving a given objective, but not whether an objective is worth attaining. This may involve identifying the least cost option or the most effective option. It is important to note the distinction between the two: the former is the cheapest option still capable of delivering a given objective (effectively cost-minimisation), while the latter is the option that gives the highest ratio of a quantified measure of the physical effect or the outcome of that option by its costs (i.e. the most cost-effective). The two, the cheapest and the most cost-effective, options may not be identical. CEA may be employed both ex-ante and ex-post and can potentially incorporate both economic and deliberative and participatory measures of value for quantifying both costs and effectiveness. Where effectiveness is expressed in a mixture of monetary and other units, comparisons can be made if scoring and weighting are applied which could be gathered through deliberative and participatory approaches. CEA may also form part of a ranking exercise in multi-criteria assessment.

Multi-criteria assessment (MCA) is a term covering a variety of approaches which involve: (i) developing a set of criteria for comparing options; (ii) evaluating the performance of each of the options against each criterion; (iii) weighting each criterion according to its relative importance; and (iv) aggregating across options to produce an overall assessment. Most approaches involve some form of averaging weights or evaluations across individuals and use deliberative and participatory approaches, though monetary expressions from economic valuation techniques can also be used within an MCA. Some extensions (multi-criteria mapping, stakeholder decision analysis, most recently deliberative mapping) incorporate MCA within a wider deliberative process, aiming to overcome some of the shortcomings of MCA by harnessing its strengths to enhance stakeholder discussions.

Life cycle analysis, or assessment (LCA), is an analytical method used to quantify all resources extracted from the environment and emissions to the environment are determined, when possible in a quantitative way, throughout the whole life cycle of a product or service. Based on these data the potential impacts to the environment, to natural resources and to human health are assessed (Wrisberg et al., 1997). The intention of LCA is to provide a numerical basis for comparison between alternative methods of achieving a specific function or service, for example, containing and transporting a liquid, or managing municipal solid waste. In general LCA is a site and time-independent tool with no consideration given to when and where emissions take place (Udo do Haes, 1996). However there are moves to introduce site-dependent factors that reflect types of environments and emission situations (Finnveden and Nilsson, 2005).

In addition to the Green Book mentioned above, Regulatory Impact Assessment is also worth a special mention here. While RIA is not a separate decision support method, it is (together with the Green Book) the most powerful driver behind public sector appraisals and hence the need to ensure that the value evidence base about the natural environment is extensive and robust.

RIA requires the analysis (and quantification) of costs and benefits (economic, environmental and social); impacts on small firms and competitiveness in general; and the planning for implementation, enforcement, monitoring and review. It is, in short, a framework of complete assessment of appraisal, implementation and ex-post evaluation. This study is relevant for the appraisal part of an RIA, which can incorporate any or all of the decision support methods (and associated valuation methods) summarised above. In practice, this could lead to the problem of missing value information or values expressed in different units. This is addressed in Section 3.5.4.

3.4.3 Alternative Measures of Prosperity

Typology of different measures

Alternative measures of prosperity generally come in two forms: those aggregated into a single measure, and those in the form of several disaggregated measures. Central to measures of prosperity is the specification of a social welfare function. This function, denoted as *W*, is assumed to be a function of various components, denoted as x_i, which could be specific private or public goods, measures of various types of capital, monetised costs or benefits, social indicators, etc.:

$$W = f(x_1, x_2, \ldots x_N)$$

An aggregated index is essentially an additive social welfare function of the form:

$$W = \sum_i \alpha_i x_i$$

where α_i are weights attributed to the various components. It should be remembered that any measure of prosperity which has an explicitly described mathematical form makes implications about how different components act as substitutes for each other (see Section 2.5.2 for how this relates to the measurement of progress towards sustainable development). With a set of disaggregated indicators, the form of the social welfare function is not estimated at all. Therefore, a set of disaggregated indicators makes no explicit or implicit statement about the relative contributions of different components to welfare, or about how different contributions may act as substitutes for each other.

Four different measures of prosperity are reviewed in this section and in the fiches in Annex 1. These are: the Index of Sustainable Economic Welfare (ISEW); Defra's Quality of Life indicators; the UN's Human Development Index (HDI); and 'Green' National Product along with a related concept, 'Genuine Savings'. Table 3.2 categorises the four different measures of prosperity reviewed according to the type of valuation method encapsulated and the level of aggregation.

It has not been possible during the course of this report to identify how and where any of these indicators have actually been used in a decision-making context. To some extent the usefulness of a measure of prosperity would ultimately be gauged by its ability to guide the necessary action needed. This ability is not yet apparent for the measures reviewed.

Table 3.2: Typology of the different alternative measures of prosperity reviewed		
Valuation method / Level of aggregation	**Mixed Monetised and Other Components**	**Monetised**
Aggregated	Human Development Index	ISEW Green National Product (and Genuine savings)
Disaggregated	UK Sustainable Development Indicators	n/a*

**: Economic valuation tends to be monetised which allows for aggregated measures. However, there could be satellite accounts which show conventional GNP and monetary expressions of environmental adjustments separately, e.g. eftec and IEEP (2004).*

Human Development Index

The UN's Human Development Index is a measure of development designed for the purposes of inter-country comparison (rather than for assessing an individual country's progress over time). It is calculated annually for roughly 150 countries, and is intended as an alternative measure of development progress to GDP, mostly for developing countries. It comprises of the averaged sum of three separate components: per capita GNP adjusted for purchasing power parity, average life expectancy at birth, and an educational index containing information on enrolment rates and literacy. However, raw data are not used, and the components undergo some modification; in particular, GNP is adjusted to account for the diminishing marginal utility of income[11].

Green National Product and Genuine Savings

Gross National Product (GNP) focuses on flows within a period, and though it does include investment, it does not take into account depreciation or depletion of human, social or natural capital. Green Net National Product (gNNP) is a modification which attempts to include depreciation in both manmade and these other forms of capital. Genuine Savings is a similarly modified savings figure and is intended to be an indicator of progress towards sustainability. It is equal to Green Net National Product minus consumption. The natural capital encapsulated by these measures tends to be defined by the availability of physical impact data and economic value estimates in monetary units, and often includes changes in renewable and/or non-renewable resources as well as damage done to natural capital from pollution.

Index of Sustainable Economic Welfare (ISEW)

The objective of the ISEW is to provide an alternative measure of economic welfare to GNP which is responsive to the impact of environmental and social factors on welfare, such as household labour, natural resource depletion and urbanisation. The ISEW takes personal consumption expenditures as its core measure of welfare, but then adds or subtracts numerous other monetised components representing other contributors or detractions from welfare (e.g. services from streets and highways, costs of air pollution). Personal consumption is adjusted by a distributional factor in order to account for the fact that an extra unit of consumption for a wealthy person adds less to overall welfare than an extra unit of consumption for a poor person. The ISEW is presented on a per capita basis. Economic valuation methods are required to provide measures of monetised non-market costs and benefits.

[11] *Diminishing marginal utility of income* describes the observation that an additional pound of income tends to increase utility less for wealthier people than for poorer people.

UK Sustainable Development Indicators

The primary purpose of the UK Sustainable Development Indicators is to monitor and report on progress towards sustainable development in the UK. The theoretical basis for the indicators is relatively simple compared to the other measures of prosperity. There are 68 indicators, twenty of which are labelled "UK Framework Indicators", shared by the UK Government and the devolved administrations in Scotland, Wales and Northern Ireland (SDU, 2005). The indicators are a recent refinement and replacement for the set of 147 UK Quality of Life indicators detailed in SDU (1999).

Some criticisms of alternative measures of prosperity

According to Ott (1978): "*Ideally an index or indicator is a means devised to reduce a large quantity of data down to its simplest form, retaining essential meaning for the questions that are being asked of the data … In the process of simplification, of course, some information is lost. Hopefully, if the index is designed properly, the lost information will not seriously distort the answer to the question,*" (or, more importantly, the decision-making process). In comparing different measures of prosperity, therefore, it is important to bear in mind that all methods will have their disadvantages.

Some key findings of the review of alternative measures of prosperity are that while GNP is undoubtedly a problematic indicator of economic progress, as discussed in Section 2.5.2, the alternative measures of prosperity reviewed bring their own problems. These include:

- Severe data problems when incorporating certain factors which contribute towards or detract from welfare. This is particularly true for the Index of Sustainable Economic Welfare, which is heavily based on certain components and assumptions which can only rarely be empirically verified or measured, and in the case of some assumptions do not have any empirical basis at all. This partly reflects the difficulty and expense of conducting frequent research projects to monetise environmental costs and benefits, noted throughout this report. However, there are obvious doubts whether an index incorporating many assumptions lacking in empirical justification is useful in measuring economic progress.
- Confusion of signals for decision-making. A measure of prosperity which aggregates large numbers of factors controlled by different policy areas into a single number may confuse messages about where policy effort and resources could be most effectively deployed.
- Sometimes arbitrary implicit assumptions about substitution between different components. This is best illustrated through the Human Development Index. A 0.01 increase in the index could mean, *ceteris paribus*: a 1.5% improvement in adult literacy, a 0.6 year improvement in life expectancy, or a 6% increase in GDP. It is not clear whether these really are outcomes of equivalent desirability in terms of development.

Future research on alternative measures of prosperity could benefit from consideration at the design stage of how the limited resources available for collating and processing information should be allocated in order to most effectively inform policy-making.

3.5 Discussion

This section discusses uncertainty and irreversibility which affect all valuation and decision support methods; particular issues related to the appropriateness of benefits transfer and issues surrounding the comparison of costs and benefits within the context of a Regulatory Impact Assessment.

3.5.1 Uncertainty

The mainstream approach in policy and decision-making is to deal with risk using probability distributions for outcomes and calculations of expected values. In some instances weightings are used to reflect risk aversion, however it is widely acknowledged that many of the problems we face do not involve "risk" (a term applied when the probabilities of different outcomes are known), but rather "uncertainty" (instances where probabilities associated with different outcomes are unknown).

The existence of scientific uncertainty rather than risk is particularly important for environmental changes over the medium to long term, and in the potential environmental impacts of new technologies such as GMOs and nanotechnology. However, uncertainty is also embedded in our understanding of how ecosystem services are provided currently, how they affect each other and, most importantly, how they respond to changes. Although to some extent it can be possible to put bounds on uncertainty based on previous experience, there can also often be uncertainty in the sense of totally unexpected outcomes ("unknown unknowns"). Such uncertainty affects all types of valuation methods and any valuation method can only be as good as the available information.

With regards to economic valuation, market proxies and revealed preference methods can only investigate the economic values of current or previous known changes (or at least once the changes become known). This is, to some extent, limited by the ability of science to explain the change. But so long as change can be defined, uncertainties about mechanisms that bring about the change will be less relevant for valuation than they are for designing the actions to mitigate the change or avoid future repetition. For example, the economic costs of groundwater contamination can be estimated so long as we know what the contamination is and its expected impact (risk and hazard) on ground and surface water bodies and soil if relevant. The mechanism through which contamination spreads and could actually affect the users are more relevant for designing remediation actions.

Stated preference methods can present respondents with changes that are yet to be experienced. As discussed in Sections 3.1.6 and 3.1.7, choice modelling is better at dealing with uncertainty about future changes. This is because more of the likely combinations of outcomes can be presented to respondents. For example, take the case of revising funding options for agri-environment schemes and their impacts on landscape. Contingent valuation can present a limited number of these options before the exercise becomes too difficult for respondents to take part in, or the samples needed become too large to warrant a study. Choice modelling, on the other hand, is more time and cost efficient in presenting a larger number of funding options and their landscape impacts, i.e. their attributes. This allows for a larger number of potential outcomes to be valued and increases the chances of the valuation results remaining relevant when the option selection is finalised and actual impacts are experienced.

Ecological economics approaches the issue of uncertainty somewhat differently by identifying the conditions under which the standard expected value trade-off approach (as adopted by economic valuation) is inappropriate for decision-making. These conditions include high uncertainty, potential irreversibility (see below), irreducibility, and high importance of environmental services. Under these conditions, ecological economists advocate a precautionary or minimum regrets approach aiming for ecosystem health protection. Research and policy should aim to reduce uncertainty; technological development is encouraged but not relied upon as a prospective panacea. Decisions should incorporate safeguards against potentially catastrophic effects.

Precautionary approaches will have lower (risk-neutral) expected value than an approach that aims to maximise expected value, but there will generally be less chance of very bad outcomes

or unpleasant surprises. So the key issues are how much expected value it is worth giving up in order to achieve greater security, and what our ethical obligations (e.g. to future generations) imply in terms of this trade-off. By definition, of course, we cannot know exactly what level of security we are "purchasing" via a precautionary approach, because under conditions of uncertainty we do not know the probability distribution of outcomes.

With regards to deliberative and participatory methods, uncertainties can be presented to participants as they are since a large part of the objectives of these methods is to learn how people think about all issues involved (including how to act in the face of uncertainty) rather than incorporate uncertainty in their consumer behaviour or in expressing their preferences. In methods that do not involve participation (e.g. health-based approaches) uncertainty can be presented as constraint on actions within models and/or dealt with through expert judgment.

Decision support methods are more flexible in dealing with either type of uncertainty. Sensitivity analysis should be undertaken routinely for CBA, CEA and MCA. In fact, guidance such as the Treasury Green Book (HM Treasury, 2003) explicitly requires sensitivity analysis to be undertaken. Sensitivity analysis allows for costs and benefits (or effectiveness) to be compared using different assumptions about the key parameters. At the very least, confidence intervals as well as best estimates for costs and benefits should be used. More advanced applications could use iterative programmes for Monte Carlo Analysis, even though this requires knowledge (or at least assumptions) about the distribution of probabilities.

Decision-making tools such as payoff and regret matrices can also be used. These involve re-running the decision support analyses using the assumptions of different states of the world (without a probability associated to them) and then comparing the outcomes (e.g. net present value, cost-effectiveness ratio, multi-criteria results). There are decision criteria that can help with this comparison. For example, the "maximax" criterion is for risk-neutral or risk-loving decision-makers and involves selecting the option that maximises the potential outcome. Here, for each option, the maximum outcome possible is determined and among these, the option with the highest possible outcome is chosen. There is also the "minimax" criterion which is for risk-averse decision-makers and involves selecting the option that minimises the potential loss or regret (of making the wrong decision under uncertainty). Here, for each option, the minimum outcome possible is determined. This represents the worst possible outcome if that decision option were chosen. From these minima, the maximum payoff is chosen, or in other words, the least bad amongst the bad outcomes. More advanced applications of these tools is within the realm of the Game Theory.

All valuation and decision support methods require a clear and concise definition of the environmental quality and quantity in the baseline and change as a result of a policy decision or economic activity. This, in turn, requires close cooperation between experts of all related disciplines especially at the initial formulation of the valuation context. Nevertheless, while we may be able to reduce uncertainty through better science and economics, valuation, in general, cannot offer a full "solution" to the problem. Uncertainty is something we have to live with.

3.5.2 Irreversibility

Problems with uncertainty are compounded by irreducibility and irreversibility. The interconnectedness of different ecosystem goods, services and functions limits the extent to which environmental impacts can be broken down into constituent parts for valuation and decision-making purposes. And irreversibilities and thresholds may mean that it is not possible, or extremely difficult, to reverse decisions which prove to be bad ones when uncertainty is resolved. According to Limburg et al. (2002): "*Ecosystems are complex, nonlinear systems that are only metastable: that is, we cannot predict precisely where the … shift from one stable state to another will occur, nor can we predict the magnitude and direction of the change".*

For this reason, caution is needed in applying valuation to contexts where the proposed change might surpass an (unknown) threshold, causing an irreversible shift to another state.

As mentioned in Section 2.2, economic valuation is of most use when valuing small, marginal changes in environmental goods, rather than larger changes which might transgress an ecological threshold. This is partially in recognition of the non-substitutability of environmental goods in their entirety. However, it is acknowledged that economic valuation reaches its limits when a proposed change might cause an ecosystem to change from one state to another which is qualitatively quite different, as opposed to incremental changes between qualitatively similar states. In other words, economic valuation is only usefully applied when "*the margins of choice are not at the frontier of basic species and cultural survival*" (Limburg et al., 2002).

3.5.3 Appropriateness of benefits transfer

As also mentioned in Section 3.4.1, the notion of benefits transfer is, at first glance, an appealing concept. Certainly the 'value for money' property, in terms of both time and effort spent, is desirable. However, expediency must be traded off against fundamental questions concerning the accuracy of benefits transfer.

The simplest unit benefits transfer approach implies that preferences for the good valued in the original valuation study (the 'study good') are an adequate reflection of preferences for the good which needs to be value (the 'policy good'). However, there are a number of reasons why preferences for the two goods might differ, including (Bateman et al., 2000):

- Socio-economic characteristics of the affected populations at the study site and policy site;
- Physical characteristics of the policy and study goods;
- Differences in the quality and/or quantity changes of policy and study goods that are valued; and
- Availability of substitutes at each site.

Fundamentally, the benefit transfer approach can only be carried out if a suitable valuation study exists which is a suitable match to the policy good context. It is useful to have a number of suitable valuation studies which match the policy good context, in order to provide a range of results and enable key sensitivities in the value transfer process to be identified and accounted for. Benefits transfer is at its simplest when both the affected population and the impact of the policy change are identical at the two sites; for example, a tonne of carbon dioxide emitted (or sequestered) has the same potential to affect global climate regardless of its location.

The more sophisticated adjusted WTP and function transfer approaches attempt to account for these factors by adjusting WTP estimates for socio-economic and other factors. However, this is dependent on the information relating to these factors being gathered during the original study. For example, if it is thought that the average length of time of residency in a region might be a significant determinant of the value placed on a good, this cannot be taken into account in the benefits transfer process unless it is known for both the study good and policy good. Benefits transfer is most easily achieved when clear econometric analysis has taken place in the original study involving a wide range of factors which may or may not be determinants of value, and when the relative effects of these factors have been made explicit in a regression model.

The various valuation methodologies lend themselves with varying degrees of success to benefits transfer. Transferability of values derived from production function are likely to be limited, since the estimates of consumer and surplus are based on the specific features of the final good market and the underlying factor input relationships and production and cost functions. Although hedonic pricing studies for the same environmental impact in different

housing markets tend to reveal similar result, these should not be transferred across markets without taking into account demand and supply factors in those markets. Transferability of results from the travel cost and random utility model methods will depend on an assessment of the similarity of the 'study' site and the 'policy' site for which a value is required and similarities between type and number of visitors.

With respect to stated preference methods, transferability depends on the degree to which the simulated market, i.e. the good and the change in its provision as well the socio-economic characteristics of sample population, constructed for the original study corresponds to characteristics of the 'policy market'.

As the need for economic value evidence increases, the application of benefits transfer also widens bringing with increasing concern about its robustness. However, the evidence from empirical assessments of benefit transfer is inconclusive as to the relative accuracy of unit and function transfer approaches. Moreover, the robustness of the transferred values (whichever approach is used) is impossible to know unless the transferred estimates are compared to the results of original research in the same location and context. Instead, the best that can be recommended is to ensure sufficient similarity between the environmental goods and services, the environmental change, the affected population and other factors likely to influence the value estimate.

As the above discussion implies, benefits transfer is not a substitute for original research. In fact, as environmental conditions change, the definitions of the 'current situation' used in the existing studies become outdated requiring new studies to fill the gap.

3.5.4 Comparison of costs and benefits within RIA

The decision support methods summarised in Section 3.4.2 and detailed in Annex 1, with the exception of life cycle analysis, involve listing, analysing and comparing costs and benefits[12]. This poses two potential problems in practice: (i) there may be values for some costs and benefits and not for others; and (ii) the available value estimates or expressions could be in different units (mainly monetary and non-monetary). These problems could be most acute in the context of a Regulatory Impact Assessment (RIA) which requires the simultaneous consideration of economic, environmental and social costs and benefits.

For economic impacts, values are likely to come from actual markets and predictions about changes in these. For social impacts, values could come from deliberative and participatory methods (e.g. health-based approaches for health impacts, survey approaches for effects of policy on crime) and economic methods (e.g. calculating cost of illness using market price proxies and willingness to pay estimates for intangible impacts on health or crime).

With regards to environmental impacts, RIA requires analysis of the impacts of a policy on greenhouse gas emissions, vulnerability to climate change, air quality, waste management, landscape and townscape, water quality and quantity, flood risk, habitats and wildlife and exposure to noise. Both economic and deliberative and participatory approaches can be applied here – though if monetary comparison of costs and benefits is required, economic methods take precedence.

If the policy and its impacts are deemed to be large enough, primary research may be commissioned. Even in primary research, it may not be possible to present all of the impacts to samples of the affected population (e.g. in group approaches or stated preference surveys) due to the scientific uncertainties surrounding the impact, the unfamiliarity of the individuals with

[12] Here it is worth recalling that a cost is anything that detracts from human welfare and a benefit is anything that adds to it.

particular impacts, and cognitive, time or budgetary limitations. However, if available value evidence is to be used through benefits transfer, the practice in general is to estimate each impact type separately and aggregate them later. This is because it is more likely to find previous studies (using any method) that have examined similar impacts in different policy contexts than to find studies that examined the same policy context in its entirety.

In short, whichever approach is chosen, the above mentioned problems of incomplete or differently expressed value evidence is inevitable. The implication of both problems is the same: how do we reach a recommendation for a policy if we do not have complete or uniform expressions of costs and benefits?

There are no hard and fast solutions to this problem. In fact, the RIA guidance on this issue is limited to: "You should present the costs and benefits in a summarised form. This allows the different options to be easily compared. Using a summary table may be the most effective way to do this" (Cabinet Office, 2006). Two approaches that go beyond this could be mentioned.

The first approach would be to convert different expressions into the same unit by scoring and weighting different impacts. Impacts for which we do not have value estimates can also be scored and weighted. Scales of scores or impact categories such as slight/moderate/high positive or negative impact or likelihood of impacts happening such as 'not likely', 'very likely' can be used. Scores and weights can be determined by the experts undertaking the analysis (e.g. the new Approach to Transport Appraisal, www.webtag.org.uk, provides scoring guidance), by groups of experts (e.g. through a Delphi technique) or by representatives of the affected populations (e.g. through group based and survey approaches). While this approach could satisfy the desire to reduce all costs and benefits to a single number, two caveats should be mentioned. First, the scores and weights should be in line with the relative values of those costs and benefits already quantified (e.g. if a given impact is associated with a higher economic value compared to another, further weighting should not change this). Second, this approach should not be at the expense of transparency and the list of costs and benefits prior to scoring and weighting should also be presented.

The second approach also involves comparing costs and benefits expressed in different units, but instead of doing this through any of the ways described above, it leaves the judgment to decision-makers. The decision is simple if the comparison of both monetary and non-monetary costs and benefits tell the same story: (i) proceed with an option if its monetary benefits exceed monetary costs and the non-monetary indicators are judged mainly to be positive; and (ii) reject an option if its monetary benefits are less than monetary costs and the non-monetary indicators are judged mainly to be negative. The decision is not as clear-cut if monetary and non-monetary costs and benefits tell different stories (e.g. if monetary benefits exceed monetary costs but non-monetary indicators are judged mainly to be negative or vice versa). In this case, judgment would be needed to decide whether the decision should be taken on the basis of the comparison of monetary costs and benefits or non-monetary indicators. This, in turn, would depend on what type of impacts fall into either category. For example, if all the significant impacts are already expressed in monetary units, the decision should be based on the comparison of monetary indicators or vice versa.

Spending time and resources to improve the value evidence is a decision requiring analysis in itself. Such effort should be proportionate to the scale of the policy and its impacts.

4. Consultation

This section summarises the method and the main findings of the policy makers consultations through electronic questionnaires and workshops. A detailed summary of these consultations is reported in Annex 3 along with the summary of the findings of a consultation of experts on the accuracy of the methodology fiches presented in Annex 1.

4.1 Policy Consultation

4.1.1 Method

A detailed electronic questionnaire was prepared by the study team and sent by Defra to 79 policy makers in Defra, other public sector agencies and NGOs working in the environmental policy area in December 2005. In the following six weeks or so, we received responses from 23 policy makers – a response rate of 29%. However, this is a misleadingly low response rate since some consultees answered on behalf of several colleagues as can be seen in Annex 3.

4.1.2 Summary

Respondents: The responses indicated that consultees had a wide range of roles and experience; some were economists using economic valuation techniques on a regular basis; others were social or natural scientists.

Sources of value information: Respondents drew on a wide variety of value information from governmental organisations, academia, industry, non-governmental organisations, transnational bodies, the public and the internet.

Gaps in the value information: Respondents were acutely aware of the gaps in information which they faced in trying to collate evidence and evaluate different options. However, they were also aware that data gaps could not prevent decisions from being made. The main reason given for data gaps was the expense and difficulty of commissioning original valuation work. Commercial confidentiality and previous lack of policy focus on a particular area were also given as reasons for data gaps. Some respondents also mentioned that, rather than information simply not existing, there was sometimes a lack of awareness of where it could be found, something that perhaps a greater use of central information portals could assist. Respondents dealt with data gaps by using the best available evidence, consultation or "informed guesswork"; and by applying sensitivity analysis.

Use of consultation: In terms of their own consultations, respondents were most likely to consult with immediate colleagues, (other) government agencies or departments, industry groups and environmental NGOs. Most consultations involved discussions relating to the value of the natural environment.

Concepts of value: Respondents' definitions of 'value' ranged from those which reflected economic theory definitions (encapsulated by "willingness-to-pay") to a very general sense of the "worth" of the natural environment. Many respondents mentioned an "innate" or "intrinsic" value. Many mixed these different concepts. Some responses mentioned the inputs to production of the natural environment (e.g. pollination), or the provision of resources necessary for economic activity. Others gave a heavy weighting to the amenity benefits of the natural environment ("providing an environment for recreation and enjoyment of nature"),

highlighting "quality of life". Some respondents thought of value as indicating a signal for allocating resources for protection ("a scale of worth for prioritisation").

Most respondents saw value as both a monetary and an ethical concept. To some extent this depended on respondents' interpretation or prior knowledge of monetisation, with some respondents indicating that to them money is simply a common metric. Some respondents saw "monetary" as referring only to market values; these respondents tended to weight the "ethical" or "quality of life" side. Other respondents saw the ethical concept as "important" but recognised that monetary value was useful when trying to assess the relative contribution of different environmental assets to welfare. Respondents who undertook regular CBA or RIA appraisals answered more in the context of those appraisals, i.e. in strictly monetary terms.

Value evidence: Many respondents said that they required information related both to how individuals value different environmental benefits and to how preferences are expressed in real financial transactions. Most said that it was not easy to obtain the information they required; some said that information once acquired was often incomplete. Most respondents did not undertake any original data collection themselves, but used the work of researchers.

Respondents recognised many problems with accuracy of information, but indicated that they would continue using whatever information was available until better information or techniques for gathering information was available. It was generally deemed that some inaccurate information is "a lot better than nothing", and that there are "agreed conventions" for eliciting results which had been "collectively agreed upon as fit for purpose". Value information was considered "probably less accurate" than information on physical impacts. Some respondents found it difficult to present valuation estimates to "sceptical" policy colleagues; it was helpful not to make too many claims on the data that do not stand up to scrutiny.

A few respondents indicated a great deal of familiarity with benefits transfer, and for some respondents its use was unavoidable, due to limited resources and demands for valuation information. Some felt that transferring data sometimes gives rise to problems: e.g. the fact that "values [found in valuation studies] are usually average not marginal ones which reduces their usefulness". Assumptions used in transfer must be clearly outlined.

Some respondents felt that there are "obvious advantages" to the money metric, such as ability to aggregate, and that monetised benefits "hold more weight" in discussion. One respondent wrote that he saw monetary valuation as usefully objective "otherwise non-financial values are likely to be given implied values by politicians to justify their particular prejudices". Others felt that they would be more comfortable seeing value expressed in a variety of different ways, and that there is a danger in allowing value to be too narrowly defined in monetary terms. Monetary valuation was considered problematic in areas where the physical causality is poorly understood, such as with ecosystem services.

Opinions were tilted towards scepticism on the value of expert opinion. While some respondents said that expert opinion is "complementary" or "important but different", others said that it lacks "democratic foundation" and should be limited or used as a last resort. Expert opinion was of most use on very detailed, technical issues.

Opinions on environmental valuation and decision-support methods: The techniques most frequently cited as useful were cost-effectiveness analysis and particularly cost-benefit analysis (CBA), because it "allows one to look at the whole picture", and is "important for making a case for funding". However, CBA is sometimes not possible because of "problems in obtaining benefit values or in identifying realistic opportunity cost scenarios".

Generally, respondents felt that the use of valuation information supported and enhanced the decision-making process. However, respondents also pointed out that it is just one factor, and that other political considerations sometimes dominate.

Respondents' ease with which they can communicate value information depends on how familiar their target audiences are with the valuation methods. Some found their organisation's "economic literacy" to be high, and consequently that communication was not problematic. CBA was generally understood by most people and "decision-makers are usually willing to accept the use and findings" from CBA. However, other respondents noted difficulty in explaining and convincing non-economists, and also a certain degree of scepticism.

Furthermore, it was not always understood by the layman "why a job is counted as a benefit in an economic impact study but a cost in a CBA study". It was felt that the techniques produce results that are context-specific or partial, and that it is important for the decision-makers to be aware of such caveats.

The future: Most respondents felt that the use of valuation was likely to increase in the future, because of pressure both to deliver environmental public goods and to scrutinise and justify environmental investments using evidence were increasing. One respondent noted there is "increasing pressure we are under to justify in quantifiable terms the regulatory burdens that we impose on others in order to secure environmental benefits". Some specific hopes for future improvement were:

- More studies on valuing the *quality* of change in natural resources;
- Increased understanding and validity of benefits transfer techniques;
- Developing methodologies and information for robust aggregation of values;
- More information on the relevance of valuation data for sustainability; and
- Developing a research agenda to get natural scientists to measure ecosystem services in physical units that economists can attach monetary values to.

4.2 Policy Workshops

4.2.1 Method

Two workshops were held on the 1st and 2nd February 2006. These were attended by 20 policy makers, in total, from different departments within Defra and other public sector organisations and also NGOs. The workshops were facilitated by a professional facilitator and notes taken were circulated to the participants for their comments. Only three responses were received before the submission of this report.

4.2.2 Combined summary from both workshops

Policy questions of relevance: Broadly it can be said that there were two areas of focus:

- Questions where valuation evidence was wanted in order to influence and/or understand a specific natural environment issue, and where methods are used to "get the natural environment further up the agenda"; and
- Questions related to the interpretation of the valuation evidence such as the limitations of different methods (e.g. consideration of issues of equity, access, social welfare instead of the economic activity encapsulated by GDP etc.).

Types of value evidence: A wide range of different types of evidence were drawn upon, indicating that valuation evidence is only one part of the wider evidence-gathering process. The types of evidence used can be divided into four groups:

- *Economic:* valuation, modelling, business costs;
- *Social:* stakeholder surveys both of general public and site/issue specific stakeholders, information on behavioural change, socio-economic information (indices of deprivation);
- *Scientific:* health impact assessment, environmental science data, and
- *Legal:* what might be legally possible/appropriate, international agreements, etc.

Some of the valuation methods covered in this study could be used for more than one of these groups.

Sources of value evidence: A wide range of sources are drawn upon by policy makers, including field research, data transferred from valuation research, expert committees, expert opinion, public opinion, NGOs and industry. There was some discussion over the relative robustness and credibility of various sources of evidence.

Gaps in value evidence: Gaps identified at the workshops refer not only to the availability of evidence but also to difficulties in communicating this evidence. Particular issues mentioned were:

- A lack of evidence for dealing with risk and uncertainty. A recurring theme was the emphasis on how if useful economic valuation is to be carried out, it is vital to have detailed environmental data, which often do not exist.
- Lack of monetary value for many types or specific instances of natural environment, due to time and cost of valuation studies.
- Monetary value evidence which does exist for a natural environment may not be able to be tailored to a specific instance or decision-making issue.
- The importance of communicating where evidence is lacking, in concurrence with communication of existing evidence.
- Constraints on the context in which the information is being generated. This relates to the time constraints under which evidence is to be produced and used, together with potentially poor access to information encountered by some participants.

Role of value evidence: Because of the variety of policy questions and evidence needs, different types of valuation information have to be used in combination (e.g. to use qualitative data in its own right and to set the context for the quantitative data). The benefits of using valuation information were considered to be: greater transparency over whose values are being applied in the policy process; making trade-offs explicit; finding evidence which could be consistently applied across a range of projects; and a sense that if something was explicitly valued, it would be more likely to 'count'.

Discussion in workshops also acknowledged that there is a variety of dimensions to the concept of value (e.g. health, social inclusion, economic efficiency etc.); that there are different methods that could help with understanding these and that both the population whose values are measured and the audience this information is to be presented should be considered when determining the approach to valuation. Transparency of valuation methods and accessible explanation of complex methods were also crucial in communicating the value information successfully and appropriately.

Use of value evidence: Participants felt that official guidance and recommendation supported the use of economic valuation information. In terms of the difficulties in using valuation information, the main points were:

- Difficulties due to the economic valuation methods: difficulty with benefit transfer and availability of data, dealing with intrinsic values, dealing with non-market values and the variability around results from different approaches (WTA and WTP).
- Difficulties due to the perception of the economic valuation methods and how they are regarded by other disciplines: suspicion of methods from different disciplines and concern over the sense that only if something is monetised will it "count".
- Both of the above contribute to difficulties in communicating valuation methods and results. Particularly mentioned were: communicating the caveats which accompany a technically complex valuation methodology; and combining quantitative valuation information with information from methods which are not comparable.

However, it was suggested that although the methods are complex, because there is a method there is an element of transparency in the process. The use of qualitative and quantitative evidence collected using scientific and deliberative and participatory methods could also be used to provide a context for the valuation estimates and this should also make the estimates clearer.

The future: Opinions diverged on likely future trends. Some participants felt that a move away from monetary values was likely; others that economic valuation was increasingly likely to be used for natural resources which it had not previously applied to, such as ecosystem services; and also to provide evidence for an increased drive to justify further environmental regulation.

Others linked trends in valuation with wider environmental or political trends. First, it was expected that climate change and other environmental problems will become worse, making environmental policy and decision-making more important and difficult. Despite this, however, some felt that environmental considerations will not be as important in future as it's been in the past if the current public finance policy reviews at the UK and EU levels, which do not give sufficient weight to environmental policy, are indicative of future trends.

Implications for the provision of value evidence: There needs to be greater communication between those using value evidence and those involved in providing it through research, in particular with consideration of providing evidence which has the flexibility to be used in several contexts, in order to overcome current time and budget constraint problems. Knowledge and use of non-economic valuation methods is not likely to increase without official guidance.

The importance of valuation information is likely to increase. With a realisation of the scarcity of resources, more aspects are being valued - partly to enable the trade-off between different aspects of the natural environment, and partly to justify the role of the natural environment alongside other policy areas (e.g. education and employment).

5. Conclusions and Recommendations

This study collated and assessed the research on the value of the natural environment; provided guidance on economic and deliberative and participatory valuation methods and how the value evidence can be used in decision-making (including measures of prosperity). We also consulted policy makers to assess their current experience with using value evidence and opinions about future research needs.

This section concludes the report by distilling the findings in terms of which value information to use (Section 5.1), where the gaps are (Section 5.2) and by providing recommendations for future research to close these gaps and to meet the needs of future policy (Section 5.3).

5.1 Which Value Information to Use?

As was expected at the outset of this study, the literature and consultations did not dispute the need for value evidence. In addition to expanding the evidence base for policy making, one of the key advantages in valuation methods is the explicit and relatively transparent way in which they bring values into the decision-making process. Of course this can be overstated: it is possible to manipulate both economic and deliberative and participatory valuation methods and they are affected by lack of or uncertainty surrounding scientific information. And it may be difficult or impossible for people to control the ways in which their expressed economic values, or their contributions to participatory research, are interpreted and used. Nevertheless, if the alternative is for priorities to be set with only a rough idea of what others' values are, then it seems clear that some form of valuation effort is likely to be an improvement on none at all. Therefore, the first question here in the concluding section is not 'why we should use value evidence' but which value information to use.

The overall messages arising from all parts of this research – the literature review, the expert consultation and the policy-maker consultation and workshops – are that there are a variety of dimensions to the concept of value (e.g. health, social inclusion, economic efficiency etc.) and hence there are also different methods that could help with understanding these. Therefore, there is no one type of evidence that is regarded as 'best' for all contexts.

All valuation methods have a place, and it is important to be aware of the strengths and limitations of each, the type of output they can produce, and use them in combination if necessary. While we made some recommendations as to the suitability of individual valuation methods for the valuation of different categories of the natural environment and ecosystem services in Section 3, the choice of the most appropriate type of value or valuation method is highly influenced by the specifics of the context of the intended use of the value evidence. This is why it is difficult to make prescriptive recommendations about which value concept or valuation method to use in which context and it is more useful to look at the factors that affect this choice:

- The overall role for the value evidence;
- The specific policy questions asked;
- The audience for the value evidence;
- Availability of supporting information; and
- Inherent characteristics of the valuation methods.

5.1.1 The overall role for the value evidence

The overall role for the value evidence (regardless of the method used to collate it) is one of supporting decision-making rather than making the decision based on value evidence alone. As the discussion below shows, the choice is not a case of either economic or deliberative and participatory methods, but using a combination of these as the context of the decision requires. The recommendation is to consider economic valuation methods as tools aimed at helping decision-makers with efficiency and effectiveness issues and comparing trade-offs or costs and benefits directly. On the other hand, deliberative and participatory techniques can be better used in formulating a policy question, considering what should be done in a particular policy area, and setting the context for economic valuation methods.

So the goals of economic and deliberative and participatory valuation methods can be seen to be quite different, and in many senses complimentary. For example, they can be used in combination (e.g. monetary values and scores for measure of value); consecutively (e.g. options short-listed by a technical or scientific assessment as feasible can be prioritised using monetary values) and side-by-side (e.g. extensive participatory focus groups can be used as part of stated preference surveys).

5.1.2 The specific policy questions asked

Valuation methods are used for a wide range of purposes, including policy appraisal, setting priorities and influencing policy agendas by demonstrating the importance of the natural environment and links between different policy arenas, setting targets, providing evidence of benefits or costs, and mapping distributions of gains and losses.

Economic valuation methods offer an extremely powerful tool for eliciting human preferences about environmental goods and services in a format which is ideal for comparison with other monetary data relating to preferences, such as market values and costs of environmental policy. In addition, economic valuation techniques might be particularly useful when designing policies that target the failures in the market such as environmental taxation and pricing policies or whether a subsidy for a particular activity is commensurate with the benefits enjoyed.

But they can be complimented by deliberative and participatory methods, especially when wider preferences/choices are of interest. On their own, these methods are good for deliberating and specifying objectives, but can result in the trade-offs inherent in decision-making being left as implicit, rather than made explicit.

5.1.3 The audience for the value evidence

From the policy maker consultation and workshops it was clear that the choice of valuation method is dependent not only on the type of evidence each method can collate, but also on the culture within an organisation and the expectations of their target audiences. The *raison d' être* of some of the organisations are based on economic analysis and policy makers within these organisations have higher needs and expectations for the estimates from economic valuation methods than from deliberative and participatory methods. However, understanding the theory behind economic valuation methods remains something of a niche skill necessary for not only undertaking such research but also for communicating the estimates.

Some working with valuation evidence do have ethical qualms about relating the value of the environment in monetised terms, and it would be a shame to fail to engage such people through misunderstanding of the purpose of monetisation. Familiarity with any and all of the

methods examined is, of course, not a permanent state of affairs, and can be improved upon with guidance and training.

5.1.4 Availability of supporting information

Information from valuation studies is used alongside a wide range of other information, for example legal advice, scientific data, environmental impact assessments, quality of life information, information on behavioural responses to policy, and so on. Such information comes from field surveys, expert opinions, secondary data, public opinion data, in addition to formal valuation or deliberation exercises.

The availability of especially scientific or impact data will typically be a limiting factor for the use of any valuation method: any method will produce results only as good as the information that goes into it. As discussed in detail in Section 3.5, the level of uncertainty about impacts could influence the choice of valuation methods since some are better at collating value evidence under uncertainty than others. Equally important is the form of available information For example, asking for WTP or non-monetary expressions of preferences to maintain soil biota would not be successful if the links between soil biota and its impacts on other environmental assets and related use and non-use benefits cannot be explained to individuals.

Some of the complimentary information that comes from scientific and technical analysis is likely to reflect expert opinions, or rather an expert's way of categorising different impacts and environmental processes. This may not fit well with the way individuals' preferences are organised (regardless of which valuation method is used). A typical example of this is the perception of risk by experts and by public. Another example is environmental impact assessment, which separates impacts partly along the lines of different disciplines, while the public may think of impacts as more interrelated. Thus, the interaction between complimentary information and value evidence is two-way: good quality complimentary information is vital for successful valuation, and the requirements of valuation methods for complimentary information should be taken into account when designing studies that will provide this information.

5.1.5 Inherent characteristics of the valuation methods

While policy makers are generally of the opinion that different types of value evidence have their relative merits and purposes, there are disagreements within the expert community about the relative worth, usefulness and justification of economic versus deliberative and participatory methods. In some quarters these differences are entrenched, while others see value in both approaches, and indeed there are several attempts to combine them.

Both economic and deliberative and participatory methods have problems and limitations which are continuously improved as more conceptual developments and empirical evidence comes to light. Discussion of such technical developments is outside the scope of this study. However, some of these problems or limitations, or rather perceptions about them, could influence the choice of method and hence are worth a mention here.

First, the fact that economic valuation methods use money as the unit of measure is received as an advantage by some and a disadvantage by others. As noted in Section 2.2, economists do not use monetary units because they think welfare and preferences and monetary expressions of them are identical, but rather because, so far, monetary methods are the best tools available for assessing underlying welfare. If direct, cardinal measures of welfare or utility were available, economists would use them instead, but we currently have no way of measuring welfare directly.

Second, fairness and distributional impacts is an area where the relative merits of different valuation methods are compared. While economic valuation and related decision support methods are capable of dealing with the distribution of impacts (e.g. through collecting value evidence from different groups in society and using weights in comparing costs and benefits to different groups), distributional analysis is not their main focus. They tend to view issues of fairness or distribution as external to the particular decision, i.e. government should deal with distribution and fairness primarily through tax and benefit policy. When fairness issues are more central, these are likely to be dealt with more explicitly by deliberative and participatory methods. However, it is not always the case that deliberative and participatory methods will produce fairer outcomes, as they are vulnerable to being dominated by more educated and/or articulate stakeholders.

Examples where deliberative and participatory methods could be employed include evaluation of climate change policy, decisions about siting waste processing facilities, managed realignment of the coast, and so on. In the first case, the equity issues arise through the global and long-term nature of the problem. In the second and third, the fairness issue arises from the fact that the distribution of costs and benefits is highly skewed – those living right next to the facility, or whose land is flooded, may suffer very high costs, while most of society escapes most of the costs – and there may be a need for some negotiated compensation. But this need for deliberation and compensation does not preclude the use of economic valuation methods for estimating aspects of costs and benefits associated with these decisions; indeed, we would suggest that such estimates could often be an important input into the deliberation process.

Third, the advantage of these methods is most evident when the topic of valuation is emerging trends in science and policy where the need for value evidence is for shaping of that policy before its impacts can be assessed either through economic valuation methods or indeed through further application of deliberative and participatory methods. Examples include genetically modified organisms, nuclear power and nanotechnology. Where outcomes are highly uncertain, and where there are "long tails" in distributions (that is, low probability but very high damage outcomes), the expected value approach of economics (with potential adjustments for risk aversion) may not be sufficient in itself. Rather, the expected values could form one input into a broader process seeking to understand how society wishes to deal with the risks, and trade-off economic value with risk protection.

Finally, evidence that can give as broad a view as possible is also important to decision-makers. An example from the policy maker workshops was the idea of a decision-maker interested in tangible numbers such as the number of visitors to a site. Using this indicator, they would not value highly the sites that don't receive many visitors but still are valuable to large populations (say for aesthetic reasons) or that give high value to the relatively few who visit (e.g. remote but important sites). Value evidence aims to address such shortcomings of using quantitative (or qualitative) evidence alone.

5.2 Where Are the Gaps?

Given the complexity and multi-dimensional nature of the value evidence and the policy requirements for it, there are inevitably gaps in our knowledge. Policy makers are acutely aware of the following gaps:

- **Gaps due to absence of evidence**: as our overview of the valuation literature shows (Section 3.3 and Annex 2), while the valuation literature is not insubstantial, there are still gaps such as the lack of evidence dealing with risk and uncertainty in general or specific components of the natural environment. Even when there is literature for a particular component of the natural environment, it may not be in a form that meets the needs of a given policy question. This could be partly because of the nature of the evidence as

mentioned above – individuals tend not to perceive the natural environment in the same compartmentalised way that experts or policy makers might. However, it could also partly be due to a time lag between the emergence of policy needs and building up of valuation literature.

- **Gaps in combining different types of value evidence**: policy makers find it difficult to combine the outputs of different valuation methods which are not directly comparable.
- **Gaps in guidance**: The existing government experience in the field of economic valuation and cost-benefit analysis means that there are agreed methods and guidelines for economic valuation and appraisal. These are less available or well-known for deliberative and participatory methods[13].
- **Gaps due to resources**: one factor that falls into this category and was mentioned repeatedly by policy makers is the limited time available to generate value evidence to answer specific policy questions. This, in turn, affects what type of valuation work is commissioned.
- **Gaps due to lack of awareness and familiarity**: despite literature reviews undertaken for different projects and, at least, for economic valuation evidence, the existence of online databases (see Section 3.3), awareness of and access to these sources could be limited. The limiting factor here is likely to be lack of familiarity with the methods themselves and the information sources. As mentioned above, lack of familiarity with valuation methods especially amongst the audience for the value evidence also affects what kind of valuation research is commissioned, and the ease with which the value evidence can be communicated.

5.3 What Are the Future Needs for Value Evidence?

Policy makers are aware that evidence gaps cannot prevent decisions from being made as much as they are aware of the existence of these gaps. The current practice of dealing with gaps seems to be by using the best available evidence, consultation or "informed guesswork"; and by applying sensitivity analysis. The future research needs are determined by the priorities amongst the current gaps, changes in the overall environmental policy and changes in the expectations of the audience for the value evidence.

5.3.1 Making better use of existing value evidence

In order to make the best use of available evidence, a number of steps can be taken, starting in the short term and, in time, influencing the future research agenda. One aspect of this approach is to ensure that familiarity with different types of valuation methods among policy makers is increased. For example, a common misconception is that economic valuation methods generate only monetary estimates. In fact, some are also capable of producing evidence on the motivations behind preferences and the factors that affect these. Similarly, it is not the case that deliberative and participatory methods cannot address the issue of trade-offs; rather they use metrics other than monetary units.

More dissemination about the valuation literature or even a central database or group of experts that collates value evidence and advises on the new valuation research could help. But, more in-depth and frequent communication among policy makers working in different departments under the umbrella of the natural environment and between policy makers and experts could also serve the same purpose.

Guidelines for how to implement and interpret deliberative and participatory methods of a similar status to those in the Treasury Green Book for economic methods could help improve

[13] Manuals do exist for some methods (e.g. Involve, undated), and new research such as the ongoing one by SDRN "Emerging Methods for Sustainability Valuation and Appraisal" is likely to add to these.

familiarity with these methods. At a more general level, the Defra Academic Panel could be extended and involved at the initial stages of formulating policy questions rather, than acting as peer reviewers at the later stages of research. This is not to belittle the importance of peer reviewing, which should be adopted for all policy research as a principle, but to help with formulating the policy questions at the start of the decision-making process.

5.3.2 Future valuation research

Opinions diverge about the future of environmental policy and the role of value evidence within it. In the context of the environmental policy, some policy makers expected that climate change and other environmental problems will become worse, making environmental policy and related decision-making more important and difficult. Others, however, felt that environmental considerations will not be as important in future as it's been in the past if the current public finance policy reviews at the UK and EU levels, which do not give sufficient weight to environmental policy, are indicative of future trends.

In the context of the role of valuation evidence, while there was consensus that importance of any type of value evidence is likely to increase in the future, there was little agreement about the relative importance of economic and other value evidence. Some policy makers felt that a move away from monetary values was likely; others that economic valuation was increasingly likely to be used for natural resources; and also to provide evidence for an increased drive to justify further environmental regulation especially within the Better Regulation Agenda.

Based on these expectations about the future of environmental policy and the need for value evidence, future research needs can be thought of as relating to: (i) undertaking new valuation studies; and (ii) improving the ways the value evidence can be used.

New valuation studies should seek to present a more holistic picture of the multitude of inter-related components of the natural environment (and hence ecosystem services) and their many-faceted benefits. They should also be prioritised according to policy needs but also for updating the existing literature. The value evidence for some areas is somewhat out-dated, not in terms of the time that elapsed since the studies took place, but in term of changes in environmental conditions since then. Regardless of this change, however, these studies are still used in decision-making (e.g. through benefits transfer) due to lack of more appropriate studies.

Valuation research is dynamic and responds to the needs of policy – but this response could be more immediate by greater communication between those using value evidence and those researching it, in particular with consideration of providing evidence which has the flexibility to be used in several contexts, in order to overcome current time and budget constraint problems. Designing surveys and valuation studies with sufficient foresight that their results could potentially be used in different contexts would also be helpful.

The following are some suggestions made by policy makers during the consultations that would involve or influence new studies:

- More studies are required on valuing the change in the *quality* of the natural environment.

- Dealing with uncertainty is a key issue for any valuation method, in particular in the environmental field where so much is unknown, and so much turns on probabilistic impacts. The importance of presenting sensitivity analysis in order to deal with uncertainty was stressed in the workshops, but it was felt that the policy environment was not conducive to the presentation of that type of information. More work on ways in which policy making can retain and deal with scientific and valuation uncertainty is needed.

- More information on the relevance of valuation data for sustainability.

- Further research is needed on the issues associated with participatory exercises such as representativeness of the sample, ensuring participation, and embedding outcomes in the institutional processes that instigated such exercises.

- A research agenda should be developed to encourage natural scientists to measure ecosystem services in physical units that economists can attach monetary values to.

Improving the ways in which value evidence can be used involves formulating the policy questions in such a way as to make the need for different types of value evidence explicit; comparisons of different types of values and exploring the ways of combining monetary and non-monetary measures of welfare within decision-making processes. These could be tasks that go beyond valuation research and involve decision-making research.

The following are the two suggestions made by policy makers during the consultations that would involve improving the ways value evidence is used in decision-making:

- Understanding and validity of benefits transfer techniques should be improved.

- Methodologies for robust aggregation and comparison of values need to be developed. There are a number of issues here: is it definitely the case that there are different kinds of value which cannot be traded off? Or is there a real underlying value, which is expressed in different ways? And to what extent does it matter, given that, one way or another, a decision has to be made? Mere avoidance of monetisation does not prevent an implicit trade-off resulting from the decision. There are important issues here which need to be examined in order to find the best ways of drawing together information about supposedly incommensurable values in decision-making. In any case, the aim of further research should not be trying to develop decision support tools that can come up with a single number, but to allow for a more holistic view of such evidence and, perhaps more importantly, in training policy makers in the use of different types of evidence.

5.4 Closing Remarks

The value of the entirety of the natural environment is not the topic of valuation, as human life on earth could not exist without it. However the values of the goods and services provided by the natural environment are not always recognised in their entirety by individuals or in the decision-making process. Essentially 'value evidence' as the term used in this study is a signal about how different categories of natural environment (and related ecosystem services) contribute to people's welfare and the extent to which other resources should be channelled into producing or protecting the natural environment. Reliable and robust methods of discussing, determining and taking into account the wide range of associated values are essential to effective, efficient and equitable decision-making, not only in environmental policy, but across all policy areas which influence or make use of environmental goods and services. The existing methods are useful and in most instances improve decision-making. There remains the potential for further improvement in valuation methods and in using value evidence in decision-making including better integration of different methods, and this is a research field which continues to develop rapidly. The pay-back in terms of improved decision-making and improved public acceptability of methods employed warrants continued attention to valuation research.

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