



Valuing Environmental Impacts: Practical Guidelines for the Use of Value Transfer in Policy and Project Appraisal

Value Transfer Guidelines

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INTRODUCTION

I. The policy need for these guidelines

The purpose of this document is to provide practical guidelines for valuing environmental impacts via value transfer. It augments guidance provided by Defra (2007a) in *An Introductory Guide to Valuing Ecosystem Services*, which seeks to ensure that the true value of ecosystems and the services they provide are taken into account in policy decision-making.

Assessment of the impacts of policies should be consistent and transparent. Cross-Whitehall guidance in *The Green Book* (HM Treasury, 2003) requires that all new policies, programmes and projects be subject to a comprehensive but proportionate appraisal to ensure that interventions enacted by public sector bodies are in the best interest of society overall. In order to provide a full account as possible of potential outcomes, a key component of appraisal is the comparison of the total benefits of a proposal to the full costs incurred by Government and society. Here *The Green Book* requires that all relevant costs and benefits be valued in monetary terms and the net benefit or cost of the proposal be calculated.

Costs and benefits related to market goods and services are estimated using market prices. For wider social and environmental costs and benefits, for which no market price is available, monetary evidence from non-market valuation (or 'economic valuation') methods are used.

Continued development and application of economic valuation techniques gives rise to a substantial body of evidence on the value of environmental costs and benefits. **Value transfer** - which is also known as 'benefits transfer' - is a process by which readily available economic valuation evidence is applied in a new context for which valuation is required. It is a quicker and lower cost approach to generating economic valuation evidence, compared to commissioning a specifically designed primary valuation study. This advantage of value transfer makes it a practical tool for analysis given the time and resources constraints decision-making regularly faces.

However, 'quick' and 'lower cost' do not mean that value transfer is easy and judgements are required as to when value transfer can be used and the level of effort that is appropriate in a given appraisal case. Overall, the more accurate the results need to be, the more effort is required. These guidelines emphasise transparency and appropriate use of sensitivity analysis to address concerns of accuracy. The role for value transfer as promoted here is to make the best use of available economic value and other evidence recognising both time and resource constraints and the potential limitations of the analysis.

The primary audience for the guidelines are economists in Central Government and Executive Agencies who are tasked with estimating the value of environmental costs and benefits for the purposes of decision-making.

The guidelines are intended to establish 'best practice' for value transfer to assist analysts in:

- Deciding if value transfer is appropriate for a given appraisal;

- Selecting the most appropriate approach to value transfer and applying an appropriate level of effort;
- Selecting the most suitable economic value evidence from the literature;
- Implementing the steps of value transfer; and
- Presenting the results of value transfer to inform decision-making.

The guidelines apply equally to ex-ante and ex-post policy and project appraisal and all other decision-making contexts for which economic valuation evidence is needed.

II. Basic principles of economic valuation and value transfer

Economic valuation

Analysts tasked with undertaking value transfer require a sound understanding of the concepts of economic analysis - as promoted by *The Green Book* - and should be familiar with the basic principles of **economic valuation** (see **Box 1**).

Economic valuation evidence is needed to enable environmental outcomes of a project or policy ('costs' or 'benefits') to be expressed in monetary terms so that they can be directly compared to other outcomes that are expressed in monetary terms. Typically the outcomes of interest are changes in the quality or quantity of the environmental good or service. The good or service may or may not be traded in a market (hence the terminology 'market' or 'non-market' good or service).

Value transfer

In order to estimate the economic value of a change in the provision of environmental goods and services, the analyst needs:

- i). A reliable estimate of the economic value - ordinarily in terms of 'willingness to pay';
- ii). A description of the change in the provision of the good under consideration - this may be presented in qualitative and/or quantitative terms;
- iii). Knowledge of how the economic value (i) changes due to the change in provision of the good (ii) - what is the relationship between the level of provision of the good and willingness to pay for marginal changes in the good (i.e. constant or non-constant)?; and
- iv). Knowledge of which factors influence the economic value - particularly in terms of the population affected by the change, their use of the environmental resource, their socio-economic characteristics (e.g. income, age, gender, education and so on) and substitute goods and services.

These Guidelines are designed so that analysts can gather the necessary information for (i) to (iv) above and do so in a transparent and consistent manner. This process requires not only economic analysis expertise, but also input from policy analysts and technical experts (both

positive and social sciences). A simplified picture of the value transfer process and the types of information involved is shown in **Figure 1**.

Box 1: Economic valuation

- Economic analysis - as outlined in *The Green Book* - is concerned with measuring the welfare of individuals and society in aggregate.
- Economic valuation does not measure the absolute value of environmental goods and services. It is concerned with the value of a change in the quality and/or quantity of the provision of these goods and services.
- The 'change' in the context of economic valuation is ordinarily a marginal change. The marginal value of a change is determined by the relative scarcity of the good or service, not only in terms of quantity, but also quality, location and timing of the change.
- The total economic value (TEV) comprises:

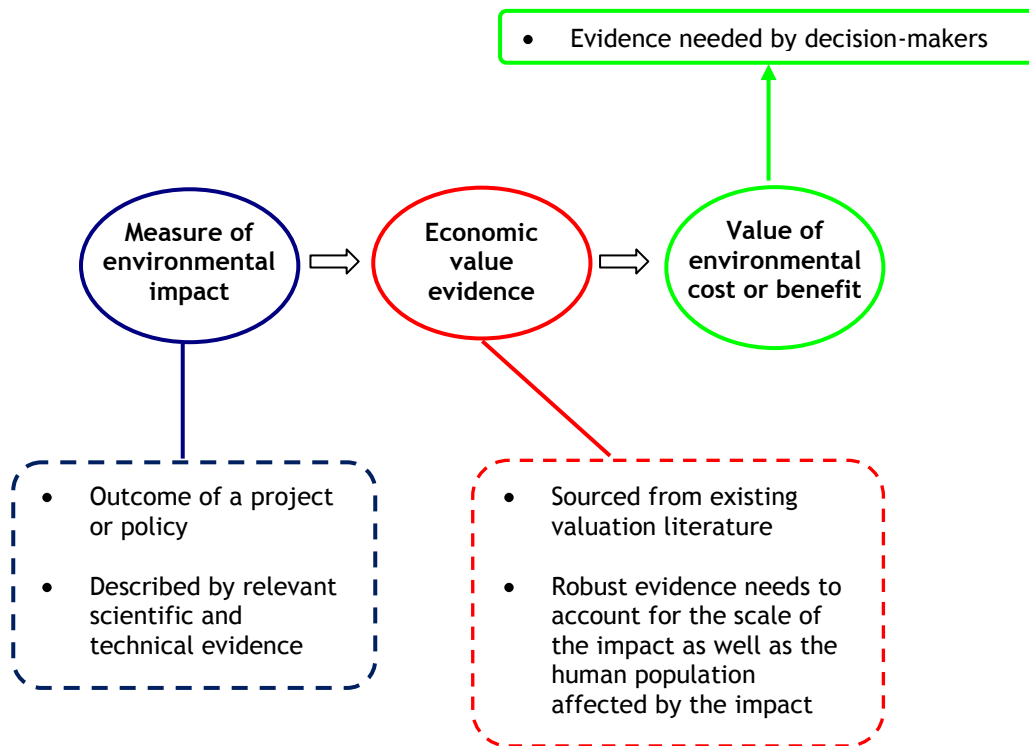
Use value relating to current or future uses of a good or service:

- ⇒ Direct use values may be 'consumptive' (e.g. timber) or 'non-consumptive' (e.g. recreational activities).
- ⇒ Indirect use values include key ecosystem services (e.g. climate regulation, flood protection, etc.).
- ⇒ Option value is associated with retaining the option to use a resource in the future.

Non-use value derived from the knowledge that environmental resources continue to exist (existence value), or are available for others to use now (altruistic value) or in the future (bequest value).

- Economic value is measured by the amount of money individuals are willing to trade-off against changes in the provision of an environmental good or service:
 - ⇒ The value of an improvement is estimated by either: (i) individuals' willingness to pay (WTP) to secure it; or (ii) their willingness to accept compensation (WTA) to forego it.
 - ⇒ The value of a degradation is estimated by either: (i) WTP to avoid it; or WTA to tolerate it.
- Using money as the unit of measure for economic values enables a common comparison of outcomes - in particular of environmental and financial outcomes.
- Economic valuation methods estimate WTP or WTA using different types of data depending on whether the good or service is traded in actual markets or not:
 - ⇒ Market prices where goods and services are traded in a market (for example timber);
 - ⇒ Revealed preference data where the environmental good or service itself is not traded but its quality or quantity influence a marketed good (e.g. the influence of environmental amenity on house prices, the influence of the quality of a recreational experience on visitors' spending); and
 - ⇒ Stated preference data where there are no actual or surrogate markets but the individuals are asked to trade off money against the change to be valued in a hypothetical market created through a questionnaire.

Figure 1: Information needs and output of value transfer



An example illustrates the process presented in Figure 1:

- Policy-makers may wish to assess the costs and benefits of proposed regulations for reducing effluent discharges from waste water treatment works.
- Investments by treatment works operators mean that water quality at beaches will improve from 'moderate' to 'good' status - this is based on scientific modelling of water quality.
- Existing valuation evidence reports that a visit to a beach with 'moderate' water quality is worth £x per person per visit, but £y per person per visit to a beach with 'good' water quality (where y is greater than x). Thus, the unit economic value of the change in water quality from 'moderate' to 'good' status is £(y-x) per person per visit.
- The total value of this change is estimated by multiplying the value £(y-x) per person per visit by the number of visits to beaches, and summing this over the time period over which the change in water quality will be sustained. This particular example assumes that the improvement provides benefits to the existing visitors and does not attract new visits or visitors.

Inevitably this example over-simplifies a process that can involve detailed scientific and economic analysis and expert and stakeholder consultation. However, it conveys the 'high level' story that needs to be understood by all involved in the appraisal of project and policy proposals.

Approaches to value transfer

In short, value transfer involves taking economic value evidence estimated in one context (the ‘study good’ context) and using it in another (but similar) context (the ‘policy good’ context):

- The ‘study good’ (SG) is the good that has been valued by an existing economic valuation study; and
- The ‘policy good’ (PG) is the good for which economic value evidence is required.

There are several approaches to value transfer. These differ in the degree of complexity, data requirements and expected reliability of the results. The two main variants of value transfer are: (i) **unit value transfer**; and (ii) **value function transfer**:

- **Unit value transfer:** this may involve either the transfer of *unadjusted* values, or the transfer of *adjusted* values to estimate the value of the change in the provision of the policy good:

Unadjusted unit value transfer: **unit value PG = unit value SG**
 [e.g. £/household/year for PG = £/household/year for SG]

Adjusted unit value transfer: **unit value PG = adjustment factor × unit value SG**
 [e.g. £/household/year for PG = a × £/household/year for SG]

Adjustments to transferred values are based on empirical evidence and control for differences between the policy good context and the study good context that cause the unit value to differ between the two contexts.

- **Value function transfer:** The ‘value function’ estimated for the study good is used to estimate the value of the change in the provision of the policy good:

Factors determining the value of PG = Factors determining the value of SG
 [e.g. £/household/year for PG = $f(X_{PG}) = f(X_{SG})$]

Where f is function and X is the set of factors (related to the good, the change, and the affected human population) that are found to influence the value of the study good.

The choice of value transfer approach to use will depend on a number of considerations including the available economic valuation evidence and other evidence to support the analysis, time and resources available to the analyst and the requirements of the decision-context.

Limitations of value transfer

Notwithstanding its practical advantages, value transfer has limitations. In particular:

- i). There can be a scarcity of suitable studies from which to source valuation evidence;
- ii). There are likely to be ‘transfer errors’ when evidence from an existing study is used in a new policy context and the level of error may be unknown; and

- iii). Selection and adjustment of the value evidence from the literature involves a degree of expert judgement which may entail assumptions that are not widely agreed across stakeholders and may generate results that are not comparable across transfers by different experts.

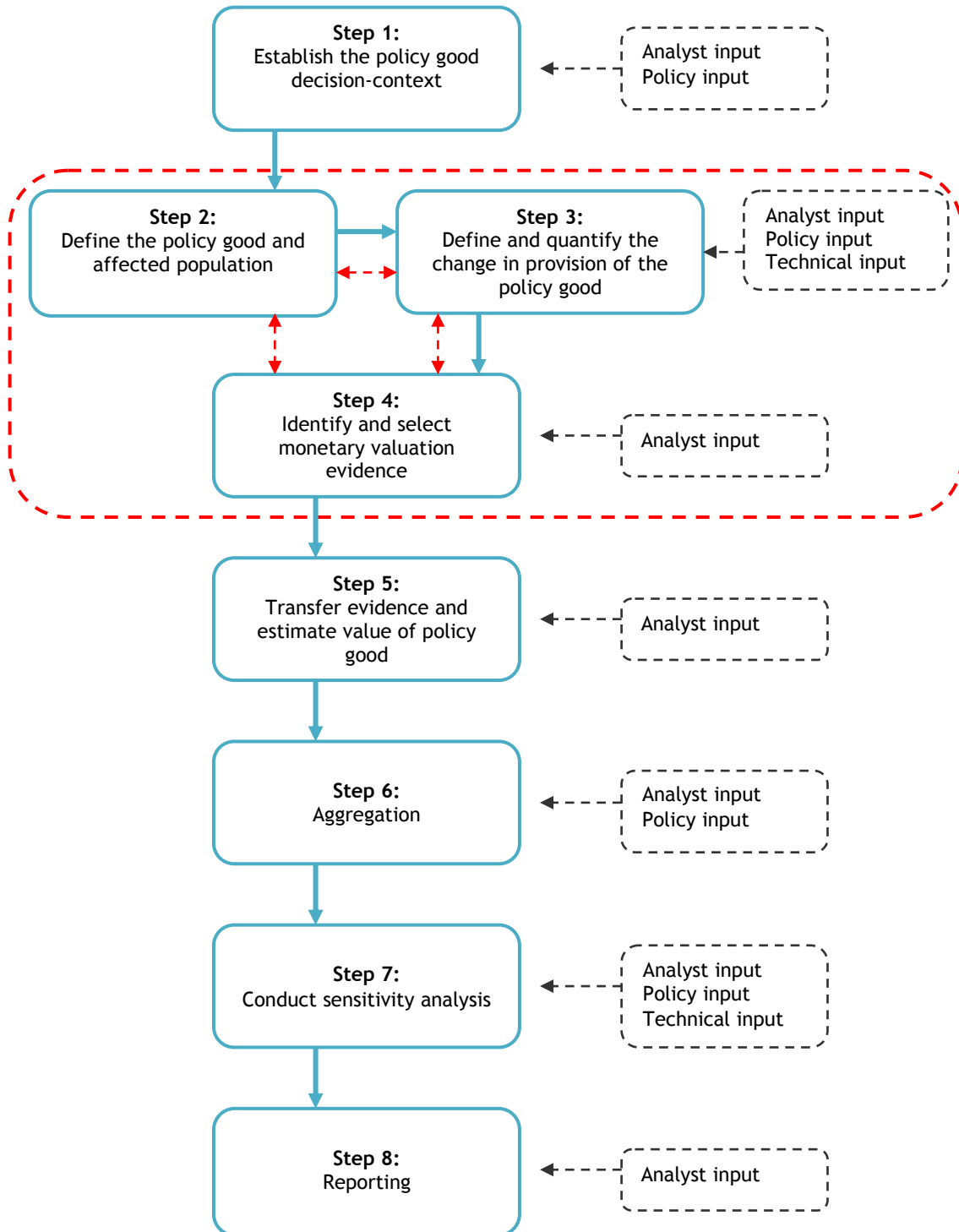
The eight step approach recommended in these Guidelines is intended to provide sufficient information so that limitations, (iii) in particular and (ii) to a certain extent, are addressed. In addition **Annex 1** (*Protocol for Primary Valuation Studies*) provides some suggestions to improve future availability and quality of valuation studies.

Value transfer steps

The practical steps for value transfer are illustrated in **Figure 2**. They follow a logical process that requires the analyst to assess the overall decision-making context (Step 1) before establishing the details of the policy good and the change in its provision (Steps 2 and 3). This provides the basis for selecting appropriate valuation evidence and using this evidence to estimate the value of the change in the provision of the policy good (Steps 4 to 6). Following this the analysis should be subject to sensitivity testing (Step 7) before results are reported for decision-making (Step 8).

In practice the analysis usually does not follow a linear progression through the eight steps. In particular an iterative process can be required through Steps 2-4 where analysts are tasked with collecting the basic information and selecting the appropriate evidence for value transfer.

Figure 2: The steps of and input to value transfer



III. The structure and the format of the guidelines

Structure

The guidelines are composed of:

- *Guidelines document*
 - ⇒ Introduction (this section) - Background to value transfer, its role and basic concepts.
 - ⇒ Practical Steps for Value Transfer - Steps 1-8 for undertaking value transfer with emphasis on highlighting key principles, requirements of analysis and limitations.
 - ⇒ Value Transfer Checklist - A list of tasks to undertake and questions to answer for value transfer.
 - ⇒ Glossary - Definitions of key economic valuation and value transfer terms.
 - ⇒ References - Further reading and relevant material.
- *Annexes to the Guidelines*
 - ⇒ Protocol for Primary Valuation Studies (Annex 1) - An 'ideal' checklist for practitioners undertaking economic valuation studies to ensure that the results are readily available for value transfer.
 - ⇒ Assessing the Quality of Primary Valuation Studies (Annex 2) - Criteria to assist in selecting the best evidence for value transfer.
 - ⇒ Glossary of Econometric Terminology (Annex 3) - Glossary of econometric terms to help analysts interpret econometric and statistical analysis undertaken in economic valuation studies.
- *Case studies*
 - ⇒ Separate documents illustrating the application of value transfer using different levels of effort and in different policy areas.
- *Technical report*
 - ⇒ Separate document providing the basis for the Guidelines by reviewing best practice and the 'state of the art' for value transfer.
- *Summary documents*
 - ⇒ Non-Technical Summary - An explanation of the role for value transfer and the valuation of environmental impacts for the non-economist audience.
 - ⇒ Summary of Value Transfer Steps - A quick reference document for analysts, highlighting the key tasks in Steps 1-8 for undertaking value transfer.
 - ⇒ Technical Report Executive Summary - The main messages, recommendations and findings from the Technical Report.

Key terminology

Key terms used throughout the Guidelines are defined here:

<i>Adjusted unit value transfer</i>	Transfer of a mean average (or median) value estimate for a study good that is adjusted to account for some factor (or factors) to estimate the value of policy good.
<i>Change in provision</i>	This is the outcome of the policy or project on the policy good. It could be a change in the quantity or quality of the good or a change in its timing and availability. It may be an environmental impact (e.g. a reduction in water quality, increase in air pollution) or other.
<i>Economic value</i>	Applied in terms of the unit (or marginal) economic value. For market goods this is ordinarily measured by market price; for non-market goods by willingness to pay (WTP) or willingness to accept (WTA) compensation estimates from economic valuation studies.
<i>Economic valuation evidence</i>	Economic values, value functions and other empirical evidence available from existing (primary) valuation studies that provide the basis for value transfer. Previous value transfer analyses may also provide evidence for current applications.
<i>Policy good</i>	This is the good or service for which monetary valuation evidence is required. It could be a physical commodity and market good (e.g. timber), it could be a non-market amenity (e.g. recreation) or service (e.g. water quality). It could also be an environmental bad (e.g. air pollution) corresponding to a policy good (e.g. clean air).
<i>Primary study</i>	This is an economic valuation study specifically designed to estimate the value of the change in a policy good (e.g. a revealed preference study or a stated preference study).
<i>Study good</i>	This is the good or service for which economic valuation evidence is available.
<i>Unit value transfer</i>	Transfer of a mean average (or median) value estimate for a study good to estimate the value of policy good.
<i>Value function transfer</i>	A statistical relationship between the value of a study good and a set of explanatory variables that is transferred to estimate the value of the policy good.
<i>Value transfer</i>	A process by which readily available economic valuation evidence is applied in a new context for which valuation is required. Value transfer is also often referred to as ' benefits transfer '. In the guidelines value transfer is used since this recognises that the approach applies equally to market and non-market costs and benefits.

STEP 1: ESTABLISH THE POLICY GOOD DECISION-CONTEXT

This step addresses the following questions:

- *Is value transfer the appropriate approach to meet the evidence needs of the decision-making context?*
- *Is value transfer possible?*
- *If yes, what is the appropriate level of effort for the value transfer analysis?*
- *If no, would a primary valuation study or an approach other than economic valuation be better?*

With input from:

- *Policy analysts - on the purpose of the policy or project, the need for economic value evidence, and time and resources available to collate this evidence.*

Note that:

- *Reviewing the decision-context concerning the policy good will help decide when value transfer is appropriate and/or sufficient.*
- *Reviewing the context will also assist with determining the degree of effort justified for value transfer.*

This step is closely linked to:

- *All other steps since it sets the purpose and scope for the entire value transfer application.*

1.1 Value transfer and the decision-context

To determine if value transfer is possible and appropriate to inform decision-making, the basic details of the decision-context should be established. This is informed by the wider policy or project objective described by¹:

- The issue under consideration and the rationale for intervention;
- The objective and the intended effects of intervention; and
- The policy or project options that are to be appraised.

Analysts should consult with relevant colleagues as to the specific details of the decision-context. The **Case Studies** that accompany these Guidelines illustrate the decision-context in a variety of applications, each based on a recent UK project or policy initiative.

¹ In an Impact Assessment the decision-context is covered by the Interventions and Options summary.

Analysts need to answer two initial questions when presented with a policy or project proposal for which monetary valuation evidence is required:

- A. *Is value transfer appropriate*: what level of uncertainty can be accommodated in decision-making? and
- B. *Is value transfer possible*: is there sufficient economic valuation evidence, supporting information and time to carry out robust analysis?

Box 2: Recent evidence on transfer errors

The concept of ‘transfer error’ relates to the difference in economic value estimate that is obtained from a primary valuation study compared to the use of value transfer. In practice, the analyst is not able to formally measure the degree of transfer error, since a primary valuation study will not be commissioned to test this. However, the academic literature features a large number of studies that have been specifically designed to test the accuracy of value transfer and estimate transfer errors.

The basic calculation is:

$$\text{Transfer error (\%)} = (\text{Predicted WTP}_{PG} - \text{Observed WTP}_{PG}) / \text{Observed WTP}_{PG}$$

Where the transfer error is presented as the percentage difference between two WTP estimates: predicted WTP for the policy good (PG) is estimated using value transfer (either unit value or value function transfer); and observed WTP is the ‘actual’ value estimated for policy good.

Since transfer error testing studies estimate WTP for the policy good at a variety of sites, the predicted WTP is generated by using information from the other sites and then compared to the observed value for the site of interest. In general, a broad range of transfer errors have been reported by studies, from 0% up to 1,000%’s (see Annex 1 of the *Technical Report* for an overview).

A recent study for Defra (Christie et al., forthcoming) investigates the transfer errors in relation to a choice experiment (CE) valuation study of the ecosystem service benefits delivered by the UK Biodiversity Action Plan (UK BAP). Transfer error tests are performed for transfers between 12 UK regions (i.e. the individual sites) and also from a pooled UK dataset. Transfer errors from site-to-site transfer between regions range from 37% to 1054%, with average errors across the regions in the range 140-500%. Use of the pooled dataset to predict the policy good WTP results in the smallest average transfer errors (128%), with the pooled data providing the lowest error in two-thirds of all cases.

The *Technical Report* presents analysis of transfer errors for unit value and value function transfer across European countries for water quality improvements. Site similarity - judged primarily on the socio-economic characteristics of the affected population - is highlighted as a key issue for transfer errors. When the analysis is restricted to include similar sites only, transfer errors are minimised when unit value transfer is used. When dissimilar sites are included, value function transfer results in lower transfer errors, since it controls for greater heterogeneity between sites. Errors are minimised by transfer functions including only variables that are generic across sites and expected by economic theory to influence economic values; i.e. the characteristics of the good including the change in its provision, the availability of substitutes, household income. For further detail see **Step 5** and the *Technical Report*.

1.2 Criteria for assessing the feasibility of value transfer and the level of effort justified

The feasibility of value transfer and level of effort justified depends on:

- i). The level of accuracy that is required in evidence presented to decision-makers;
- ii). The availability of information concerning the policy good, the change in its provision (scale, location, timing, duration), the affected population and economic valuation evidence; and
- iii). The time and resources available.

In short, the higher the level of accuracy required, the higher the level of effort that is justified for generating economic value evidence. Put another way, there is less room for transfer error (see **Box 2**) in these circumstances. Whether the value evidence should be sought from value transfer or from a primary valuation study depends on all three considerations above and is a case-specific decision. The rest of this section provides further information to help decide the appropriateness and possibility of value transfer in a given case.

Criteria for assessing if value transfer is appropriate

<i>What is the level of accuracy required in the evidence presented to decision-makers?</i>	
<p>For policy and project appraisal, higher requirements for accuracy in evidence are generally linked to factors such as:</p> <p><u>The phase in the policy or project decision-context</u> ⇒ Is the decision context at a scoping / screening or final decision stage?</p> <p><u>The scale of effects of the policy or project:</u> ⇒ How significant are the expected effects of the action of interest, including the change in the provision of the policy good? ⇒ How significant is the change in the policy good in relation to the overall decision to be made?</p> <p><u>The scale of investment/expenditure:</u> ⇒ Does the decision involve significant investment or expenditure or opportunity cost?</p> <p><u>Legal, political and stakeholder context:</u> ⇒ Is the decision likely to be subject to significant scrutiny, potentially contentious to some stakeholders and/or subject to media interest?</p>	<ul style="list-style-type: none"> • The answers to the questions on the left are case-specific. • What they mean in different decision-making contexts is illustrated in Box 3. • Answers may only become evident as analysis progresses; for example the understanding of the significance of the change in the policy good may develop as it is assessed. • Scrutiny of value transfer evidence should not be disproportionate to other aspects of uncertainty; the robustness of all types of evidence (scientific, economic, etc.) should be assessed. • Value transfer may be the only option; often time and resources do not allow for a primary valuation study even if the scale of effects and investment, or the stakeholder context warrant it.

In deciding if value transfer is appropriate, analysts will likely have to weigh various aspects of the decision-context. For example:

- Value transfer is appropriate - a clear cut conclusion: in some instances determinations will be relatively easy; e.g. high level screening of options. Analysts should consider what level of effort is warranted and if this is possible given the available information, data and time (see below).
- Value transfer may be appropriate - a qualified 'yes': analysts may need to review aspects of the decision-making context in further detail before making a determination. For example to see if necessary information (i.e. scientific, economic valuation evidence) is available to allow for a robust analysis given the level of accuracy required by decision-making.
- Value transfer is not appropriate - accuracy requirements are too high: Analysts should consider if a primary valuation study is warranted (see Section 1.3). If further scientific evidence is needed, analysts may recommend further work in this area, with a view to facilitating future economic valuation.

Criteria for assessing if value transfer is possible

<i>Is sufficient information and data available?</i>	
<p><u>Requirement for value transfer:</u></p> <ul style="list-style-type: none"> ⇒ Definition of the policy good and its characteristics; ⇒ Understanding of the change in the provision of the policy good; ⇒ Definition of the affected population; ⇒ Data on the socio-economic characteristics of the affected population; ⇒ Data on the policy good site including substitutes; and ⇒ Relevant and robust economic valuation evidence from existing studies. 	<ul style="list-style-type: none"> • In practice this is the information that is collated in Steps 1-4. However, at the outset of the analysis a rapid assessment of whether the necessary information is likely to be available. This is part of the iterative nature of the value transfer (as depicted in Figure 2). • Information requirements will vary case-by-case depending on the level of detail and approach taken (e.g. available evidence may mean that only unit value transfer is possible). • Initially analysts should focus on a basic assessment of the policy good and decision-context in order to identify if there is sufficient information to enable value transfer.

<i>Are sufficient time and resources available?</i>	
<p><u>Timescale</u></p> <p>⇒ Are there days, weeks or months before the value transfer results are needed?</p> <p>⇒ What stage is decision-making at - will there be opportunity to update and refine the analysis?</p> <p><u>Resources</u></p> <p>⇒ If required, is other expertise (e.g. science, geographical information system) affordable?</p> <p>⇒ If required, is peer review of the analysis affordable?</p> <p>⇒ Is the expert capacity required available?</p>	<ul style="list-style-type: none"> • Value transfer is often presented as a ‘quick’ approach to producing economic valuation evidence. This can be true if necessary information inputs are readily available. • In practice the approach taken (e.g. unit value transfer, adjusted unit value transfer, function transfer) will determine the time and resources <i>needed</i> for the analysis. This has to be reconciled with the time and resources <i>available</i> for the analysis. • If there are significant time and resource pressures, the scope to undertake a ‘complete’ analysis will be limited and results should be presented and interpreted accordingly.

Box 3: Judging the level of accuracy required in appraisal evidence

The level of accuracy in evidence required will vary on a case-by-case basis. In some circumstances - for example cases of large investment or expenditure - there is likely to be high degree of accuracy demanded from any type of evidence.



Source: Brookshire (1992)

As a general rule, the level of accuracy required can be linked to different types of decision-contexts:

- Where analysis is focussed on improving knowledge - such as ‘highlighting the importance of an issue’ - or if an initial assessment of policy outcomes is required (e.g. scoping/screening exercises) relatively low levels of accuracy are likely to be acceptable. Value transfer should be the first approach considered in these cases and is likely to be sufficient for most.
- Moving towards actual policy decisions is likely to require greater confidence in results and require compelling evidence as to their accuracy.

Overall, the accuracy requirement for evidence that informs decision-making cannot be judged on the type of decision-context alone; it is also determined by scale of the action and effects, the stakeholder context, the availability of data to inform, and time and resources available for analyses.

The Green Book (HM Treasury, 2003) recommends that ‘*appraisal effort should be proportionate to the action being appraised*’, reflecting the fact that analysts tasked with producing evidence are subject to time and resource constraints, and effort should be focused where it is most appropriate and valuable. Drawing together the information, time and resources considerations for a given appraisal will provide analysts with an understanding of what level of effort is realistic in the timescale available.

Analysts then need to judge if the level of effort that can be achieved is sufficient in light of the assessment of the level of accuracy required for decision-making. This links consideration of the appropriateness of value transfer to whether value transfer is possible:

- *If value transfer is possible and is the only option*: decide on the level of effort (e.g. a unit value or value transfer approach when both are possible). More detailed analysis should be undertaken where the accuracy requirements for evidence informing decision-making are higher.
- *If value transfer is possible and but is not the only option*: decide whether primary valuation is justified. The decision should be weighed by taking note of the ‘value’ of spending more on a primary study in relation to the perceived gain in accuracy in light of decision-context (e.g. scale of expenditure, effects and stakeholder considerations outlined above).
- *If value transfer is not possible*: this can arise due to: (i) lack of information; and/or (ii) time and resource constraints. If a lack of information is the determining factor then it may be the case that either further scientific evidence or a primary valuation study is required (particularly if monetary valuation evidence is viewed as integral to the appraisal decision). If time and resource constraints are the determining factor then opportunities to improve the evidence base for decision-making are likely to be limited, and analyst will need to consider alternative approaches (see Section 1.3 or make a case to decision-makers for more time and resources).

Sometimes the feasibility of value transfer may not be possible to determine until Steps 1-4 have been completed in detail, and the analyst has a more comprehensive view of the evidence available. In fact, the decision whether unit value of value function transfer is appropriate is taken in Step 5. However, it is possible to scan ahead as shown in **Box 4**.

1.3 Alternatives to value transfer

Primary valuation study

A primary valuation study is preferred over value transfer, when:

- The decision-context requires a higher level of accuracy from economic value evidence than can be provided by value transfer; and
- There is no (or no appropriate) economic value evidence available in the literature.

However it should be noted that a primary valuation study cannot be guaranteed to deliver more accurate valuation evidence; these also can be complex and require careful design and analysis to ensure robust results. Whether a primary study is possible, in turn, is determined by the availability of necessary time, data and budget. Guidance for commissioning and undertaking primary valuation studies is provided by a numerous documents which are listed in **Annex 2** (Assessing the Quality of Primary Valuation Studies).

Other inputs to decision-making

Value transfer interacts with many other decision-support tools such as environmental impact assessment (EIA), strategic environmental assessment (SEA), life cycle analysis (LCA), environmental and health risk assessments, multi-criteria analysis (MCA) and cost effectiveness analysis (CEA) as well as deliberative and participatory approaches.

On the one hand, these other tools provide inputs to economic valuation (whether through value transfer or primary valuation). They also provide qualitative and quantitative information on the assessment of the impacts on their own right as requested by Impact Assessment guidelines and *The Green Book. An Introductory Guide to Valuing Ecosystem Services* (Defra, 2007a) provides further discussion.

In addition, information processing tools like MCA and CEA, can be used as alternatives to value transfer (and primary valuation), when environmental costs *and* benefits need not be expressed in monetary terms.

Box 4: Scanning ahead - what information is needed to judge if value transfer is feasible - five Ws (and one H)

- **What is the policy good?** The answer is particularly useful to rapidly assess the likely relevance of existing valuation studies (e.g. a quick look at the EVRI database - see *Step 4*).
- **Why is there a change in the provision of the policy good?** Scientific (or similar) evidence is needed to establish the likely effect of the change to be valued on wellbeing.
- **Where is the policy good?** The answer helps identify the affected population and the spatial factors that are likely to influence the value evidence.
- **When is the change?** Scientific (or similar) evidence is needed to establish the likely timing and time profile of the change to select the studies and aggregate values over time.
- **Who is affected?** The answer is particular useful to rapidly assess the likely relevance of existing valuation studies.
- **How?** An initial survey of the subject matter, time and resources available and requirements of the decision-making context will help analysts formulate the approach to the analysis in terms of level of effort and the approach (i.e. unit value transfer, adjusted unit value transfer and function transfer - see *Step 5*).

STEP 2: DEFINE THE POLICY GOOD AND AFFECTED POPULATION

This step addresses the following questions:

- *What is the good to be valued (the 'policy good')?*
- *Which characteristics of the policy good are likely to influence its economic value (e.g. size, location, uses and/or unique features that may lead to non-use values)?*
- *Who is affected by the change in the policy good and whose values should count?*

With input from:

- *Policy analysts - on the definition of the good and the characteristics of the good and the affected population.*
- *Technical experts - on the physical, biological and chemical parameters of the good and its characteristics including the scientific assessment of the availability of substitutes or its unique features, and also the affected population.*

Note that:

- *The term 'good' is applied broadly to denote something that generates flows of welfare in terms of use values and/or non-use values.*
- *Use of an ecosystem services framework is recommended where the policy good generates multiple environmental goods and services.*

This step is closely linked to:

- *Step 3 - the definition of the policy good determines the baseline;*
- *Step 4 - the appropriateness of value evidence from the literature is determined on the basis of the characteristics of the policy good and the affected population;*
- *Step 6 - the aggregation of economic value over the affected population requires the definition and quantification of this population; and*
- *Step 7 - assumptions made in defining the policy good and the affected population can be tested in sensitivity analysis.*

2.1 What is the policy good?

Analysts need to provide a clear definition of the policy good so that the value evidence sourced from existing valuation studies (**Step 4**) matches the policy good. The definition of the policy good also influences the definition of the change to be valued (**Step 3**), but here the emphasis is on understanding the policy good in terms of its characteristic and the use and non-use value it generates.

Market goods and services

The price for **market goods and services** is an indication of *direct use value*. For example the benefits of an afforestation project can be estimated by transferring market prices for timber.

The price needs to be net of market distortions such as taxes and subsidies (e.g. the subsidies for agricultural products)².

Presence of monopoly supply in a market will also likely mean that the price does not reflect the true value. For example in the case of water supply, bills paid by household and business users often do not provide a full account of the environmental impacts of supply. Here value transfer - and more generally economic valuation - can be used to estimate the full extent of value of the opportunity cost of supply (e.g. low flows in rivers, degraded habitats, lower recreational amenity).

Non-market goods and services

In most cases, however, the policy good generates goods and services that are not traded in markets, i.e. they are **non-market goods and services** (and also often **public goods**). Here, the evidence for value transfer comes from economic valuation methods that analyse the data from surrogate markets (revealed preference methods) or from hypothetical markets (stated preference methods).

Characteristics of the policy good

The policy good can be described by: its physical characteristics (both real and perceived); its spatial location; the timing of its provision; and the population affected by its provision.

As complete a definition of the characteristics of the policy good as possible is crucial as it helps with (i) identifying suitable valuation evidence in Step 4; and (ii) appropriate aggregation in Step 6.

- **Physical characteristics**: In many instances the policy good may be concerned with a well defined 'commodity' (e.g. carbon emissions) or a single dimension of an environmental good or service (e.g. air quality, water quality³). In other cases the policy good may have a number of attributes or be multi-dimensional (e.g. a land management change that affects habitats, recreation and landscape amenity - see **Case Studies 2 and 3**). In addition, characteristics of the policy good may also include aspects such as designations (e.g. SSSIs, SPAs, SACs - see **Case Study 5**).
- **Location**: use values may be 'spatially sensitive'⁴ and hence addressing the location and the wider spatial context for the provision of the good is crucial. The classic example is

² Analysts should seek advice from relevant Departments. For example: the Single Payment Scheme for farmers is administered by the Rural Payments Agency (<http://www.rpa.gov.uk/>); Natural England administers agri-environmental schemes ('Environmental Stewardship') in England (<http://www.naturalengland.gov.uk>); and the HM Revenue and Customs website reports details of various taxes it administers (<http://www.hmrc.gov.uk>).

³ In reality, a good such as 'water quality' is composed of a number of parameters (e.g. the physical, chemical and biological characteristics of water and measures of these, such as dissolved oxygen). Part of the purpose of this step is to ensure that there is sufficient scrutiny by the analyst in understanding the level of detail with which the good should be described.

⁴ Spatial factors are generally not relevant in the case of global pollutants such as greenhouse gases in terms of their climate change impact; i.e. where the emission originates does not influence the overall

recreation sites such as woodlands where a sizeable body of empirical evidence gives rise to expectations such as:

- ⇒ Proximity to populations: a closer site is easier to access (both in terms of travel time and likely transport links) which may imply greater use value;
- ⇒ Proximity to substitutes: sites with a greater number of substitutes may imply lower use values than those with fewer substitutes;
- ⇒ Proximity to complements: sites with complementary amenities (e.g. a lake) may imply greater use values than those without; and
- ⇒ Proximity and socio-economic factors: sites closer to deprived areas and populations may result in positive distributional effects.

In practice spatial factors can influence both marginal value estimates (e.g. £/household/year) and aggregate value estimates (see **Box 5**). Failure to identify and appropriately account for them can lead to significant errors in the transfer of valuation evidence and estimates of aggregate values (see **Case Studies 3** and **4** and the *Technical Report* for examples of the treatment of spatial factors in value transfer).

- **Timing:** for some policy goods the issue of timing (including temporary versus permanent effects) and seasonal variation may be of importance since this can have a significant bearing on its scarcity. For example in the case of water supply, in times of low availability (e.g. summer droughts) the implied marginal value of water is likely to be greater for uses such as irrigation, domestic supply and retaining water in rivers for environmental quality purposes, than in times of greater abundance.

'Strategic level' policy goods

Often decision-making is concerned with a policy good at the strategic level; i.e. assessing the costs and benefits to the nation of a policy proposal or the implementation of a European Directive. At this phase in decision-making the characteristics of the policy good may be only broadly known, or understood as the attainment of some target. For example the Water Framework Directive (WFD) requires EU Member States to achieve 'good ecological status' for all water bodies by 2015. In practice, implementation of the Directive means varying levels of quality improvements across rivers in England, where site-specific factors will determine the benefits that are generated (see **Case Study 4**).

In these circumstances there is a risk that inappropriate selection of valuation evidence can lead to significant over- or under-estimates of the aggregate costs or benefits of a policy. This can result from applying evidence based on a study good that is not representative of the policy good⁵. For example consider the transfer of values estimated by a single study for clean-up of a highly polluted urban river to measure the benefits of the implementation of the WFD. This could be an appropriate exercise for a subset of polluted urban rivers but a very poor

scale and distribution of climate change impacts. Effects on local air quality and health, however, do vary over spatial areas, based on weather patterns and population distribution.

⁵ This is a form of 'generalisation error'. The criteria for matching the policy good context to the study good context in **Step 4** (see Section 4.2) are intended to minimise the risk of this error, by requiring analysts to carefully consider each context and where possible control for differences via adjusted unit value transfer or function transfer.

proxy for other water courses such as chalk rivers and upland streams which have different water quality levels prior to WFD implementation⁶.

The key point is that inappropriate selection of valuation evidence can stem from poor definition of the policy good. This is relevant to both 'site-specific' and 'strategic level' goods, but can be a particular risk for analysis at the strategic level where the policy good characteristics are only roughly established without account for site-specific variation. The task for analysts is to ensure that appropriate valuation evidence is selected in these cases, based on the criteria set out in **Step 4**. In instances where existing studies do not provide suitable evidence, analysts should consider if a primary valuation study is warranted (see **Step 1**).

Box 5: Spatial sensitivity in non-market values: some rules of thumb

The importance of accounting for the influence of spatial factors is a key theme throughout these guidelines and the *Technical Report*.

In many cases of site-specific goods (e.g. recreation), relatively quick and simple transfer of unadjusted unit value estimates from some previous study can result in an unreliable and inaccurate estimate of the aggregate value of the change in the provision of the policy good. This is due to a failure to account for spatial sensitivity in unit values. In this regard some useful 'rules of thumb' should be kept in mind by analysts:

- **Distance decay:** as distance from the policy good (site) increases and opportunity costs (e.g. travel time and cost) rise, the proportion of users to non-users will decline. Given that users typically hold higher values than non-users, distance decay in unit values is implied. This effect should hold where there is no change in the quality of the policy good.
- **Non-user to user conversion:** a quality improvement in the policy good can result in some non-users becoming users of the improved good. This trend is likely to be more significant the larger the improvement, and is more likely to occur for non-users closer to the policy good site than further away.

Overall analysts need to identify the 'extent of the market' (the affected population) and determine how this may vary with changes in the provision of the good. In some cases the extent of the market may well be more important in determining aggregate values than issues concerning the precision of the estimates of unit values.

For further detail see: *Technical Report* (Section 6) and Bateman et al. (2006).

Ecosystem services framework

A key tool analysts can use in defining the policy good in terms of its characteristic and the use and non-use value it generates is the **ecosystem services framework** as outlined in *An Introductory guide to Valuing Ecosystem Services* (Defra, 2007a).

Defra (2007a) presents the framework as a systematic approach for identifying, assessing and valuing the goods and services supported by the condition, structure and functioning of the natural environment. In practical terms it can help analysts:

⁶ Note this is an illustrative example. The WFD actually provides a case in point where the scale of the policy, investment and stakeholder context, plus deficiency in available valuation evidence required the commissioning of a primary valuation study (see Nera, 2007).

- i). Determine the entire range of environmental impacts that result from a proposed policy or project - in particular a checklist of ecosystem services is provided for use in policy appraisal⁷;
- ii). Map the links between changes in ecosystem processes and final goods and services that generate use and non-use values - note that these interactions can be complex and should be informed by scientific evidence. Analysts should seek advice from scientists where necessary;
- iii). Avoid double counting in valuation by defining the final good to be valued as identified in (2) above - this is achieved by ensuring that the final goods and services are independent outcomes in terms of the use and non-use values derived by the affected population(s);
- iv). Consider potential for substitution effects between the final goods to be valued and the influence this may have on use and non-use values derived by the affected population (see **Box 6**); and
- v). Identify appropriate measures of the physical quantity/quantity provision change in the policy good that are compatible with valuation - note this overlaps with **Step 3**.

The ecosystem services framework is recommended in cases where the decision affects multiple environmental attributes and market and non-market values. If a decision context affects more than one policy good (e.g. soil quality and water quality), each should be defined and their ecosystem goods and services should be identified separately. Similarly, values for multiple benefits (e.g. all or some of the ecosystem services from a policy good) should be sought throughout the value transfer process (but subject to caveats in (iv) above and **Box 6**).

Case Studies 2 and 3 demonstrate practical use of the ecosystem services framework, in the context of valuing in changes to upland land use management and valuing environmental benefits of a flood risk management scheme, respectively. Both case studies present a summary of the *ecosystem service - final benefits - affected population* mapping in a tabular format. **Table 1** presents the template for this, providing an illustrative example from Case Study 3. The table also illustrates the types of affected population which is addressed in Section 2.2. Analysts are encouraged to adapt this template to the needs of their analysis.

⁷ See Table 3.1 in *An Introductory guide to Valuing Ecosystem Services* (Defra, 2007).

Box 6: Substitution effects between ecosystem services

An ecosystem services approach can be particularly useful in distinguishing the final goods and services derived from the natural environment, and help to avoid problems of double-counting where multiple ecosystem services and functions contribute to use and non-use values derived by human populations. However, in cases where projects or policies subject to appraisal impact on multiple final benefits, analysts need also to consider potential for substitution effects between these, since failure do so can lead to over-estimation of aggregate benefits due to independent valuation and summation (IVS) effects. See for example Hoehn and Randall (1989) and Hoehn and Loomis (1993) for classic references.

In particular benefits derived from environmental attributes such as recreation, landscape amenity and biodiversity conservation may be substitutes for each other. Here, simultaneous improvements in each attribute will lessen the value of the improvements in the others, in contrast to the case where each of the improvements is delivered in isolation. This can be viewed as a 'part-whole' issue, where, when a set of goods (the parts) are valued individually, the sum may exceed that for the same set of goods value together (the 'whole').

An illustration is provided by Santos (1998) which estimates the value of attributes of the Environmentally Sensitive Area (ESA) scheme in the Yorkshire Dales National Park. Per household WTP estimates for the ESA attributes when valued individually were £43.01 per year for stone walls and barns, £42.62 per year for meadows, and £42.90 per year for woodland. Summation of these individual estimates suggests a value of £128.52 per household year. However despite being seemingly diverse goods, the three ESA attributes were found to be substitutes for each other. When valued jointly, WTP was £72.05 per year, implying that the individual summation of benefits over-estimated WTP by almost 80%.

IVS can be a particular challenge in value transfer exercises if analysts apply evidence from multiple source studies to estimate benefits for different final goods that are potentially substitutes for each other. Ad-hoc adjustments to value estimates are conceivable, although an empirical basis for these should be sought. Where IVS is expected to be a significant issue and the accuracy requirements for evidence informing decision-making are high, commissioning of a primary study that can explicitly control for this should be considered.

Table 1: Template for mapping ecosystem service - final benefits - affected population inland grazing marsh example from Case Study 3				
Ecosystem service	Contributing functions	Final benefit	TEV	Affected population
<i>Details of the ecosystem service provided by the policy good</i>	<i>Details of the functions that support the service; e.g. recreation is dependent on multiple supporting and provisioning processes</i>	<i>Details of the final good or service derived by human populations, including household, agriculture and commercial sectors</i>	<i>Component of TEV that the final good or service corresponds to</i>	<i>Extent of user and non-user population for the final good or service</i>
Provisioning services				
Food and fibre	Primary production, habitat provision, nutrient cycling, water quality	Livestock grazing	Direct use	Local landowners (livestock farmers)
Water supply	Cycling processes, water quality	Water for commercial uses	Direct use	Local manufacturing sites
		Water for agriculture	Direct use	Local landowners (arable farmers)
	Bioremediation of waste, nutrient cycling	Waste disposal (including detoxification of water and sediment)	Indirect use	Local and regional population
Habitat provision	Primary production, habitat provision, landscape, biodiversity	Biodiversity	Non-use	Potentially local-regional-national scale
Regulating services				
Climate regulation	Cycling processes, soil formation and retention	Carbon sequestration	Indirect use/non-use	Global population
Water regulation	Soil formation and retention	Flood protection	Indirect use	Local and regional population
Water purification	Cycling processes, soil formation and retention	Drinking water quality and quantity	Indirect use	Local and regional population
Cultural services				
Cultural and heritage	Soil formation and retention	Heritage / archaeological value	Direct use/non-use	Potentially local-regional-national scale
Recreation	Primary production, habitat provision, nutrient cycling, water quality, landscape, biodiversity.	Freshwater angling (migratory)	Direct use	Recreational anglers
		Freshwater angling (coarse)	Direct use	Recreational anglers
		Other wildlife recreation	Direct use	Birdwatchers and other nature watchers
Landscape	Primary production, habitat provision, landscape, biodiversity	Landscape (amenity to local residents)	Direct use	Local population

Notes: Ecosystem service categories are based on Defra (2007a).

2.2 Who are the affected population?

Correct definition of the affected population within the bounds of the decision-making context for the policy good is crucial to identifying appropriate monetary valuation evidence (**Step 4**) and estimating robust aggregate values (**Step 6**).

Assumptions made about the size and composition of the affected population should be tested via sensitivity analysis (**Step 7**) to establish their importance on the final value estimates.

The affected population

The affected population is the sum of the relevant user and non-user populations:

- User population: this consists of individuals deriving use values (direct, consumptive and non-consumptive, and indirect) from the policy good.

Users can also hold non-use values for the policy good; i.e. in addition to the value an individual derives from using a good they may also derive value from altruistic and bequest motivations for others and existence value.

Different types of value held by users are generally not estimated separately.

- Non user population: this consists of individuals deriving non-use value from the policy good due to altruistic, bequest and existence motivations. If the decision results in an improvement in the quality or quantity of the policy good, then some individuals within the non-user population may become users (see also **Step 3**).

The affected population is essentially the ‘market’ for the policy good even if no market transaction takes place. It is also referred to as the **economic jurisdiction**.

The analyst should identify the key characteristics of the affected population in terms of whether:

- The policy good is relevant to users only;
- There are different types of users for the policy good: distinguishing between user and non-users, and different groups within the user population (e.g. specialist recreational users - anglers, bird-watchers, etc.; informal recreation users; households benefiting from flood protection; etc);
- There are non-users;
- There are data to estimate the number of users and non-users in order to aggregate the unit value estimates (e.g. census data, visitor counts, etc.); and
- There are data available on the characteristics of the affected population (e.g. socio-economic and demographic) in order to adjust unit values or use a function transfer approach.

Sources for these data types are considered in **Step 3** (see Section 3.2).

Use of an ecosystem services framework as shown in **Table 1** provides an explicit account of the affected population for each benefit identified, linking the definition of the policy good to the affected population.

As with all aspects of the practical use of value transfer, effort spent on defining the affected population should be reflective of time and resource available overall. For example, if it is possible to justify measures to improve water quality in a particular river by valuing benefits to specialist users such as anglers alone, the values held by other recreational users or non-users would not be necessary to estimate. That said, a pragmatic approach should still be a robust approach and account for the principles and considerations set out below.

Economic versus political jurisdiction for the policy good

Political jurisdiction is typically defined by national and regional (e.g. Government Office Regions) boundaries or other administrative boundaries (e.g. Local Authorities, utility supply areas, etc.) and is often the basis for decision-making. The economic jurisdiction for the policy good may not necessarily match its political jurisdiction:

- *Economic jurisdiction could be larger than political jurisdiction:* for example a World Heritage Site such as Stonehenge attracts both use (overseas tourists) and non-use values from beyond the UK. Whether non-resident economic values should be accounted for in decision-making is case-specific, but ordinarily appraisal is limited to the national level and this should be established by analysts in Step 1.
- *Economic jurisdiction could be smaller than political jurisdiction:* for example the change in the policy good may only affect specialist recreational users. If aggregate values are based on the size of the political jurisdiction population this will over-estimate aggregate values, particularly where spatial factors strongly influence use values associated with a site-specific policy good.

Users

The user population (or specific groups within it) is often readily identified; for example visitors to a recreation site. With respect to recreation users of a site, **Case Study 1** highlights how use values can differ between different visitor types (e.g. cyclists, horse riders, nature watchers, etc.) and also the importance of establishing the number of visits versus numbers of visitors to a site. In particular visitors may make multiple visits and the typical expectation is that the unit value per visit will likely decline as number of visits increases - so called '**frequency decay**' - due to diminishing marginal utility. Therefore applying a constant unit value across visits can result in an over-estimate of the use value derived by an individual.

The user population may also include individuals deriving indirect use values, such as households receiving flood protection benefits within a river catchment. Different elements of use value can be relevant at different spatial scales and this should be explicitly considered by analysts. For example some uses may only be relevant at a local level, while others may confer benefit on a larger regional / national / multi-country scale, while indirect use values in terms of carbon storage and sequestration are relevant at a global scale.

There is also a relationship between the distance and economic values; the so-called ‘**distance-decay**’ relationship which shows that use value, and the user proportion within the population, declines with distance from the valued resource. This relationship is part of the spatial element of the value and is crucial for site-specific goods and services (see also **Step 6** and the *Technical Report*).

The ecosystem services framework can be particularly useful in terms of identifying the spatial scale over which specific ecosystem services contribute to human welfare (Table 1).

Non-users

The non-user population for a policy good requires careful consideration as this can be a key sensitivity in estimating the aggregate value of the policy good. In many instances, such as local recreation sites with an abundance of substitutes of a similar quality and no ‘unique’ features, non-use values are likely to be insignificant. However, if the total size of the likely non-user population is large, ‘insignificant’ per household non-use values can quickly add up to very large numbers. In contrast, policy goods that are unique (e.g. an iconic natural landmark, a habitat for significant or rare species of flora and fauna) or are subject to substantial changes in the level of its provision may give rise to significant non-use value.

In general, economic theory and evidence from the literature do not offer any clear expectation as to how non-use value may vary with spatial scale and how factors such as distance may influence it⁸. Therefore evidence and assumptions used to define the non-user population must be clearly presented. Where supporting empirical evidence is not available, analyst should provide justification for the definition of the non-user population in qualitative terms.

⁸ The lack of empirical evidence generally arises because the literature of existing stated preference studies have in most instances not sampled from a sufficiently wide spatial area to enable analysis to investigate distance decay effects in relation to non-use values.

STEP 3: DEFINE AND QUANTIFY THE CHANGE IN PROVISION OF THE POLICY GOOD

This step addresses the following questions:

- *What are the baseline conditions of the policy good (without the change)?*
- *What is the change described in qualitative terms?*
- *What is the change measured in quantitative terms?*
- *As well as the data on the baseline and change, is there other supporting data to help with value transfer?*

With input from:

- *Policy analysts - on the policies and projects that will affect the baseline and those that give rise to the change, and qualitative description of the change.*
- *Technical experts - on the baseline conditions, qualitative description of the change, and the physical, biological and chemical data for quantifying the change.*

Note that:

- *The baseline to which the change is relevant should be defined first.*
- *The change could be in the quality or the quantity of the good; it could be positive or negative.*
- *The change could vary over time and space.*

This step is closely linked to:

- *Step 2 - the definition of the policy good and the affected population helps define the baseline from which the change is identified;*
- *Step 4 - the type and scale of the change is crucial in selecting the relevant economic value evidence from the literature;*
- *Step 6 - unit value (or the value function) is aggregated across the change; and*
- *Step 7 - assumptions made in quantifying the change can be tested in sensitivity analysis.*

The 'change' in the provision of the policy good is the difference between the level of provision of the policy good without the decision being appraised (the 'baseline') and the level of provision of the policy good with the decision (e.g. with the project or policy). The change can be:

- A quantity change (e.g. an increase in carbon emissions); or
- A quality change (e.g. an improvement in water quality); or both, and
- Described qualitatively (e.g. an increase in emissions; an improvement in quality; a change in access); and
- Measured quantitatively (e.g. 100 tonnes of pollutant; a 1 mgNl⁻¹ change in biological oxygen demand in river water; change in number of visitors).

In order to define and measure the change in the policy good, analysts need to:

- i). Identify the sources of technical evidence for the decision to be appraised⁹: for some policy and project outcomes there may be a good understanding of the expected effects, for others there may be much more uncertainty and gaps in knowledge;
- ii). Assess the baseline: determine the level of provision of the policy good and expectations as to its current and future provision *without* the policy or project intervention;
- iii). Describe the change in the provision of the policy good with the decision (qualitative assessment);
- iv). Measure the change in the provision of the policy good with the decision in physical units (quantitative assessment);
- v). Identify and collate supporting data: that will facilitate adjusted unit value transfer or function transfer (Step 5) and aggregation (Step 6), including socio-economic characteristics of the affected population and availability of substitutes for the policy good; and
- vi). Assess uncertainty and gaps.

In some cases it will not be necessary to work through all of (i) to (iv) above. The scope of this step depends on:

- The overall decision-context for the policy good that will determine the types of evidence required;
- The availability of scientific and technical evidence; and
- The value transfer approach used (e.g. unit value transfer, adjusted unit value transfer, function transfer).

The baseline and the change in provision of the policy good need to be defined such that it is possible to identify suitable valuation evidence from existing studies. The iterative nature of defining the good, the change and selecting value evidence (Steps 2 - 4) is shown in Figure 2.

Analysis of the change in the provision of the policy good is led by technical experts. The role for analysts is to ensure that the evidence available is appropriate to inform value transfer. This requires analysts to work closely with technical experts to ensure a common understanding of the needs of value transfer analysis.

⁹ Note that the terms 'scientific and technical evidence' and 'physical changes' should be interpreted broadly. Essentially these terms are used to mean any form of evidence such as statistical predictions, modelling, design specification, scientific investigation, population survey (both species and human populations), etc. that provide an assessment of the change in the provision of the policy good.

3.1 What is the change in the provision of the policy good?

Analysts should seek advice from technical experts to collate and analyse the evidence relating to the change in the provision of the policy good. With such evidence gathered, analysts should interpret what it means in terms of changes in human welfare (use and non-use values) for example by using the ecosystem services framework.

Scientific and technical evidence may be available via:

- Formal reports that have been commissioned specifically for the policy or project proposal, or undertaken for similar circumstances. For example, the outputs of an environmental impact assessment (EIA) or strategic environmental assessment (SEA), life cycle assessment (LCA) or similar assessments; and/or
- Judgement from technical experts; and/or
- Consultation with stakeholders to form a basis for establishing the change in the policy good. For example, in an Impact Assessment relevant stakeholders are likely to be engaged within the consultation phase and this provides an opportunity for analysts to identify further sources of information to aid value transfer.

Assessing the baseline

The baseline is the condition of the policy good now and in the future *without* the decision (project, policy etc.) being appraised. The assessment of the baseline is an extension of the definition of the policy good set out in **Step 2. Box 7** summarises why baseline information is important.

Accounting for future trends

Accounting for future trends includes expectations about economic conditions (e.g. the influence of market forces, government policies, etc.) and environmental conditions that are influenced by factors other than the decision being appraised. For example climate change is likely to imply changes in the abundance of terrestrial habitats and species types, which should be included in a baseline assessment for analysis focussed on valuing changes brought about by any decision that is likely to affect habitats and species.

Accounting for relative scarcity

Scarcity may not only be concerned with the quantity of the policy good, but also its quality, location and timing. For example, consider water: its quantity can be scarce (e.g. low flows in rivers), its quality can be scarce (a river may be heavily polluted), its scarcity may vary between different locations (e.g. where river flows are controlled through weirs) and its scarcity can be time-dependent (due to seasonal variation; e.g. dry hot summers).

Location dependent scarcity may also apply at larger scales from local to regional, national and international levels. This is particularly relevant for biodiversity in terms of habitats and species. For example, the Golden Eagle (a large bird of prey) is uncommon in the UK and is mostly restricted to upland areas in Scotland, but it is more commonly found across Europe. In contrast the Corn Crane (a small bird native to grazing meadows) is becoming increasingly

scarce in the UK and also across the rest of its range, due to decline in its natural habitat. Hence both species of bird are scarce at the UK level, but the latter is also scarce at the international level.

The scarcity of a policy good is also influenced by the abundance and quality of substitutes available to the affected population. A large number of 'close' substitutes typically implies lower relative scarcity for a given good. Consider urban fringe green space that provides informal recreational amenity. Loss of a specific site - say 5 hectares - may be relatively insignificant in relation to the overall availability of such land in the area that can provide a similar function. If however the site to be developed provides specific amenities (e.g. sports pitches, play areas, etc.) then comparable sites in the local area may not be available. Hence at the local scale, which is the appropriate basis for the user population, the site to be developed would have potentially few, if any, substitutes.

Uniqueness, rarity or importance of a policy good, particularly in scientific terms may also be signalled by statutory designations (e.g. SSSIs, SACs, SPAs, etc.).

While the baseline is integral to the assessment of the change in the provision of the policy good, the need to assess it does not imply that the analyst has to pull together a complete inventory of the policy good in its current and future baseline condition. In many instances it is sufficient to know whether the change is a marginal change, i.e. a proportionally small change in relation to the total stock of the good (**Box 8**).

Qualitative assessment of the change

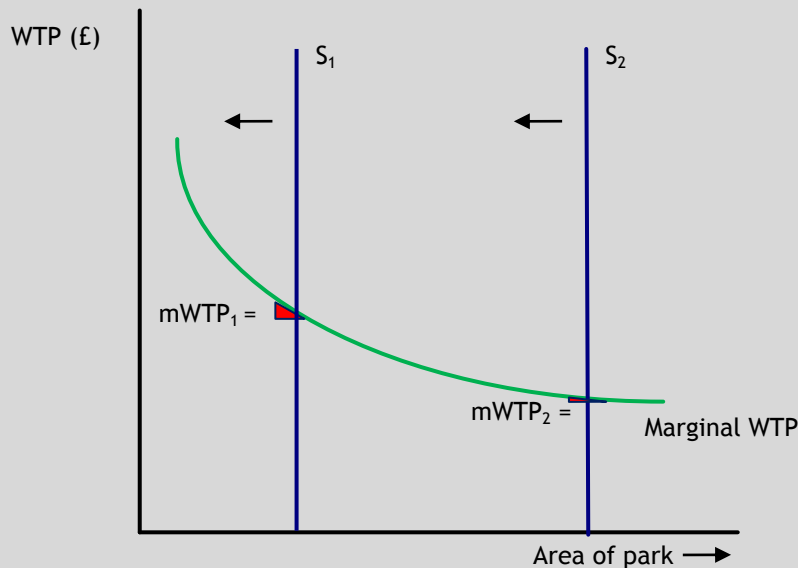
A qualitative assessment of the change will typically:

- **Describe the nature of the change**: change in quantity (e.g. emissions of carbon) or quality (e.g. river water quality);
- **Describe the direction of the change**: an increase or decrease (quantity) or improvement or deterioration (quality);
- **Describe the temporal nature of the change**: a change that will occur immediately or gradually over time, for a limited period of time (e.g. effects during the construction phase of a project) or permanent;
- **Describe the spatial nature of the change**: the location(s) as to where the change will occur; and
- **Describe the scale of the change**: an assessment of the significance of the change based on scientific and technical understanding of the policy good and the expected policy or project outcomes (e.g. whether marginal or non-marginal compared to baseline).

In each of the above, uncertainties and gaps in knowledge should also be identified. This provides a basis for sensitivity analysis (**Step 7**) or in instances where there are considerable gaps in evidence, assessing whether value transfer is feasible.

Box 7: Why does the baseline provision of the policy good matter?

Consider the policy good to be an inner city park and the Local Authority has the option to develop some of this land for housing. This will reduce the area of park that provides amenity value and recreation opportunities to local residents. Suppose that a primary economic valuation study has been undertaken and the expected relationship between demand (as traced by the marginal willingness to pay (WTP) schedule) and area of park is found where the WTP for an extra unit of park declines as the available park area increases (e.g. a downward sloping curve exhibiting diminishing marginal utility):



If the current size of park is S_1 , marginal reductions in the size of the park will be valued much greater than if the current area is S_2 , since $mWTP_1 > mWTP_2$, as given by the gradient of the marginal WTP schedule at S_1 and S_2 .

In practice many value transfer applications use average WTP estimates, which imply constant marginal values. This would mean a linear marginal WTP schedule instead of the declining curve shown above so that $mWTP_1$ would be equal to $mWTP_2$ regardless of the baseline size of the park.

In cases where there is a good match between the baseline and the scale of changes in policy and study goods (**Step 4**), constant WTP may be an adequate assumption. The task for analysts is to assess if the change in the policy good is large enough to 'shift' the supply substantially enough along the demand curve to imply non-constant marginal WTP over the range of the change in provision (see also Box 8). In practice it may also be the case that the demand curve is unknown and available evidence may provide a marginal value for one context (e.g. at supply = S_2). Analysts may need to judge if this value is appropriate in a different context (e.g. at supply = S_1).

Box 8: Marginal and non-marginal changes and economic valuation

Marginal changes

Economic valuation is primarily concerned with estimating the value of marginal changes. What constitutes ‘marginal’ can vary. In some instances it may literally be a unit change (e.g. 1 hectare of wetland), in other instances, several units may change but the size of the change could be relatively small in comparison to the provision of the good or service (e.g. 10 hectares of wetland from 10,000 hectares available).

Non-marginal changes

Non-marginal changes (due to human activities or natural processes) are disproportionately large compared to the total stock. Such changes can be understood through environmental thresholds and limits (Haines-Young et al, 2006):

- ***Environmental threshold***: a rapid change or sudden collapse in a natural resource system that results in an alternative and lower stable state (in terms of the provision of goods and services); for example the collapse of marine fisheries due to over fishing.
- ***Environmental limit***: the point at which a natural resource system no longer functions, implying a loss of all services associated with it. Exceeding environmental limits implies an irreversible change within human time frames.

As Defra (2007a) highlights, economic values based on stable levels of provision of a good will not fully reflect the value of non-marginal changes. While this can represent significant difficulty for decision-making, the difficulty stems from both economic *and* scientific evidence. The pragmatic response is for the analyst to ensure that the key assumptions and limitations of the analysis are transparently reported and that sensitivity analysis reflects the full extent of gaps in evidence.

Qualitative assessments may also feature:

- ***A ‘rating’ of the policy or project outcome of interest***: this mostly relates to assessment methodologies, such as EIA, SEA and also MCA that not only collate evidence but also assess the significance of impacts. **Case Study 5** provides an illustration of a qualitative assessment of the benefits of designation of marine conservation sites. Other examples include the appraisal of landscape, biodiversity and cultural heritage impacts of transport scheme proposals via the Department for Transport’s ‘New Approach to Appraisal’¹⁰.
- ***Application of an ecosystem services approach***: the framework for an ecosystem services approach set out in *An Introductory Guide to Valuing Ecosystem Services* (Defra, 2007a) details a basic scoring approach to assessing the effects of policy and projects on the provision of ecosystem services¹¹. A key benefit of this form of assessment - particularly instances where the policy good involves multiple environmental attributes - is the systematic ordering of information which conveys a high level summary of the key effects of interest. In turn this signals to analysts the aspects of the appraisal case that are likely to require detailed analysis.

¹⁰ See WebTAG (Transport Appraisal Guidance), environmental objective: www.webtag.org.uk

¹¹ See Table 3.1 in *An Introductory Guide to Valuing Ecosystem Services* (Defra, 2007a). This is similar to a scoring approach that is set out in eftc (2007) in relation to valuing environmental effects of flood and coastal erosion risk management schemes.

The outcome of the qualitative assessment should be a clear description and understanding of the change in the provision of the policy good and the overall context within which the change occurs.

Quantitative assessment of the change

Quantification of the change should *measure* the direction and magnitude of the change (and the profile over time) or provide a proxy measure of it. This should be informed by available scientific and technical evidence and/or collation of supporting data (see Section 3.2). The measure will depend on the nature of the policy good:

- **Quantity change**: typically measured in the physical unit of account for the policy good. For example: pollutants such as greenhouse gas emission can be quantified in tonnes of emissions; marketed products such as timber and agricultural commodities in tonnes of produce; water supply in volume (e.g. megalitres per day); species in size of population or catch (e.g. fish) or area of habitat (e.g. hectares); etc.
- **Quality change**: typically related to physical, chemical or biological parameters of the policy good. For example: river water quality can be measured in terms of parameters such as biological oxygen demand (BOD) and dissolved oxygen (DO).
- **Probability of occurrence**: scientific evidence may relate to the risk of outcomes occurring. For example flood risk is presented in terms of the return period, such as a 1 in 50 year event. Where probability data are available, the measurement is one of expected outcomes (i.e. probability × outcome)¹².
- **Population**: The quality or quantity of the policy good may not change but the type or number of those benefitting from its provision may¹³. For example for a recreation site the decision may affect access (e.g. an increase in the price of entry or closure to improve conservation), hence the number and type of the affected population is the unit of change. **Case Study 1** provides an example in terms of visits to a forest recreation site. Alternatively indirect use values, such as flood protection, may be measured by the number of households benefitting from flood storage (and hence flood risk reduction) in a river catchment. In general, quantifying the change is not sufficient. The analyst needs to interpret the quantitative evidence in terms of what it means for human welfare (i.e. types of use value and non-use values).

For example, BOD is not valued on its own but because of its effect on the availability of fish populations which could attract use values through commercial fishing and angling, and non-use values through existence, bequest or altruistic motives. **Case Study 4** highlights the use of a classification that translates chemical measures of water quality (e.g. BOD) into an indicator based on ecological classifications (e.g. species of flora and fauna) (see

¹² *The Green Book* (HM Treasury, 2003) provides some detail on the treatment of risk, particularly in terms of expected values.

¹³ Note that this links to the definition of the affected population in **Step 2** and changes in the extent of the market, which are cited in Box 5 (conversion of non-users to users in the case of quality changes), and overlaps with aggregation of values over a user and/or non-user population (**Step 6**). Analysts are referred to the *Technical Report* (Section 6) for a more thorough account of issues.

Step 3 in Case Study 4; see also *Technical Report*, Section 4). Proxy measures can be used for this purpose (e.g. area of habitat can be a proxy for ecosystem service provision). **Case Study 3** quantifies the change in the provision of the policy good in terms of hectares of habitat restored and created.

The outcome of the quantitative assessment should be a measure of the change and an interpretation of what the change means in human welfare terms.

3.2 Supporting data

Applications of value transfer also require collation of data in addition to that directly related to quantifying the change in the provision of the policy good. As a minimum, analysts will need supporting data about:

- *The size of the affected population*: e.g. numbers of users and non-users where relevant.
- *Socio-economic and demographic characteristics of the affected population*: specific requirements will vary case to case but could include: household income or GDP per capita; socio-economic group; education; occupation status; age profile; household size; number of dependents, etc.
- *Patterns and frequency of use*: e.g. number of visits.
- *Availability of substitutes to the policy good*: see Case Study 3 for an explicit account of identification of substitute sites for the policy good.

This information is needed for analysts to assess the match between the policy good context and study context in **Step 4** when assessing the suitability of available valuation evidence. It can play a major role in determining the choice between unit value transfer, adjusted unit value transfer and value function transfer (see **Step 5**). As part of the iterative process of value transfer, analysts may also need to collate supporting information as a result of identifying further information needs in Steps 4 and 5.

Case Studies 3 and **4** show types of data needed when using a function transfer approach. Case Study 3 also documents the data sources and data collection process entailed in the analysis.

Potential sources for supporting data are highlighted in **Box 9**. For site-specific policy goods geographical information system (GIS) can be used to collate spatially referenced data (e.g. distance to policy good site, distance to substitute sites, socio-economic characteristics at post code level) that can be inputted to a function transfer (see also **Case Study 7**).

Requirements for supporting data will be case-specific; analysts may need to revisit Step 3 once data needs have been identified from the review of available valuation evidence in Step 4.

3.3 Uncertainty and gaps in evidence

Sensitivity analysis should be used to address uncertainty and gaps in scientific and technical evidence and the definition of the change in the provision of the policy good including:

- *Applying ranges in addition to point estimates*: for example identifying a ‘best estimate’ for the change in the provision of the policy good and appropriate lower and upper bounds to this estimate. As well as being appropriate for quantity and quality changes, this can also account for uncertainty in the timing of the provision of the change in the policy good.
- *Specifying scenarios that account for sensitivity in multiple parameters*: for example identifying a ‘minimum change’ scenario and a ‘maximum change’ scenario that apply minimum and maximum estimates respectively for a set of parameters (see for example **Case Study 5**). This may also account for issues such as threshold limits and non-marginal changes (e.g. if population collapse of a species is an uncertain but possible outcome).
- *Assign probabilities to outcomes*: a distribution approach can be more useful than assessing minimum and maximum extremes, particularly if neither are particularly likely outcomes¹⁴.
- *Switching analysis*: identifying the value of parameter that changes recommendations for decision-making (see Step 7 for further discussion).

Analysts should identify the key sensitivities in the assessment of the change and gauge their relative importance in comparison to other aspects of the analysis.

Box 9: Supporting data - example sources

Socio-economic and demographic characteristics

- Official statistics: e.g. ONS census data, national level, by Government Office Region, postcode level etc. (www.statistics.gov.uk); Local Authority statistics.

Patterns and frequency of use

- UK Day Visits survey (<http://p1.countryside.gov.uk/LAR/Recreation/visits/index.asp>).
- Reports, articles and statistics published by authorities managing sites - these can be identified by web search, consultation responses or direct contact with relevant individuals.

Information of policy good and identification of substitutes

- GIS datasets, for example www.magic.gov.uk (designations, landscape character areas, habitat types, recreation sites, etc).
- Websites for particular sites of interest; e.g. Forestry Commission, National Trust, Wildlife Trust, RSPB, other conservation agencies etc. all provide visitor information and in some case visitor statistics for specific sites.
- Other searches to identify specialist user population. For example, for a water quality valuation study concerning recreational angling, sources of information could include:
 - ⇒ British Waterways web site - contact details for angling clubs are provided;
 - ⇒ Specialist interest papers - Angling Times or web forums;
 - ⇒ Angling license database and associated literature (gives numbers of licenses sold in different regions over years) - held by the Environment Agency;
 - ⇒ Reservoir operators - management statistics on use; or
 - ⇒ Private fishery owners - data on permits.

STEP 4: IDENTIFY AND SELECT MONETARY VALUATION EVIDENCE

This step addresses the following questions:

- *Is there any economic value evidence that matches the policy good, the change and the affected population?*
- *Is the evidence of sufficiently good quality?*
- *What is the unit value(s) and/or value function(s) to be transferred?*

With input from:

⇒ *The analyst - on economic value evidence. It is good practice to consult policy analysts and technical experts on the assumptions and selected unit value(s) and /or value function(s), and to consult with valuation experts to identify suitable evidence.*

Note that:

- *A literature review is required to identify existing valuation studies that are relevant to the change in the policy good.*
- *The suitability of economic value evidence is determined by the 'match' between the policy good and its context and the study good and its context.*
- *Not all valuation studies are of good quality. The quality of the evidence should be assessed before the it is used.*
- *If there is no sufficiently good unit value or value function for value transfer, alternatives need to be considered (see Step 1).*

This step is closely linked to:

- *Steps 1 - 3 - which set the context, define the good, the change and the affected population, and help with matching the value evidence for the study good(s) to the policy good.*
- *Step 5 - the evidence selected in this step is used for value transfer.*
- *Step 6 - the value evidence from this step is transferred, aggregated over the different changes, the affected population and time.*
- *Step 7 - the effect of the uncertainty surrounding the value evidence on the transfer results can be tested via sensitivity analysis.*

There are four main tasks that analysts must undertake:

- i). Conduct a thorough review of existing studies to ensure that all evidence potentially relevant to the policy good is identified;
- ii). Assess the match between the policy good (as defined in **Step 2**) and the change in its provision (as defined in **Step 3**) and the study good and the change in its provision;

- iii). Assess the quality of the valuation evidence available to determine if it is sufficiently robust to be applied in policy good decision-context; and
- iv). Select appropriate valuation evidence to transfer.

Key considerations for each of these tasks are set out below. Further guidance for assessing the quality of and interpreting evidence from primary valuation studies is provided in **Annex 2** (*Assessing the Quality of Primary Valuation Studies*) and **Annex 3** (*Glossary of Econometric Terminology*).

The value evidence sought could include:

- Unit value(s): e.g. mean average WTP / WTA values;
- Value function(s): e.g. function of parameters (explanatory variables) used to predict WTP / WTA;
- Ranges and confidence intervals for unit values and function coefficients: e.g. lower and upper bound parameter estimates; and
- Supporting data: e.g. distance decay relationship, frequency of visits, empirical basis for attributing non-use values, etc. (see also **Steps 2 and 3**).

The type of evidence required is case-specific depending on the:

- Details of the policy good, the change and the affected population (from **Steps 1-3**);
- Value transfer approach adopted (unit value, adjusted unit value, function transfer); and
- Level of effort justified and time and resources available (**Step 1**).

4.1 Searching for economic value evidence

Value evidence can be sourced from individual primary valuation studies (using any valuation method or market prices) or from meta-analyses. Meta-analyses collate data from multiple valuation studies on a particular good, with the purpose of identifying the key factors that influence estimated economic values. **Case Study 3** demonstrates the use of value transfer from a meta-analysis study.

Sources for value evidence (in particular for non-market goods and services) include:

- Existing guidance documents: for example DECC *Carbon valuation*; Defra *Air quality strategy*; DfT *WebTAG*; HSE appraisal values (see **Step 5** for further detail).
- Government and other organisations' research: both primary valuation studies and other value transfer applications. See **Box 10** for a summary of recent economic valuation research commissioned by Government departments and agencies in relation to environmental goods and services.
- Value transfer databases: A number of databases have been developed to summarise the key content of valuation studies for the purposes of value transfer (see **Box 11**). Summaries include details that help match the policy and study good contexts and assess the study

quality (e.g. the study area and characteristics, the study good characteristics, the study methodology and results).

The most comprehensive database is the **Environmental Valuation Reference Inventory (EVRI)**, which Defra co-sponsors. In instances where the analyst is uncertain of the extent of available literature, EVRI is a very useful 'first port of call'. An initial search of the database will likely provide a quick indication of the number of studies available, how recent they are and the countries in which they have been carried out. **Box 12** provides basic instructions for accessing and using EVRI.

Note that summary information contained in databases is unlikely to be sufficient for value transfer (in particular for function transfer). Therefore the analyst should obtain the original report or article.

- Academic journals and texts (e.g. edited books): journal websites facilitate searches of content which may include articles on primary valuation studies, meta-analyses and testing of value transfer.
- Working papers and conference papers: typically these will be accessed via web-searches¹⁵ and may include articles on primary valuation studies, meta-analyses and testing of value transfer.
- Consultation with economic valuation and other experts.

Even if the analyst is familiar with the literature and available evidence, search is still required; newer studies may have become available that can aid the value transfer analysis.

¹⁵ For example via Google Scholar (<http://scholar.google.co.uk/>) and Research Papers in Economics (RePEc) (<http://repec.org/>). The RePEc main page provides access to IDEAS (working papers, journal articles, software components, author information, directory of institutions), EconPapers (online on-line working papers, journal articles and software) and a number of other resources.

Box 10: Recent UK Government funded economic valuation research

This box lists references for recent UK Government funded economic valuation research including primary studies and value transfer. The references may provide analysts with useful starting places for conducting wider literature reviews, and in some cases evidence suitable for value transfer.

Agriculture, agri-environmental schemes and non-market benefits (Defra)

- Willis et al (forthcoming) *Estimating the Non-market Benefits of Environmental Stewardship**.
- Jacobs et al (2008) *Environmental Accounts for Agriculture*.
- eftec (2006) *Economic Valuation of Environmental Impacts in the Severely Disadvantaged Areas**.
- Oglethorpe (2005) *Environmental Landscape Features (ELF) Model Update*.
- eftec (2004) *Framework for Environmental Accounts for Agriculture*
- University of Edinburgh and Scottish Agricultural College (2001) *Estimating the Value of Environmental Features*.

Air quality (Defra)

- Defra (2007b) *Economic Analysis to Inform the Air Quality Strategy*
- Chilton et al (2004) *Valuation of Health Benefits Associated with Reductions in Air Pollution**.
- MacMillan (2001) *Valuation of Air Pollution Effects on Ecosystems*.

Biodiversity (Defra)

- Christie et al (forthcoming) *Economic Valuation of the Benefits of the UK Biodiversity Action Plan**.
- Christie et al (2004) *Developing Measures for Valuing Changes in Biodiversity**.

Ecosystem services - general (Defra)

- Jacobs (2008) *A Valuation of England's Terrestrial Ecosystem Services*.
- eftec (2005) *The Economic, Social and Ecological Value of Ecosystem Services: A Literature Review*.
- GHK Consulting Ltd and GFA-Race Partners Ltd. (2004) *Revealing the Value of the Natural Environment in England*.

Fisheries (Environment Agency)

- Lawrence and Spurgeon (2007) *Economic Evaluation of Inland Fisheries: Welfare Benefits of Inland Fisheries in England and Wales**.
- Drew Associates (2003) *Research into the Economic Contribution of Sea Angling**.
- Radford et al (2001) *Economic Evaluation of Inland Fisheries Module A: Economic Evaluation of Fishing Rights*.
- Spurgeon et al (2001) *Economic Evaluation of Inland Fisheries Module B: Indirect Economic Values Associated with Fisheries**.

Landscape

- eftec (2009) *Valuing Transport's Impact on the Natural Landscape: Phase 2* (DfT)*.
- Swanwick et al (2007) *Scoping Study on Agricultural Landscape Valuation (Defra)*.

Marine biodiversity (Defra)

- Scottish Agricultural College (2008) *Determining Monetary Values for Use and Non-use Goods and Services - Marine Biodiversity - Primary Valuation**.
- Beaumont et al (2006) *Marine Biodiversity - An Economic Valuation*.

Box 10: Recent UK Government funded economic valuation research (continued)

Forestry (Forestry Commission)

- Social and Economic Research Group (2008) *A Valuation of the Economic and Social Contribution of Forestry for People in Scotland*.
- Christie et al. (2006) *Valuing Forest Recreation Activities**.
- Crabtree (2005) *Economic Benefits of Accessible Green Spaces for Physical and Mental Health: Scoping Study*.
- Crabtree (2005) *A Review of Evidence for the Formulation of Forestry Policy in England (Defra)*.
- Jones et al (2003) *Estimating Arrival Numbers and Values for Informal Recreational Use of British woodlands**.
- Brainard et al (2003) *Carbon Sequestration Benefits of Woodland*.
- Scarpa (2003) *The Recreation Value of Woodlands**.
- Powe and Willis (2002) *Mortality and Morbidity Benefits of Air Pollution Absorption by Woodland*.
- Macmillan (2002) *The Value of Managing Forests to Protect Archaeology*.
- Hanley et al (2002) *Valuing the Benefits of Biodiversity in Forests**.
- Garrod (2002) *Landscape Benefits*.

Noise (Department for Transport)

- Bateman et al. (2004) *The Valuation of Transport-Related Noise in Birmingham**

Undeveloped land (Communities and Local Government)

- ODPM/CLG (2002) *The External Benefits of Undeveloped Land: A Review of the Economic Literature*.

Water quality (Defra)

- Nera (2007) *The Benefits of Water Framework Directive Programmes of Measures in England and Wales**.
- eftec (2002) *Valuation of Benefits to England and Wales of a Revised Bathing Water Quality Directive**.

Notes:

List of studies as of July 2009. Full citations are provided in the reference section.

* Denotes primary valuation study

Box 11: Databases for value transfer

- Environmental Valuation Reference Inventory (EVRI) www.evri.ca: currently the most comprehensive database with the greatest coverage of UK studies. See **Box 12**.
- ENVALUE www.epa.nsw.gov.au/envalue: the main database for valuation studies in Australia. It contains over 400 studies, one third of which are Australian, covering nine different environmental goods. However it has not been updated since 2001.
- Valuation Study Database for Environmental Change in Sweden (ValueBase^{SWE}) www.beijer.kva.se/valuebase.htm: this contains a survey of Swedish studies.
- Review of Externality Data (RED) www.red-externalities.net: this is listing of studies mainly related to environmental costs (from a life cycle perspective) of energy and other sectors. It contains mostly details of value transfer exercises rather than primary valuation studies.
- Benefits Table (BeTa) (<http://ec.europa.eu/environment/enveco/air/pdf/betaec02a.pdf>): a database developed for the European Commission DG Environment to estimate to provide the external costs (health and environmental) of air pollution.
- Natural Resource Conservation Service (NRCS), US Department of Agriculture, <http://www.economics.nrcs.usda.gov/technical/recreate>: a database and listing of unit value estimates for different recreational activities.
- National Oceanographic and Atmospheric Administration (NOAA) <http://marineeconomics.noaa.gov/bibsb/welcme.html>: provides three databases and 4 annotated bibliographies for coastal and marine resources.

For further details see: Danish Environmental Protection Agency (2007) *Practical tools for value transfer in Denmark - guidelines and an example*. All weblinks accessed July 2009.

Box 12: Environmental Valuation Reference Inventory (EVRI)

EVRI (www.evri.ca) is an Environment Canada initiative designed to assist analysts undertaking value transfer to estimate economic values for changes in environmental goods and services or human health. Defra is a co-sponsor and EVRI offers free subscription to registrations from a <<.uk>> email address. As of July 2009 EVRI covered over 2200 studies from North America, Europe and rest of the world.

How to Use EVRI

EVRI contains three main 'modules':

- Capturing module: for entering and editing data on studies (note this is not relevant for an analyst undertaking value transfer).
- Searching module: for searching the database for matches to the environmental good or service and its characteristics to be valued for the purposes of finding suitable studies.
- Screening module: summarises studies to allow users to identify key information for value transfer from studies identified by the search.

Searching EVRI

There are two methods for searching for studies on EVRI:

- A full text search text box: this functions like an internet search engine, returning all studies that include the search term(s) and allows use of the Boolean operators (i.e. 'AND' and 'OR').
- Searching protocol: This method allows the user to select as many or as few characteristics of interest (e.g. type of environmental media, type of stressor, geographic characteristics, etc.) by selecting relevant terms from a list.

Both types of search return a 'search map' which displays the numbers of studies under each characteristic chosen and the final number of studies resulting from the search.

Screening results

Search results are reviewed in the screening module. Results can be viewed as a list of study references or full summaries. Summaries are broken down into key content headings that are consistent across all study entries. Functions of the screening module include selecting or rejecting of studies, saving search sessions, loading previously saved search sessions and navigating through full study summaries or selected excerpts.

Further information on the use of EVRI is available from the EVRI tutorial, which can be accessed from web-address above.

Source: Information on EVRI accessed July 2009.

4.2 Criteria for matching study good to policy good

The review of existing studies may result in identifying a study or number of studies that are relevant to the policy good. If no relevant evidence is identified then analysts will need to consider alternative options to value transfer (see **Step 1**).

Assessments of the relevance of available evidence should focus on the factors that could cause the value of a good to change between the policy good context and the study good context. Criteria for comparing the policy and study good context include the similarity of¹⁶:

- i). The policy good and study good;
- ii). The change in the provision of the policy good and study good;
- iii). The locations where the policy good and study good are found;
- iv). The policy good and study good affected populations;
- v). The number and quality of substitutes for the policy good and study good; and
- vi). The policy good and study good market constructs.

Ideally a policy good and study good comparison would satisfy all of these conditions. However such a ‘perfect match’ is rare in practice. Where significant differences are evident between the policy good context and the study good context, analysts need to determine if these can be controlled for in the analysis or if alternative evidence should be sought. Some differences can be controlled for via adjusted unit transfer or value function transfer approaches (**Step 5**). **Table 2** provides an example comparison between a policy good context and study good context based on **Case Study 1** on forest recreation sites.

What ‘significant difference’ means is case-specific and depends on all aspects assessed in **Steps 1-3** (the information needs of the decision-context, the characteristics of the policy good and the change and the affected population). Analysts may need to revisit **Steps 1-3** to collect more data for the policy good to enable a comparison with a study good, or to enable evidence to be used in **Step 5** (e.g. to collect further data if a function transfer approach is to be used). Analysts should also consider how sensitivity analysis could be used to mitigate against concerns as to the correspondence between the policy good and study good context.

The following gives an overview of key points for each criterion (i-vi). It goes without saying that the relevance of value evidence is not sufficient and it also needs to be of sufficiently high quality. Section 4.3 reviews the aspects of the quality of value evidence with further information provided in Annexes 2 and 3.

¹⁶ These criteria are based various publications dating back to the 1992 special issue of *Water Resources Research*. See *Technical Report* (Annex 1) for a survey of value transfer literature.

Table 2: An example of comparing policy good context and study good context(s)				
<i>Selection Criteria - similarity between study and policy goods in terms of:</i>	<i>Policy good and site</i>	<i>Study 1: study good and site</i>	<i>Study 2: study good and site</i>	<i>Comment</i>
i). The good itself	Differentiated recreational activities (e.g. walking, cycling, horse-riding)	Differentiated by recreational activity type	Undifferentiated recreational activities (e.g. general visitors)	Study 1 provides a close match to the policy good recreation activities. Study 2 does not distinguish between activity types.
ii). The change	Site visitors differentiated by activity type (as above)	Differentiated by visitor type (e.g. cyclists)	Generic, non-specific activity visitors	As above - Study 1 provides a close match
iii). The location	Forestry Commission site: commercial forest site with recreation amenities (footpaths, cycle paths, visitor centre)	Forestry Commission sites: 7 forests in Great Britain with a range of recreation amenities	Woodland site and nature reserve	Study 1 covers a selection of sites; the facilities available at these mostly cover those available at the policy site. The Study 2 site has only basic facilities (car park, and footpaths)
iv). The affected populations	Majority of visitors originate from local area with small towns and larger urban areas	Approx. 50% visitors are self-reported day-trippers	Majority of visitors originate from local area with small towns and larger urban areas	The user population of Study 1 features a high degree of day-visitors. Study 2 provides a closer match in terms of visitors. Both studies provide socio-economic characteristics to enable adjusted unit value transfer
v). The number and quality of substitutes	Some alternative recreational sites nearby, but nothing directly comparable based on size, type of activity, and diversity of available activities.	Considers substitute sites such as other nearby woodlands, by including variable of travel distance to nearest substitute in travel cost model	Considers substitutes such as other nearby woodlands	Both Study 1 and Study 2 report the availability of substitute sites; Study 1 explicitly controls for substitutes using a travel cost model.
vi). The market constructs	The policy good site is open-access with minimal entry fee (car parking charge). The policy context is concerned with improvements to site quality	The study uses revealed preference approaches (travel cost and RUM) to value benefits of recreation facilities at an open-access site	The study uses a hypothetical market (contingent valuation) to estimate WTP for access to a new recreation site	Study 1 is concerned with the value of facilities at existing sites, which is a closer match than Study 2 which considers the establishment of a new site.
Study quality	N/A	A robust study with a full account of validity and potential biases in estimates	Generally a robust study although based on an older datasets	Study 1 is preferable on the basis of more recent data and state of the art method
<i>On the basis of the comparison Study 1 is determined to be a closer match to the policy good context and appropriate for value transfer.</i>				

(i) Similarity of the policy good and study good

The literature search should identify studies that value changes in goods sufficiently similar to the policy good. The comparison is based on the description of the policy good in **Step 2** and should account for:

- The physical characteristics of the goods: e.g. the impact, pollutant, habitat, species, resources, etc., and
- The types of use and non-use value derived from the goods.

The ecosystem services framework provides a useful basis for summarising available evidence to determine the final goods and services valued by a study or selection of studies (see **Step 2**).

Studies that do not provide a close match in terms of the definition of the good should be not be used for value transfer. For example valuation evidence relating to indirect use values from a wetland site (e.g. WTP to maintain flood protection benefits from the site) will not be an appropriate match to a policy good that is concerned with amenity and recreation benefits (non-consumptive direct use value) of a wetland site.

(ii) Similarity of the change in provision of the policy good and study good

The study good and policy good changes are compared using the factors from **Step 3** to define the change in the policy good:

- The nature of the change; e.g. quantity, quality change;
- The direction of the change; e.g. increase, improvement, decrease, deterioration;
- The timing of the change; e.g. gradual, sudden, temporary, permanent; and
- The scale of the change in relation to the baseline provision of the good; e.g. a complete loss, a marginal change, etc.

If significant differences are evident between the policy good and study good change, unadjusted unit value transfer will not be appropriate. Analysts may be able to control for factors such as the scale of change via adjustments or, more likely, value function transfer if relevant information is available (i.e. a WTP function that includes the magnitude of the change as an explanatory variable).

Alternatively analysts should consider other studies for value transfer, or how sensitivity analysis can be applied. For example, if there are no suitable studies, valuation evidence may be presented on the basis of a benefits threshold approach; i.e. estimating how large the benefit (or cost) of an environmental change ‘needs’ to be compared to the financial cost (or benefit) of the policy or project appraised (see **Step 7**).

(iii) Similarity of the locations where the policy good and study good are found

For site-specific goods, comparison of the policy good site and study good site is crucial. Comparison here should make use of the spatial factors reviewed for the policy good in **Step 2**:

- Proximity to populations (including accessibility to sites);

- Proximity to substitutes (see also (vi) below); and
- Proximity to complements.

The similarity of affected populations and their characteristics is addressed in (iv) below.

If significant differences are evident between the policy good and study good, unadjusted unit value transfer will not be appropriate. Analysts will need to control for differences between the policy good and study contexts via adjusted unit value transfer or value function transfer (if a robust WTP function is available). Supporting information and data will be needed for the policy good (see Step 3) for adjusted unit value transfer or function transfer. **Case Studies 3 and 4** provide examples of the application of value function transfer that account for differences in policy good site and study good site.

Alternatively analysts should consider other studies for value transfer, or how sensitivity analysis can be applied.

(iv) Similarity of the policy good and study good affected populations

The study and policy goods need to be sufficiently similar in terms of:

- The population type; e.g. users, different types of users (specialist groups, general public, etc.) and non-users; and
- The population characteristics; e.g. socio-economic characteristics, frequency of use, etc.

Studies that do not match the policy good affected population type (as defined in **Step 2**) should not be used for value transfer. For example economic value estimates for specific user groups (e.g. specialist groups such as anglers and bird-watchers) should not be transferred to estimate use values held by local residents (within which specific users will form only a small proportion of the wider population). Likewise use value estimates should not be transferred to estimate non-use values held by the general public. Generally in these cases it is difficult to envisage adjustments that could be made to mitigate differences between different groups in the affected population since they exhibit different preferences towards the policy good which results in distinctions between them in the first place.

Population characteristics data collected in **Step 3** in relation to the policy good should be compared to the characteristic of the population sample for the study good. Differences in population characteristics (for a given population type) will likely render (unadjusted) unit value transfer inappropriate; i.e. the 'average' individual in the study good population sample is not representative of 'average' individual in the policy good affected population (for example, due to differences in household income).

Adjusted unit value transfer can be used by analysts to control for differences in characteristics such as income (see **Step 5**). Where there is the need to control for multiple differences between the policy good and study good context, including population characteristics, but also spatial factors and the provision change, then a value function transfer approach is likely to be more appropriate (if a suitable function is available). **Case Studies 3 and 4** provide examples of the application of function transfer that account for multiple differences in policy good and study good contexts.

(v) Similarity of the number and quality of substitutes for the policy good and study good

The availability and quality of substitutes in the policy good context and the study good context is linked to the comparison of the policy and study good sites in (iii) above. Information concerning substitutes for the policy good should be collated in **Step 3**.

Ideally details on the availability of substitutes for the study good will be reported in the selected study or studies. See also **Annex 1** and **2** for what should be in such reports. Where studies do not report this information, the analyst will need to collate it for study good as well as policy good. General searches (e.g. for recreation sites close to the study good site) to determine potential substitutes and consultation with relevant experts or the study's author can help gather further information.

Case Studies 3 and **4** provide examples of controlling for the effect of the availability of substitutes in estimating the value of the change in the provision of the policy good via function transfer.

(vi) Similarity of the policy good and study good market constructs

The term 'market construct', which should be interpreted broadly, is additional to all the factors covered in (i) - (v) above and includes the correspondence between the following for the study and policy good contexts:

- **The circumstances of the change:** e.g. what are the drivers of the change (e.g. development of land, natural processes, change in management); is the change a 'one-off'; is the change independent of other effects; is the change part of a sequence of provision changes; or part of a series of simultaneous changes in a set of goods?
- **The (implied) property rights:** e.g. whether the affected population is 'entitled' to the baseline (*without* the policy or project) or the changed level of provision of the policy good (*with* the policy or project).
- **The economic conditions in which the change occurs:** e.g. how the prevailing economic outlook (economic growth, relative prices, other sectors) influences preferences towards the study good.
- **The institutional context:** e.g. who is responsible for the provision of the good (Government, private sector, charity and voluntary sector).
- **The cultural context:** here the most obvious distinction relates to non-UK studies and policy goods in the UK, where a seemingly similar good may have a different cultural significance to the affected population. Therefore, preference should typically be for UK studies (if they satisfy all criteria). A non-UK study should be used only if its suitability can be justified on the basis of comparison of all criteria. This will be a case-specific consideration.

Some of the above considerations may be covered in previous steps, while others could be covered in assessing the quality of primary studies (to see to what extent these factors were taken into account in the study) (see **Annex 2**).

Substantial differences between the above factors will likely imply that the study good is not a good match to the policy good. Moreover controlling for them via adjustments or function transfer is likely to be difficult and hence in these cases, alternatives to value transfer should be considered. As per criteria above, what constitutes a substantial difference is case-specific.

The analysts should assess the suitability of studies from the literature using the above criteria, presenting the information and judgements clearly. Where judgements are likely to be uncertain or sensitive, the analyst should consult with relevant colleagues before proceeding further with value transfer.

4.3 Assessing the quality of available valuation evidence

Value transfer is only as good as the methodology and assumptions employed in the primary study or studies from which the evidence is sourced. Assessing the robustness of the evidence sourced from existing studies is a fundamental task for analysts.

Studies that are judged to be of poor quality should not be used for value transfer even if the match between the policy good context and study good context is satisfactory.

Criteria for judging the quality of a study include:

- Sound data collection procedures and for survey-based economic valuation methods representative samples;
- Use of best practice methods; and
- Consistency of the results with expectations based on the economic theory.

Annexes 1 - 3 provide information to help analysts judge how each study fares compared to these criteria. Judging study quality requires a level of understanding of valuation methods and best practice on the part of the analyst, and thorough and detailed reporting on the part of the study authors. Note that sufficient detail to assess the quality of a study is unlikely to be available in a summary provided by a value transfer database. Analysts should obtain the original report or article.

Where further detail is required, analysts should consider contacting the study author. In the case of research commissioned by Government Departments and other organisation the analyst should obtain details of peer review comments on the study and wherever possible consult the project manager. Literature review sections in journal articles and reports may also assist analysts in critically assessing the robustness of a study in comparison to others available.

4.4 Selecting the appropriate evidence

If suitable economic value evidence is available, this should include:

- Unit values (e.g. WTP and WTA estimates);
- Value functions (to predict the value of the change in the policy good based on a set of explanatory variables);
- Appropriate ranges for unit values and function coefficients should also be identified for the purposes of sensitivity analysis; and
- Supporting data (e.g. a distance decay function - see **Cases Studies 4** and **7** for examples where such information is also transferred to the policy good context).

Application of the unit values and value functions in the policy good context is addressed in **Step 5**.

If there is a choice between several suitable value estimates or functions, best practice will generally be to use all available evidence to aid better sensitivity analysis. Analysts should avoid being 'selective' in choosing evidence if there is no justification for not applying it based on relevance and quality criteria. The outcome to avoid is the choice of evidence to support a particular conclusion, where use of alternative evidence may indicate otherwise.

STEP 5: TRANSFER EVIDENCE AND ESTIMATE THE VALUE OF THE POLICY GOOD

This Step addresses the following questions:

- Which value transfer approach is to be used?
- What is the transferred value of the change in the provision of the policy good?

With input from:

⇒ *The analyst - on economic value evidence. It is good practice to consult policy analysts and technical experts on the assumptions and selected unit value(s) and/or value function(s).*

Note that:

- *The value transfer approach is dependent on the type of evidence available from relevant literature (Step 4) as well as the level of effort required in generating evidence for decision-making.*
- *Unadjusted unit transfers that do not account for differences between the policy good and study good contexts are likely to imply a greater degree of uncertainty in the results of value transfer.*

This step is closely linked to:

- *Step 1 - determines the level of accuracy required and influences the choice of value transfer approach.*
- *Steps 2 & 3 - set out the policy good, affected population, change and supporting data which all feed into the value transfer.*
- *Step 4 - identifies the unit values and value functions from the literature.*
- *Step 6 - the value evidence from this step is transferred, aggregated over the different changes, the affected population and time.*
- *Step 7 - assumptions made in this step can be tested in the sensitivity analysis.*

There are two basic tasks for analysts in applying transferred valuation evidence:

- i) Choose the value transfer approach; and
- ii) Implement the chosen value transfer approach - including adjustments if necessary. This may require returning to Step 3 to collate the relevant supporting data.

5.1 Approaches to value transfer

There are two basic variants of value transfer: (i) unit value transfer; and (ii) value function transfer; and some variations within these. The different approaches to value transfer are

distinguished by their degree of complexity, the data requirements and the perceived reliability of the results.

Unit value transfer

Unit value transfer can take one of three forms:

- **Unadjusted unit value transfer from a single study**: a mean value estimate (and confidence interval) is transferred. Ideally the selected study focused on the same good and was carried out at the same location but at a different point in time. However, and more commonly, studies from a different yet comparable location and time are used for such transfers.
- **Unadjusted unit value transfer from multiple studies**: mean value estimates (and confidence intervals) from two or more studies are used to specify a range of values or calculate an average value for the change in the provision of the policy good¹⁷. This can include the use of mean values from a meta-analysis study, which summarises economic value estimates across multiple studies.
- **Adjusted unit value transfer**: a mean value estimate is adjusted to account for the differences between the study and policy goods with regards to one or more factors that are expected to influence economic value. Analysts should identify the factor(s) to control for in assessing the match between the policy good and study good context(s). The most common adjustment factor is income, as it is expected influence values and easy to find data for.

Section 5.2 reviews the application of unadjusted unit value transfer and Section 5.3 adjusted unit value transfer.

Value function transfer

Value function transfer allows the analyst to control for a set of factors found to explain variation in economic values (for the study good), such as the socio-economic characteristics of the affected population, characteristics of the good, the change in its provision and the availability of substitutes:

- **Value function**: this is transferred from the study good context to predict a mean value for the policy good. The coefficients of the explanatory variables in the study good value function are multiplied by the average values for these variables in the policy good context.

Adjusted value function approaches are also possible where the function coefficients can be based on multiple data sources (e.g. coefficient values are drawn from multiple studies).

¹⁷ Calculating an average value based on results from multiple studies is a form of adjusted unit transfer. However the adjustment does not control for differences between the policy good and study good contexts so it is not classified as adjusted unit transfer here.

- Meta-analysis function: estimated on the basis of results from multiple valuation studies this approach accounts for a broader base of evidence in predicting the value of the change in provision of the policy good. As with value function transfer, the average values of the explanatory factors in the policy good context are multiplied by the meta-analysis function coefficients.

Section 5.4 reviews the application of value function transfer.

Unit value transfer or value function transfer?

The answer depends on:

- The time and resources available for the analysis (from Step 1): more detailed analysis will require a longer timescale to collect necessary data.
- The available economic valuation evidence (from Step 4): value function transfer is only possible if a suitable and robust function is available from the literature.
- The match between the policy good context and study good context (from Step 4): this will identify the differences between the two contexts that need to be controlled for. Some differences can easily be controlled for by adjusted unit transfer (e.g. the socio-economic characteristics of the affected population). Where adjustments are required for multiple factors a function transfer is typically more appropriate, since this can simultaneously control differences between the two contexts.

Some rules of thumb for analysts are set out in **Table 3**. While these can be interpreted as a general guide, based on the arguments developed in the *Technical Report* (see **Box 13**), analysts still need to cover all considerations listed here and ensure sufficient quality valuation evidence and supporting information is available for the approach chosen. Note also that Table 3 does not summarise all possible combination of policy good and study good 'match'.

- The availability of supporting data (from Step 3): value function transfer is more data intensive and only viable if suitable data can be collated for the policy good context.
- Expectations of the 'level of error': error in this context is the difference between the transferred value for the policy good and the value for the same good that would have been estimated by a primary valuation study; i.e. the transfer error as defined in **Box 2**. In practical application of value transfer this comparison cannot be made. Based on academic research the general expectation is that value function transfer should be preferred to unit value transfer since it permits the analyst to control for differences that arise between the policy good and study good contexts. Empirical testing of unit value and value function transfer approaches (see *Technical Report*), however, do not necessarily confirm this view.

The *Technical Report* investigates in detail the comparison of unit value and value function transfer. It recommends the use of value functions that are firmly predicted by economic theory to influence economic values; i.e. the characteristics of the good including the

change in its provision, the availability of substitutes, household income. If value functions focus on ad-hoc variables that are specific to the study good context, and these cannot be matched or adjusted for in the policy good context, value function transfer is likely to have as large transfer errors as unit value transfer¹⁸.

Overall the task for analysts is to decide the level of analysis that is appropriate to the needs of the decision context given the available evidence. This will vary on a case-by-case basis.

Table 3: Some rules of thumb for choosing between value transfer approaches

<i>Selection Criteria (See Section 4.2)</i>	<i>A selection of possible policy good and study good 'matches'</i>							
i). The good	✓	✓	✓	✓	✓	✓	✗	✓
ii). The change	✓	✓	✓	✓	✗	✓	n/a	✓
iii). The location	✓	✓	✓	✗	✗	✓	n/a	✓
iv). The affected populations (characteristics)	✓	✗	✓	✗	✗	✗ or ✓	n/a	✓
v). The number and quality of substitutes	✓	✓	✗	✗	✗	✗ or ✓	n/a	✓
vi). The market constructs	✓	✓	✓	✓	✓	✗	n/a	✓
Study quality	✓	✓	✓	✓	✓	✓	n/a	✗
Rules of thumb:								
Unit value transfer:	👍	👎	👎	👎	👎	👎	👎	👎
Adjusted unit value transfer:	👍	👍	👍	?	?	?	👎	👎
Function transfer:	👍	👍	👍	👍	👍	?	👎	👎

Notes:

Criteria comparison: ✓ = close match between policy good context and study good context; ✗ = not a close match between policy good context and study good context; ✗ or ✓: Indicates that policy good and study good context match for the criteria is unlikely to be the determining factor for the choice of adjusted unit value transfer or value function transfer; n/a = not applicable.

Rules of thumb:

👍 = Approach likely to be appropriate provided sufficient supporting information is available (for adjusted or value function transfer).

👎 = Approach unlikely to be appropriate.

? = Uncertain: will depend on how different the policy good context and study good context are.

¹⁸ These variables are also known as 'contextual' factors. A contextual factor is best thought of as a variable that is not present in both the policy good and study good context; in effect it has a strong influence on the value of the study good, but is not relevant to the policy good context. Plummer (2009) provides a relevant example where the total value of a small area (2.4 hectares) of wetland in Louisiana, USA, was estimated to be \$215,000 (approximately \$90,000/ha). The value arises from the waste water treatment function that the site provides for an adjacent potato chip factory, in terms of avoided treatment costs. Here the factory represents a contextual factor; few wetlands are located by potato chip factories hence transferring either unit values or a value function from a context such as this is likely to result in serious error.

Box 13: Unit value transfer versus value function transfer

A common expectation is that because value function transfers allow the analyst greater control over differences between the policy good and study good context they should yield lower transfer errors than basic unit value transfers. The *Technical Report* adds two important qualifications to this assertion:

- A. Any value function which is to be used for transfer purposes should be carefully specified to focus on factors which are generic across the study and policy good contexts.
- B. Value function transfers, even when using well specified functions, may still not outperform unit value transfers if conducted for policy good changes in provision and contexts which are very similar to those given in source studies.

Analysts are encouraged to read the *Technical Report* which provides both a comprehensive theoretical and empirical assessment of value transfer to arrive at these recommendations.

In practice, of course, the level of transfer error will be unknown. Consider **Case Study 3** which contrasts:

- An average unit value per hectare for UK wetland sites: approximately £3,000 per hectare per year; and
- A value function transfer accounting for the size of the policy site affected population, their socio-economic characteristics and availability of substitutes: approximately £400 per hectare per year.

Both values are derived from the same source study, a meta-analysis of wetland valuation studies (Brander et al., 2008). While substantial variation is observed in the two estimates, there is no direct way to determine for certain which involves the greatest transfer error. Therefore the analyst needs to scrutinise the correspondence between the study good context and the policy good context as per **Step 4**.

Superficially there is an apparent close match, as an average value for a UK wetland site is clearly in the ‘ballpark’ for the policy good (a wetland site in the UK). However, the unit value reflects the ‘average conditions’ of UK wetland sites, which in fact may not be indicative of the conditions at any given site in the UK. ‘Wetland’ is a very broad term and sites are heterogeneous in terms of size, habitat types (e.g. upland peat bogs, inland marsh, coastal or intertidal marsh) which imply differences in ecosystem services provision, the size and socio-economic characteristics of the surrounding population and the availability of substitutes in the surrounding area. In this case then, the opportunity to control for these factors provides justification for preferring the function transfer approach.

In summary, as the *Technical Report* recommends, when transferring across similar goods and sites, unit value approaches are likely to be preferred. When transferring across similar goods, but heterogeneous sites, value function transfers are likely to be preferable and the specification of those functions should be restricted to include only those generic variables for which there are prior economic expectations. This reasoning provides the basis for the ‘rules of thumb’ in **Table 3**, which of course are subject to the analyst identifying relevant and robust valuation evidence (and then having the choice between unit value or value function transfer).

5.2 Application of unadjusted unit value transfer

Unit value transfer is the simplest value transfer approach. It assumes that the unit economic value of the change in the provision of the policy good is equal to unit economic value estimate for the study good:

$$\text{Unit value PG} = \text{Unit value SG}$$

where PG is the policy good and SG is the study good. Note that the physical change in the provision of the policy and study goods may differ (and/or the size of the affected population), and this will drive differences in aggregate values even in the case of unadjusted unit values.

For market goods and services the value measure may be a market price, or opportunity cost or shadow price. For non-market goods and services the value measure is typically willingness to pay (WTP) or in some instances willingness to accept (WTA).

The measurement units will depend on the valuation evidence applied, for example:

- Market goods: £ per tonne (e.g. timber), £ per fish, £ per hectare (e.g. agricultural land), etc.;
- Non-market goods: £ per tonne emissions (e.g. air pollutants), £ per visit (e.g. recreation); £ per household (e.g. non-use value); and
- A time unit may also be assigned to the unit value, for example many WTP values are expressed as an annual payment; e.g. £ per household per year.

Box 14 highlights instances where measurement units for the change in the provision of the policy good and economic valuation evidence may be ‘mismatched’.

An example of unadjusted unit value transfer is provided in **Case Study 1** in relation to improvements to recreation facilities at a forest site. It applies unit value estimates from a single study and for sensitivity testing an average value based on multiple studies.

In adopting a unit value transfer approach, analysts assume that the preferences of the average individual for the change in provision of the study good are an adequate description of the preferences of the average individual in the policy site context. In practice, however, the expectation should be that the economic value of the change in the provision of the policy good will not be equal to the value estimated in the study good context. A series of factors are expected to influence economic values in a specific circumstance. In summary these relate to:

- The characteristics of the good and its level of provision;
- The characteristics of the affected population;
- The availability of substitutes; and
- The context in which the good is provided (the ‘market construct’).

Not controlling for differences in the above factors between the policy good context and study good context will likely imply a greater uncertainty in the accuracy of the results of value

transfer. Whether a higher level of uncertainty can be accommodated depends on the requirements of decision-context (Step 1).

Box 14: Mismatching units - the quantitative assessment of the provision change and economic values

An issue typically encountered in practical value transfer exercises is a ‘mismatch’ between the physical units in which the change in provision of the policy good is measured (e.g. hectares of habitat) and the units in which economic valuation evidence is available (e.g. £ per household per year for habitat conservation).

This is most likely to be an issue for non-market goods where candidate valuation evidence is drawn from travel cost and stated preference studies which explicitly survey user (e.g. visitors or households) and non-user populations (in the case of stated preference techniques). In contrast value evidence for market goods and non-market goods based on damage costs (e.g. air pollution) and hedonic pricing approaches are more likely to match the physical units of the policy good. Note that choice experiment approaches can provide marginal values for the change in provision of a good (e.g. £ per hectare per household per year).

From a convenience perspective analysts may be tempted to convert study good values in to the same physical units as the policy good (e.g. convert £ per household per year to £ per hectare per year). Such a process however is subject to strong caveats, particularly since it can lead the analyst to ‘by-pass’ the definition of the affected population and as a result not account for factors such as a spatial sensitivity in unit values.

As an example ODPM/CLG (2002) *The External Benefits of Undeveloped Land: A Review of the Economic Literature* provides details £ per hectare values for a range ‘land’ types (e.g. forests, natural and semi-natural habitats, urban parks, etc.) as part of a gap-analysis and scoping of a primary valuation study. These were converted from the original studies on the basis of the size of the study site (e.g. number of hectares) and the size of the affected population (e.g. number of households). Simply applying these values in a practical exercise could lead to a significant over- or under-estimate of both unit and aggregate values since there is no account for differences in population characteristics between the policy good site and study good site, the availability of substitutes and other factors detailed in Step 4.

Ideally analysts should source valuation evidence from the original study in order to compare the policy good and study good contexts. Any conversions to values that are carried out by analysts should be explicitly documented and subject to appropriate sensitivity analysis.

Use of standard values

Standard values represent a ‘special case’ of unadjusted unit value transfer where guidance requires the use of specific monetary values. For example¹⁹:

- Carbon valuation (DECC, 2009):
http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/valuation/valuation.aspx
- Air quality damage costs (Defra, 2008):
<http://www.defra.gov.uk/environment/quality/air/airquality/panels/igcb/guidance/index.htm>

¹⁹ Weblinks accessed December 2009.

- Values of prevented fatality (value of statistical life) and prevented injuries (DfT 2005): <http://www.dft.gov.uk/webtag/index.htm>
- Value of illness and prevented injuries (HSE): <http://www.hse.gov.uk/economics/eauappraisal.htm>
- Value of time (DfT): <http://www.dft.gov.uk/webtag/>

Relevant guidance should be applied when undertaking policy and project appraisal in relation to the above.

Inflating unit values to current prices

A requirement of policy and project appraisal is that costs and benefits are estimated on a consistent basis, so that analysts will likely have to inflate unit values from a study to current prices or the base year for the analysis. Indices for inflating values are highlighted in **Box 15**.

Box 15: Inflating unit values

Unit values can be inflated to present day terms via a selection of price indices. Options include the Consumer Prices Index (CPI), the Retail Price Index (RPI) and variants and Producer Price Index (PPI). See: <http://www.statistics.gov.uk/instantfigures.asp>. Guidance for using a GDP deflator is also available: http://www.hm-treasury.gov.uk/data_gdp_index.htm.

Choice of index may be influenced by the type of policy good, for example non-market goods valued in terms of willingness to pay may be more reflective of consumer purchases, and hence the CPI is an appropriate index.

To update (or backdate) a monetary value, the value needs to be multiplied by an inflation factor, which is calculated from the index values of the time period the monetary value is provided in (e.g. 1996 £'s) and the target time period that the monetary value is needed for (e.g. 2008 £'s):

$$\text{Inflation factor} = \frac{(\text{index value of target time period of conversion})}{(\text{index value of original time period of conversion})}$$

Example: to update a value of £500 in 1996 to 2008 £'s using the CPI:

- 2008 index value = 108.5
- 1996 index value = 88.1
- Inflation factor = $108.5 / 88.1 = 1.23$

Therefore multiply the 1996 value of £500 by 1.23 to get the 2008 £ value of:

$$£500 * 1.23 = £615$$

Where the choice of price index is not clear, analysts should use sensitivity analysis to assess the implications for overall results of the use of alternative indices.

Transferring values from international studies

The criteria for comparing the policy good and study good contexts set out in Step 4 imply that valuation evidence from international studies will in many cases not be suitable for value transfer. Typically this is due to differences in the affected population (both types of user and socio-economic characteristics), the availability of substitutes, institutional and cultural differences, etc. For example the availability of recreational fishing lakes differs immensely between the UK and Canada; transfer of evidence from a Canadian study is likely to poorly represent UK circumstances for this activity and resource.

Where suitable evidence is available from an international study, analysts will need to convert estimated values to UK £s. This requires the selection of an appropriate exchange rate. For this a **purchasing power parity (PPP)** adjusted exchange rate should be used. PPP controls for distortions in economic values that application of ordinary exchange rates might introduce²⁰. After a PPP-adjusted exchange rate is used to convert the original currency to £ for the year of the study (or its data), the UK £s should be inflated to current prices or the base year for the analysis. Data sources for PPP-adjusted exchange rates are highlighted in **Box 16**. An example conversion is provided in **Box 17**.

Box 16: Purchasing power parity adjusted exchange rates

Key sources for PPP-adjusted exchange rates are:

- World Bank International Comparison Program (<http://go.worldbank.org/UI22NH9ME0>)
⇒ Covers approximately 150 countries; data for every 3-5 years depending on region.
- OECD Statistics Directorate (www.oecd.org/std/prices-ppp)
⇒ OECD countries, annual data from 1960.
- Penn World Tables (University of Pennsylvania Center for International Comparisons of Production, Income and Prices: <http://pwt.econ.upenn.edu/index.html>)
⇒ 188 countries, annual data 1950-2004.
- European Union Eurostat (<http://epp.eurostat.ec.europa.eu>: search for 'purchasing power parity')
⇒ EU countries, annual data 1996-2007.

Note that these different sources will give different converted values. Sensitivity analysis can be used to determine the relative importance of the choice of PPP-adjusted exchange in the overall results.

Sources: websites accessed July 2009.

²⁰ For example ordinary exchange rates reflect the influence of macro-economic factors. A PPP-adjusted exchange rate accounts for the relative cost of living by comparing the price of basic goods in different countries.

Box 17: Example of PPP-adjusted exchange conversion

OECD Statistics provide PPP-adjusted exchange rates for OECD countries and a few non-member countries (www.oecd.org/std/prices-ppp).

Currency conversions should be ‘within’ year; i.e. 2003 US \$’s to 2003 UK’s. A price index should be used to inflate £ values to the required year (see Box 15).

The calculation for using a PPP-adjusted exchange rate is:

$$\text{Target value} = (\text{value} \times \text{PPP UK for the currency year}) / \text{PPP original currency value for year}$$

Example: to convert 500 Icelandic kronurs in 2008 to UK £ using the OECD table:

- Iceland PPP 2008: 123.085
- UK PPP 2008: 0.653
- 500 Icelandic Kroners = $500 \times 0.653 / 123.085 = \text{£}2.65$

5.3 Application of adjusted unit value transfer

Adjusted unit value transfer can account for differences between the policy good context and the study good context by weighting the transferred value. For example:

$$\text{Unit value PG} = a \times \text{Unit Value SG}$$

where *a* is the ‘adjustment factor’. Adjusted unit value transfer may account for a single factor or may control for multiple factors. Based on the criteria for comparing the policy good and study contexts from Step 4, a common requirement may be to control for differences in the characteristics of the affected populations. For example, household income is typically a key determinant of WTP for non-market goods and services; transferring average WTP from a lower average income study good population to a higher average income policy good population will likely under-estimate the value of the policy good (see **Box 18**).

Box 18: An example of adjusted unit value transfer

Adjusted unit value transfer will likely be of most use where the policy and study good contexts are similar but there is a potentially significant difference in relation to the characteristics of the affected population. Household income is typically a major determinant of household WTP so differences in income between the policy good and study good sites could imply different WTP (all else equal). This can be controlled for by adjusting WTP to reflect the income difference between the two sites:

$$WTP_{PG} (\text{£/hh/yr}) = a \times [WTP_{SG} (\text{£/hh/yr})]$$

Where *PG* is the policy good and *SG* is the study good. Here the adjustment factor *a* can be defined as ratio of the average income of the study good population to the average income of the policy good population:

$$a = (\text{avg. income}_{PG} / \text{avg. income}_{SG})^e$$

The term *e* specifies the **income elasticity of WTP**. This is an estimate of how WTP varies with changes in income. It is similar to the income elasticity of demand, which measures the responsiveness of demand for a good to a change in income and indicates whether a good is an inferior good (negative income elasticity), normal good (positive income elasticity but less than one) or luxury good (positive income elasticity greater than one). However income elasticity of WTP does not inform on whether a non-market or public good is an inferior, normal or luxury good (for further discussion see Jacobsen and Hanley, 2009). What can be inferred are the distributional implications of WTP:

- If $e < 1$ it is distributed regressively and increasing the supply of the good will benefit poorer households more than richer households;
- If $e > 1$ it is distributed progressively and increasing the supply of the good will benefit richer households more than poorer households.

Most evidence indicates that income elasticities of WTP for different goods lie between 0 and 1 (see Kristrom and Riera, 1996; Hokby and Soderqvist, 2003).

As a practical example, consider a study that reports WTP for preservation of otter populations in a specific area as £10 per household per year. Average annual household income for the study good population is £24,000. At the policy site average household income is £27,500. Jacobsen and Hanley (2009) estimate the income elasticity of WTP for biodiversity conservation from a meta-analysis of 46 studies to be 0.38. This gives:

$$WTP \text{ for } PG = [(27500/24000)^{0.38}] \times \text{£}10 = \text{£}10.53 \text{ per household per year}$$

This is based on an adjustment factor of 1.053 (= $(27500/24000)^{0.38}$). In this example the adjusted unit value transfer increases the unit value of the policy good by approximately 5% in relation to the original study good value. Evidence relating to the income elasticity of WTP may be reported by the study from which unit value evidence is being transferred from; i.e. the income elasticity of WTP for the study good is provided. Meta-analyses may also summarise evidence from a group of studies (for example Jacobsen and Hanley, 2009). Where evidence is not available a 'default' assumption can be to assume that $e = 1$. In the above calculation this would give:

$$WTP \text{ for } PG = [(27500/24000)^1] \times \text{£}10 = \text{£}11.45 \text{ per household per year}$$

Here the adjustment factor is based only on the ratio of policy and study good site household income. Note that this results in a higher adjusted unit value estimate. Analysts should subject any adjustments to unit values to sensitivity analysis to determine their significance in overall results.

The requirements for analysts to make adjustments to unit values include:

- i). Identifying the factor(s) to control for (from Step 4); i.e. the significant difference(s) between the study good context and policy good context that are expected to cause unit values to differ (such as household income);
- ii). Collecting data for the value of the factor of interest in the policy good context (e.g. average household income for the affected population) (from Step 3);
- iii). Collecting data for the value of the factor of interest in the study good context (e.g. average household income of study good population sample) (from Step 4); and
- iv). Information about the relationship between the factor of interest and economic value in the study good context (e.g. the income elasticity of WTP) (from Step 4).

Whilst income is an obvious example, adjustments are possible for a wide range of factors provided suitable data are available to calculate the weighting parameter. The task of the analyst is to identify appropriate adjustments, based on the interpretation of the results of the study good analysis and an understanding of the key determinants of economic values (e.g. socio-economic and other characteristics of the affected population, the level of provision of the good, etc.)

5.4 Application of value function transfer

Transferring a value function

Where there is the need to control for multiple factors in value transfer, data permitting, an appropriately specified²¹ and executed function transfer approach should be used.

Value function transfer applies information from the study good context to the policy good context regarding the relationship between economic value and a number of explanatory factors. For example, a WTP (or 'bid') function relates WTP for a non-market good to changes in parameters such as the characteristics of the good and the change in its provision, socio-economic and demographic characteristics of the affected population, patterns of use and the availability of substitutes:

$$WTP_{PG} (\text{£/hh/yr}) = a_{SG} + \beta 1_{SG} X1_{PG} + \beta 2_{SG} X2_{PG} + \dots + \beta n_{SG} Xn_{PG}$$

The a and the β s are parameters (coefficient estimates) from the WTP function estimated for the study good. The X s are the values of the explanatory variable for the policy good (e.g. average household income, distance from site, number of substitutes, etc.).

²¹ As discussed in the *Technical Report*, an 'appropriately specified' function can be interpreted as a function based on variables predicted by economic theory to influence economic values; i.e. the characteristics of the good including the change in its provision, the availability of substitutes, household income.

The values of explanatory variables should be derived from the supporting data for the policy good collated in **Step 3**. Again this illustrates the iterative nature of Steps 1-4. Data requirements for a value function transfer approach will be identified in Step 4, so analysts will need to undertake these data collection efforts before proceeding to Step 5. This process is illustrated in the **Appendix to Case Study 3** in the case of applying a meta-analysis function. **Case Studies 3** and **4** illustrate the practical application of value function transfer. Both examples control for differences between the study good affected population and the availability of substitutes. In the context of ecosystem services provided by freshwater wetlands, Case Study 3 also controls for the provision of different services, i.e. the characteristics of the policy good, based on a meta-analysis function. Case Study 4 provides an illustration of the use of a spatially sensitive WTP function in conjunction with GIS. **Box 19** provides some practical considerations for the application of value function transfer.

Adjusted function transfer

Adjustments to function coefficients may be appropriate in instances when functions are transferred from relatively dated studies. Information from multiple studies (on the same or similar good) and expert judgement may be needed to account for factors such as increases in income and changes in the income elasticity of WTP of over time.

Where adjustments are made these should be supported by empirical evidence. If quantitative evidence is not available, qualitative justification should be provided. All assumptions and adjustments made in these circumstances should be subject to stringent sensitivity testing.

Box 19: Transferring a value function

A transfer function may be sourced from a single study, a meta-analysis or from multiple studies (where information from different studies may inform adjustments to function coefficients). Practical steps for undertaking value function transfer include:

Interpreting the function

- Identify the estimation method and type of model (e.g. OLS, logit, etc.).
- Assess the overall validity of model:
 - ⇒ Goodness of fit
 - ⇒ Tests of model significance
- Note the definition of the dependent variable (e.g. WTP per household per year):
 - ⇒ Identify any transformations (e.g. using the natural log of WTP is a typical transformation in econometric analysis)
- Note the definition of the explanatory variables:
 - ⇒ Identify continuous, categorical or dummy variables
 - ⇒ Identify any transformations
- Note the interpretation of the coefficient estimates for the explanatory variables:
 - ⇒ The sign of the coefficient (positive or negative)
 - ⇒ The statistical significance of the coefficient
 - ⇒ Accordance with prior expectations (or reasonable explanation for departure from prior expectations)
- Determine if the ‘full ad-hoc contextual’ model is appropriate for transfer or whether a ‘limited’ function (based on expectations from economic theory) is more appropriate (see *Technical Report* for further discussion).

Note that guidance for assessing the quality of and interpreting evidence from primary valuation studies is provided in **Annex 2**. This includes assessments of the validity of econometric results. In addition a glossary of econometric terminology is provided in **Annex 3**. Detailed discussion of value function transfer is also provided in the *Technical Report*.

Using the function

- Use a spreadsheet.
- Collate data for the policy good values of the explanatory variables (e.g. average household income for the affected population) (see Step 3).
- ‘Reverse’ any transformations (e.g. natural log of variable $X \Rightarrow e^{(\ln X)}$; take the exponential of the actual value of ‘ $\ln X$ ’ to reverse the log-transformation).
- Omit any explanatory variables for which the coefficient estimate is not found to be statistically significance (or consider their inclusion as a sensitivity) - note that ordinarily a ‘best fit’ function will ordinarily include only statistically significant parameters.
- Consider confidence intervals for coefficient estimates for sensitivity analysis; this will permit a range of economic values to be estimated for the change in provision of the policy good.

Case Studies 3 and **4** both illustrate the practical application of value function transfer. Analyst should refer to these for further detail for apply a function.

5.6 Sensitivity analysis

Testing the sensitivity of economic valuation information transferred from source studies should be an integral element of any value transfer exercise. With respect to transferred valuation evidence, sensitivity analysis should consider:

- Unit values: upper and lower bounds of a mean estimate should be applied. Note that this is applicable to both unit value transfer and value function transfer (where a function is used to estimate a unit value). Ranges of values may be based on a statistical confidence interval for the point estimate from the selected study, or sourced from different studies based on the judgement of the analyst.

A more sophisticated approach is to recognise the probability distribution of value and coefficient estimates. For a 95% confidence interval the upper and lower bound estimates will occur typically 2.5% of the time; hence the analyst should be aware that these extreme values are less likely to occur than those closer to the mean value.

- Adjustment factors: sensitivity of adjustment factors and components within adjustment factors should be considered, particularly where adjustments are based on expert judgement and assumptions invoked by the analyst. This is relevant to both adjusted unit value transfer and value function transfer. Adjustment factors also include inflating economic values to current prices and transferring values from international studies.
- Value function transfer: all components within the function are candidates for sensitivity analysis, permitting a range of economic values to be estimated for the change in provision of the policy good:
 - ⇒ Coefficient estimates: upper and lower bounds based on confidence intervals can be applied or less extreme values based on the probability distribution (as noted above); and
 - ⇒ Explanatory variable values: collation of supporting data on the policy good should identify suitable ranges of values for the purposes of sensitivity testing.

Step 7 addresses sensitivity analysis in relation to the entirety of data applied in the value transfer process (i.e. from Step 2 - 6).

STEP 6: AGGREGATION

This step addresses the following questions:

- *What is the annual value of the change in the provision of the policy good?*
- *What is the present value of the change?*

With input from:

⇒ *The analyst - on economic value evidence. It is good practice to consult policy analysts and technical experts on the assumptions, the affected population and time period over which to aggregate the unit values.*

Note that:

- *Economic values are aggregated across the types of values, the affected population and time.*
- *The accuracy of the aggregate value estimate is dependent on the accuracy of the information and analysis in the preceding steps.*

This step is closely linked to:

- *Step 2 - the affected population over which values are aggregated.*
- *Step 3 - the change (and change in the affected population if relevant) over which values are aggregated.*
- *Steps 4 and 5 - the unit value or value transfer function that estimates the value of the change in the provision of the policy good.*
- *Step 7 - assumptions about aggregation (e.g. that discount rate, affected population) can be tested through sensitivity analysis.*

The tasks for estimating the aggregate value of the change in provision of the policy good are:

- i). Aggregate the unit value across the type of value and policy good; and/or
- ii). Aggregate over the affected population;

then

- iii). Aggregate over time.

Spatial and temporal variation in unit values should be taken into account as much as possible.

Whether (i) and/or (ii) is appropriate depends on the unit in which the change is measured (Step 3) and valued in economic terms (Step 4).

6.1 Aggregation of economic values

Estimating the aggregate value of the change in provision of the policy good

The estimated aggregate value of the change in the provision of the policy good is the ‘headline’ result that is inputted to decision-making. It can be used to demonstrate the importance of an issue, estimate likely damage in a liability case or, as is used often, inputted into a cost-benefit analysis or an Impact Assessment.

There are three dimensions to aggregation:

- Aggregation over type of value and policy good: Where value transfer is applied to estimate the value of a number of costs and benefits for appraisal, the values for each need to be aggregated. There could be:
 - ⇒ More than one type of value (e.g. adding benefits for different visitor types to a recreation site, or adding benefits of flood protection to benefits of water quality improvements as a result of a wetland conservation project, to provide an estimate of the total monetary benefit of such a project²²);
 - ⇒ More than one type of policy good (e.g. improvements in quality of soil *and* quality of water); and
 - ⇒ Some benefits (e.g. increase in recreational opportunities) and some costs (e.g. increase in carbon emissions).
- Aggregation over the affected population: Summing unit economic value (use and non-use) per household or per individual over the *affected population*. When aggregating over the affected population *spatial variation* in economic values (e.g. the existence of a ‘distance-decay’ relationship - see Section 6.2) may need to be accounted for. When the unit value is expressed as £ per units of the type of benefit or good (e.g. £ per hectare, £ per tonne of emissions etc.), aggregation over the affected population is not necessary.
- Aggregating over time: Estimating the present value of the change in the provision of the policy good over time involves discounting the annual stream of the total value of the change in the provision of the policy good over time.

The first two dimensions of aggregation estimate the total annual value of the change in the provision of the policy good. Once the total annual value is calculated, it should then be aggregated over time (over the policy or project lifetime, or appraisal time horizon) to estimate the present value of the change in the policy good.

The complexity of the aggregation step depends on the overall scope of value transfer. For unit (or adjusted unit) value transfer, aggregation is straightforward, while it can be more complex for value transfer incorporating spatial distribution of values.

²² Analysts should account for potential ‘part-whole’ effects in summing economic values for multiple attributes of a good. The key issue is whether there are substitution effects between attributes such that independent estimation and aggregation of attributes will over-estimate the value of the good as a whole (see also Box 6).

The profile of annual costs or benefits over time

Analysts will need to determine the profile of annual benefits or costs over time including:

- the change;
- the unit value; and
- the affected population.

One reason why the affected population may change, is for example, that the improvement in the quality of a policy good may increase the user population. The task for analysts is to determine if new users have transferred their use from a substitute good or service (effectively a transfer of welfare) or if they are genuinely new users (a net gain in welfare). This will require empirical data (e.g. from user surveys that include details of visits to substitute sites) or use of assumptions (see Case Study 1, Step 4) that can be tested via sensitivity analysis.

In many appraisal cases, annual costs and benefits are assumed to be constant. In other cases the nature of the baseline provision of the policy good (*without* the policy or project) may imply non-constant annual values. If the baseline conditions are assumed to decline over time, an improvement in future will generate higher benefits (the change is greater) in undiscounted terms. If the baseline is predicted to show gradual recovery over time in the absence of intervention, the benefit of intervention will decline over time. Overall the specification of the profile of annual benefits or costs needs to reflect scientific and technical understanding of the baseline and change from Step 3.

With respect to marginal economic values over time, the default assumption is usually that these are constant in the short to medium term - although an exception to this is the treatment of the carbon emissions, where analysts should follow DECC guidance (DECC, 2009). If changes in relative values are assumed, this should be supported by empirical evidence²³.

6.2 Estimating the total annual value of the change in the provision of the policy good

In most cases - certainly in terms of cost-benefit analysis - total benefits or costs of the change in the provision of the policy good are estimated in annual terms. The following considers the calculation of an annual aggregate value in a number of generic settings.

Aggregating over physical change

The basic formula for estimating the total value of the change in the provision of the policy good, where the change is measured in physical units (e.g. tonnes or hectares) is:

²³ Generally few studies test the 'temporal stability' of non-market values (see for example Brouwer and Bateman, 2005.). *The Green Book* (HM Treasury, 2003) also provides guidance on adjusting for relative price changes over time.

$$\text{Total value of change (£/yr)} = \text{physical change (unit)} \times \text{economic value (£/unit/yr)}$$

Example 1: £ per year = Tonnes of emissions × £ per tonne

Example 2: £ per year = Hectares of habitat × £ per hectare

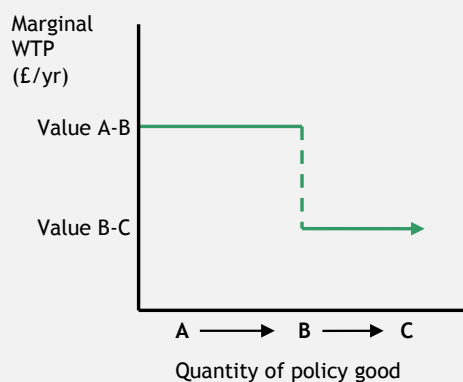
This represents the case where marginal economic values are assumed to be *constant*. In other cases, the unit economic value may change depending on the quantity of physical change. The simplest approach is to consider a ‘step change’ in the unit economic value:

$$\text{Total value of change (£/yr)} = \text{total value change 1} + \text{total value change 2}$$

Where:

$$\text{Total value change 1} = \text{physical change A-B} \times \text{economic value A-B}$$

$$\text{Total value change 2} = \text{physical change B-C} \times \text{economic value B-C}$$



Based on:

- Physical change is from quantity A to quantity C
- The unit value of the change from quantity A to quantity B is: economic value A-B
- The unit value of the change from quantity B to quantity C is: economic value B-C
- And economic value A-B > economic value B-C

In principle, a number of step changes in unit value could be applied, provided sufficient evidence on the relationship between the unit value and the provision of the study good is available.

Aggregating over affected population

The basic formula for estimating the total value of the change in the provision of the policy good when unit economic values are expressed in terms of population units (e.g. households or visitors) is:

$$\text{Total value of change (£/yr)} = \text{Number of users or non-users (unit)} \times \text{economic value (£/unit/yr)}$$

Here the calculation is explicitly associated with values derived by user or non-user populations. Some stylised presentations of aggregation with affected population units are

presented in **Box 20**. Note that this approach to valuation does not account for spatial sensitivity in unit values for user (and non-user) populations due factors such as distance decay (this is addressed below).

Where aggregate values are to be combined over different population types, such as users and non-users, the total value is the sum of the value for the population types:

Total value of change (£/yr) = total use value + total non-use value

Where:

Total use value (£/yr) = no. of users (unit) + unit value for users (£/unit/yr)

Total non-use value (£/yr) = no. of non-users (unit) + unit value for users (£/unit/yr)

Case Study 1 presents an example where the aggregation process accounts for different types of users in the case of recreation visits to a forest site. This illustrates the importance of distinguishing heterogeneity in user types (e.g. walkers, cyclists, horse-riders) and the different economic values of different activities.

Box 20: Aggregation over user populations

Typical calculations for aggregating over user and non-user populations include:

<i>Total value of change</i>	=	<i>Affected population</i>	×	<i>Unit economic value</i>
Example 1: £ per year	=	Number of households	×	£ per household per year
Example 2: £ per year	=	Total number of users or visitors in a year	×	£ per person or visitor
Example 3: £ per year	=	Total number of visits in a year	×	£ per visit
Example 4: £ per year	=	Visits per user × total number of users	×	£ per person per visit

Note that these examples assume constant unit values; this may not be an appropriate assumption in certain circumstances (see Case Study 1).

Literature shows that, in general, individual users tend to have higher willingness to pay than non-users (all else equal). However, non-user populations for some policy goods could be so much larger than user populations that the former determine the majority of the aggregate value. Here it is essential for analysts to establish the economic jurisdiction for the policy good as described in **Step 2**. Assumptions as to the extent of the non-user population should be based on empirical evidence and where this is unavailable explicitly justified in qualitative terms. In many instances assuming that all individuals within the political jurisdiction for the good hold non-use values will likely inflate aggregate value estimates substantially.

Aggregation with spatial sensitivity values

The typical example of a spatially sensitive economic value is the *distance decay* relationship, where it is observed that users who live further away from a site-specific good tend to have lower economic values than those who live nearer. It is also observed that the proportion of users of a site-specific good in the overall population declines as distance from it (due to the influence of substitutes) and opportunity costs (e.g. travel time) increase. For the purposes of aggregation, this means a constant unit value across the entirety of the affected population does not apply. The unit value for each distance band should be estimated and multiplied with the population in that band. The distance band should be defined based on the evidence from the literature or the facts of the case for the policy good.

Case study 4 illustrates a detailed approach to taking distance into account when aggregating the unit values as well as spatial variation in household income. **Box 21** summarises the aggregation step from the case study. Analysts should also refer to the *Technical Report* for further detail (especially Section 6).

A similar relationship exists for frequency of use, namely, *the frequency decay* relationship - the less frequently a user uses a resource, the less they would be willing to pay for each use.

In most instances, spatial variation is concerned with use values. Expectations (and empirical evidence) for non-use values are less clear. There is likely to be a relationship between non-use values and distance from the policy good, but the former do not necessarily decline with the latter (see also *Technical Report*).

Where spatial variation in economic values is a key component of assessing the value of the change in the provision of the policy good, use of GIS tools should be considered by analysts. **Case Studies 2** and **7** provide practical examples of the use of GIS in value transfer.

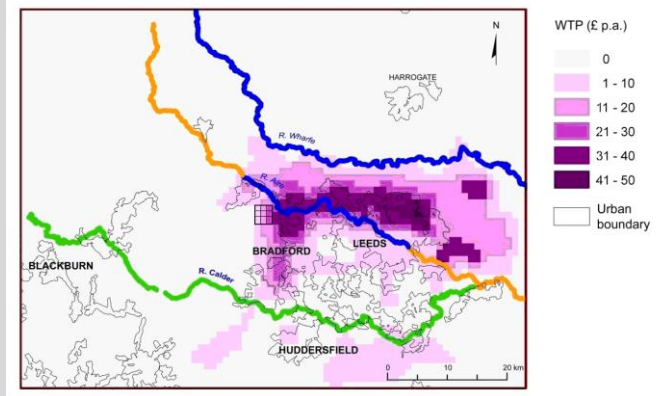
6.3 Estimating the present value of the change in the provision of the policy good

The present value of the change in the provision of the policy good should be estimated in accordance with *The Green Book* (HM Treasury, 2003). In calculating present values, the assumed profile of monetary costs or benefits over time should reflect the definition of the change in the policy good established in Step 3 (as discussed above) and use the same time horizon applied in the rest of the appraisal.

Box 21: Estimating total benefits from a spatially sensitive WTP function.

Case Study 4 estimates the value of benefits associated with improvements in river water quality via a function transfer approach. This controls for spatial variation in use value associated with distance to the policy good site and substitute sites, and the socio-economic characteristics of the affected population. Specifically, the function estimates household WTP for water quality improvements in pre-defined geographical area units within the affected population. On the basis that the affected population for the change in provision of the policy good is confined to a 2,827km² area (see case study reporting for further detail), 2,827 separate WTP values are estimated in the analysis; one WTP value for each 1 km² within the affected population area. This can be illustrated on a map that highlights spatial variation in values and a distance-decay effect:

WTP for improvement in river water quality (£/household/year)



Source: Hime et al. (2009)

Estimated household WTP in each 1 km² (a) is then multiplied by the number of households in each 1 km² (b) to estimate total WTP (c). Summing over all 2,827km² provides the estimate of total aggregate annual benefits of improvements in river water quality:

1 km² Area	WTP (£/household/yr)	Population in 1 km² (No. households)	Total WTP for each km² (£/yr)
	(a)	(b)	(c)
Area 1	£8.70	3,000	£26,108
Area 2	£10.42	2,000	£20,849
Area 3	£20.47	5,000	£102,357
Area 4	£9.60	5,000	£48,000
Area 5	£12.75	1,500	£19,119
Area 6	£21.77	3,000	£65,314
Area 7	£9.97	5,000	£49,857
Area 8	£14.90	1,000	£14,897
Area 9	£23.59	3,000	£70,785
...
Area n	£5.00	4,000	£20,000
TOTAL		~1.25 million	£4,050,000

Note also that the table illustrates how unit values (£/hh/yr) vary over each 1 km²; this is driven by the variation in the distance to the policy good site and substitute sites and the socio-economic characteristics of the affected population.

STEP 7: CONDUCT SENSITIVITY ANALYSIS

This step addresses the following questions:

- Which key parameters affect the transferred value the most?
- What is the nature and significance of such effects?
- What is the switching value?
- What is the benefit threshold?

With input from:

⇒ Policy analysts and technical experts - on the key assumptions to test via sensitivity analysis.

Note that:

- Key parameters related to all aspects of value transfer should ideally be tested to enable judgements 'certainty' of the valuation evidence generated for decision-making.

This step is closely linked to:

- Steps 2 - 6 where key parameters for sensitivity testing should be identified.
- The results of sensitivity analysis may require re-iteration of Steps 2 - 6 and if the results are too uncertain for the purposes of the decision-making, alternatives to value transfer may be re-considered (Step 1).

Sensitivity analysis for value transfer follows the same basic tasks as sensitivity analysis in other parts of appraisal or other analyses²⁴:

- i) Identify the key parameters for sensitivity analysis;
- ii) Select the appropriate approach to sensitivity analysis; and
- iii) Estimate the switching value or benefits thresholds.

While the scope and level of effort of sensitivity analysis is case-specific (Step 1), as a minimum, analysts should assess the that effect different assumptions about key parameters have on the unit and/or aggregate economic value estimates for the policy good.

If sensitivity analysis shows the transferred values to be too uncertain (e.g. too large a variation between results under different assumptions) for the purposes of decision-making, alternative approaches should be considered (see Step1).

²⁴ Note that general principles for sensitivity testing, such as those detailed in *The Green Book* (HM Treasury, 2003) guide those presented in this step.

7.1 Identifying parameters for sensitivity testing

Key parameters for sensitivity testing from **Steps 2- 6** include but are not limited to:

Step 2 - the policy good and the affected population

- Assumptions about the type and size of the affected user and non-user population(s).
- Assumptions about the types of economic value (and ecosystem services) the policy good is likely to generate (especially when there is uncertainty about the baseline conditions).

Step 3 - the change

- Assumptions as to the magnitude, direction, the timing and the spatial nature of the change.
- Quantitative estimates of the change.
- Uncertainties and gaps in supporting data (e.g. socio-economic characteristics of affected population, patterns of use, availability of substitutes).

Step 4 - the economic value evidence

- The selection of evidence from existing studies such as unit values, value functions and empirical relationships (e.g. distance decay). As discussed in Step 4 the practical recommendation is that all robust relevant evidence be used to inform decision-making; this can provide a basis for sensitivity testing by applying value evidence from different studies.

Step 5 - value transfer

- Best estimates and confidence intervals for unit value of change.
- Best estimates and confidence intervals for value function coefficients.
- Adjustment factors that are applied to unit value estimates or function coefficients.
- Policy good values of explanatory variables in value functions.

Step 6 - aggregation

- The time profile of the change, the affected population and economic value.
- Discount rate and time horizon for calculation of present value of change in provision of the policy good.

Note also that **Steps 3 and 5** provide further discussion on identifying parameters for sensitivity testing in relation to the change in provision of the policy good and estimating the value of that change.

7.2 Basic approaches to sensitivity analysis

Sensitivity analysis involves repeating the value transfer (all or some of the steps) by:

- Changing one parameter at a time to see the effect on the resulting value estimate;
- Using scenarios to account for sensitivity in multiple parameters;
- Assigning probabilities to outcomes; and

- Using Monte Carlo analysis to account for sensitivity in multiple parameters especially when there are significant uncertainties, where possible²⁵.

Further guidance on these parameter specific sensitivity analyses is not provided here on the assumption that analysts are familiar with using sensitivity analysis for other purposes.

Analysts can also undertake more ‘strategic’ sensitivity analyses (not specific to key parameters). These are ‘switching values’ and ‘threshold values’ in relation to other costs and benefits in the policy or project appraisal case (see below).

7.3 Switching values and threshold values

Switching and threshold values can provide analysts with an indication of the level of uncertainty that can be accommodated in a given appraisal case. These are most closely associated with cost-benefit analysis and the calculation of net present value (NPV) for a policy or project proposal. The basic premise is to establish how ‘wrong’ the value transfer has to be for the recommendation to change - in other words for the NPV to switch from positive to negative or vice versa.

Box 22 illustrates calculation of switching and threshold values from **Case Study 1**.

Switching value

A switching value calculates by what percentage the benefit estimates need to decline or the cost estimates need to increase for the NPV result (or CBA recommendation) to be different. The switching value (SV), which is expressed in percentage terms (%) can be calculated as:

$$SV(\text{Costs}) \% = \frac{[PV \text{ benefits} - PV \text{ costs}]}{PV \text{ costs}}$$

$$SV(\text{Benefits}) \% = \frac{[PV \text{ costs} - PV \text{ benefits}]}{PV \text{ benefits}}$$

where SV is switching value and PV is present value. For example, a SV (benefits) of 10% means the value transfer has to be 10% less than it is for the NPV to become negative, or 10% more than it is for the NPV to become positive - depending on the sign of the NPV. The higher the switching value, the more ‘comfort’ there is around the cost or benefit estimates.

Switching value analysis does not eliminate the need for separate sensitivity analysis of key parameters. For example two project options could display the same switching value but one might entail substantially higher costs and benefits, and the other low cost - low benefits. Choosing between the options will likely require an assessment of which project’s outcomes are

²⁵ Monte Carlo analysis is possible with statistical software packages, but is dependent upon having sufficient data on the distribution of values and associated probabilities. This data may be available from valuation studies for economic value evidence but is often lacking with respect to data for quantifying the change in the provision of the policy good.

more certain - based on the strength of the underlying assumptions - since this will typically be favoured in decision-making or with reference to agreement across relevant stakeholders.

Benefits threshold

This considers whether estimated benefits are less than the cost of providing them, and if so, whether any environmental benefits that could not be estimated in monetary terms are at least worth the difference²⁶. The benefits thresholds can be calculated as:

$$\text{Benefits Threshold} = \text{PV financial costs} - \text{PV environmental benefits}$$

The larger the value of the benefits threshold, the greater the need for further monetary estimation of benefits (or stronger qualitative or quantitative arguments for non-monetary benefits). This value of the benefits threshold also indicates whether alternatives to value transfer including primary valuation study are worth the time and spending they involve.

Box 22: Switching values and benefits thresholds - improving forest recreation facilities

Improvements to recreation facilities at Bedgebury National Pinetum and Forest in Kent are estimated to cost approximately £2.5 million. This includes construction of a visitor centre, walking trails, cycle paths and other amenities.

The basic need of decision-making is to determine if the benefits of the improvements outweigh the costs: Does the present value of benefits exceed the threshold value of £2.5 million? Is the benefits threshold value exceeded on the basis of a credible set of assumptions?

Use of an upper bound value estimate (£15 per visit) from the available evidence gives an annual aggregate benefit of approximately £3.3 million per year. Hence the clear result is that improvements ‘pay for themselves’ in the first year of operation. The implied switching value in this case -24% [(2.5-3.3)/3.3 = -0.24]. That is assuming a time horizon of 1 year (!) a reduction of 24% in present value benefits would result in negative NPV for the improvements.

A more meaningful sensitivity test is produced in relation to the use of a lower bound unit value estimate (£2 per visit). This gives an annual aggregate benefit estimate of approximately £0.5 million per year. Discounted over a 5 year time horizon (at 3.5%) this gives a present value benefit estimate of approximately £2.5 million. This analysis is extended to identify the point in time where the threshold value is exceeded as the unit value is reduced:

<i>Year threshold value exceeded</i>	<i>Unit value (£/visit)</i>	<i>Annual Benefit (£m/yr)</i>	<i>PVB (£)</i>
20	0.77	0.17	2.48
15	0.94	0.21	2.46
10	1.30	0.29	2.46
5	2.39	0.53	2.47

The analysis demonstrates that the effects of changing the time scale and unit value on the Present Value of Benefits (PVB). For further detail: see **Case Study 1**

²⁶ The basis for this approach stems from the Krutilla-Fisher model of subtracting ‘known’ (i.e. monetised) benefits from costs and assessing whether non-monetised benefits might influence the cost benefit analysis decision (see for example Porter, 1982). The example provided in the main text focuses on ‘environmental benefits’ but the principle is applicable to all types of benefit in policy or project appraisal.

STEP 8: REPORTING

- *This is the culmination of all steps before it and should report all analysis and assumptions.*
- *Transparent reporting is essential for informing decision-making of the likely accuracy of evidence provided. Transparency is aided by documenting all assumptions and data sources.*
- *It is good practice to ensure policy analysts and technical experts comment on the style and content of the reporting as well as the results.*
- *The Value Transfer Checklist (subsequent to this step) is intended to help analysts with establishing an audit trail and providing transparent reporting.*

The document reporting the value transfer exercise should include a discussion of each of the Steps 1 - 7. It makes for easier reference to start the report with the aggregate results and follow these with sensitivity analysis and report of all key parameters:

- i). *The aggregate estimates for the change in the provision of the policy good (Step 6)*: the 'headline' result that will input to decision-making. The value estimates from sensitivity testing of the key parameters, switching analysis and benefits thresholds should also be reported (based on the outcomes from Step 7).
- ii). *The definition of the policy good (Steps 1 and 2)*: a concise summary of the good, its characteristics and the types of use and non-use value derived from it. This should explicitly identify which aspects of the policy or project to be appraised have been estimated in monetary terms, and which aspects are non-monetised. Where an ecosystem services framework is applied, the template for **Table 1** (Step 2) can be used to show the mapping of ecosystem services to final goods and services.
- iii). *The affected population (Step 2)*: the extent of the market for the aggregate estimate for the change in provision of the policy good.
- iv). *The change in provision of the policy good (Step 3)*: a concise summary of the change that is valued in qualitative (descriptive) and quantitative terms, accounting for the spatial location and timing of the change.
- v). *The selection of value transfer evidence from existing studies (Step 4)*: the valuation evidence applied in the analysis should be justified in terms of its relevance to the change in provision of the policy good and its robustness. The template in **Table 2** (Step 4) can be used to show the match between the policy good context and the study good context.
- vi). *The application of value transfer (Step 5)*: the specification of unit values and description of value function(s) used. Spreadsheets of functions and details of GIS and

other software that are used should be provided with the report. This allows for readers to interpret the methodology and results in more detail.

- vii). *Key assumptions and caveats (Step 7)*: A systematic account of the key sensitivities through Steps 2-6 is required. This should build on the details reported in (i) above and provide justification for supporting assumptions and parameter values. Explicit acknowledgement of limitations in evidence, gaps and key uncertainties should be provided. Where uncertainties can be 'quantified' (e.g. via switching analysis or benefits thresholds), this information should be made available for decision-making to inform on the significance of 'missing evidence'.

Importantly providing a transparent account of the value transfer analysis demonstrates that the analyst has undertaken a thorough assessment of all issues that are relevant in a given case. This in itself can instil greater confidence in the results of value transfer in comparison to cases where analysis and results are poorly reported.

Value transfer should also be subjected to scrutiny and peer review, including examination by economists and scientific and technical experts appropriate to the nature of the policy good. While this need not be a formal technical review process involving independent experts, in instances where value transfer evidence is a key aspect of decision-making this is advisable.

For any form of review to be possible, analysts must prepare a detailed audit trail of the application of each of the steps of the guidelines, referencing sources of data, justifications for assumptions and calculations of economic values. The list (i) - (vii) above and the *Value Transfer Checklist* are intended to assist analysts in reporting.

VALUE TRANSFER CHECKLIST

BASIC TASKS	DETAILS	Done (✓)
STEP 1- Establish the policy good decision-context		
Is value transfer the appropriate approach to meet the information needs of a given decision-making context?	<i>The phase in the policy or project decision-context</i>	
	<i>The scale of effects of the policy or project</i>	
	<i>The scale of investment/expenditure</i>	
	<i>Legal, political and stakeholder context</i>	
Is value transfer possible?	<i>Is sufficient economic and scientific information available?</i>	
	<i>Are sufficient time and resources available?</i>	
If yes, what is the appropriate level of effort?	<i>Record answer:</i>	
If no, would primary valuation or an approach other than economic valuation would be better?	<i>Record answer:</i>	
Rapid appraisal of the scope of value transfer	<i>What is the policy good?</i>	
	<i>Why is there a change in the provision of the policy good?</i>	
	<i>Where is the policy good?</i>	
	<i>When is the change?</i>	
	<i>Who is affected?</i>	
	<i>How?</i>	
STEP 2 - Define the policy good and affected population		
What is the policy good?	<i>Physical description</i>	
	<i>Ecosystem goods and services</i>	
	<i>Market or non-market good</i>	
	<i>Likely to attract use and/or non-use values</i>	
Which characteristics of the good are likely to influence its economic value?	<i>Size</i>	
	<i>Location (including proximity to populations, substitutes, complements)</i>	
	<i>Uses and unique features that may lead to non-use values.</i>	
	<i>Is the ecosystem services framework used?</i>	
Who is affected by the change in the policy good and whose values should count?	<i>Define and quantify the affected population</i>	
The parameters to be tested in sensitivity analysis	<i>Record answer:</i>	

STEP 3 - Define and quantify the change in the provision of the policy good		
What are the baseline conditions of the policy good?	<i>Economic baseline</i>	
	<i>Environmental baseline</i>	
What is the change described in qualitative terms?	<i>The nature of the change</i>	
	<i>The direction of the change</i>	
	<i>The temporal nature of the change</i>	
	<i>The spatial nature of the change</i>	
	<i>The scale of the change</i>	
What is the change measured in quantitative terms?	<i>Units</i>	
	<i>Quantities</i>	
	<i>Interpretation of what this means for human welfare (revisited in Step 4)</i>	
Is there supporting data to help with value transfer?	<i>The size of the affected population</i>	
	<i>Socio-economic and demographic characteristics of the affected population</i>	
	<i>Patterns and frequency of use (e.g. number of visits)</i>	
	<i>Availability of substitutes to the policy good</i>	
Identify the parameters to be tested in sensitivity analysis		
STEP 4 - Identify and select monetary valuation evidence		
Is there any evidence that matches the policy good, the change and the affected population?	<i>List sources of data checked</i>	
	<i>Identify a long list of likely suitable studies</i>	
Is there any evidence that matches the policy good, the change and the affected population?	<i>Are the policy good and study good sufficiently similar?</i>	
	<i>Are the changes in provision of the policy good and study good sufficiently similar?</i>	
	<i>Are the locations where the policy good and study good are found sufficiently similar?</i>	
	<i>Are the policy good and study good affected populations sufficiently similar?</i>	
	<i>Are the number and quality of substitutes for the policy good and study good sufficiently similar?</i>	
	<i>Are the policy good and study good market constructs sufficiently similar?</i>	
Is the evidence of sufficiently high quality?	<i>Are the data collection procedures sound?</i>	
	<i>For survey-based economic valuation methods is the sample representative?</i>	
	<i>Does the study follow the best practice?</i>	
	<i>Are the results consistent with the expectations based on the economic theory? If not, can the discrepancy be explained?</i>	
What is the unit value(s) and/or value function(s) to be transferred?	<i>List the evidence and reference</i>	
	<i>List the suggested adjustments</i>	
Identify the parameters to be tested in sensitivity analysis	<i>Record answer:</i>	

STEP 5 - Transfer evidence and estimate monetary value of policy good		
Which value transfer approach is to be used?	<i>Unit value</i>	
	<i>Adjusted unit value</i>	
	<i>Value function - collate supporting data</i>	
What is the transferred value of the change in the provision of the policy good?	<i>Convert unit values to £s if study is in another currency, and inflate to current prices</i>	
	<i>Report adjustment factors used or why none is used</i>	
Identify the parameters to be tested in sensitivity analysis	<i>Record answer:</i>	
STEP 6 - Aggregation		
What is the annual value of the change in the provision of the policy good?	<i>Aggregate over all types of value involved</i>	
	<i>Aggregate over all policy goods involved</i>	
	<i>List assumptions about aggregation in particular whether unit value is assumed to vary across space and time</i>	
What is the present value of the change?	<i>How do (i) the change in the provision, (ii) the annual value and (iii) the affected population change over time?</i>	
	<i>Aggregate over time</i>	
	<i>Report the time period and discount rate used</i>	
Identify the parameters to be tested in sensitivity analysis	<i>Record answer:</i>	
STEP 7 - Conduct sensitivity analysis		
Which key parameters affect the transferred value the most?	<u>Step 2</u> <i>The type and size of the affected user and non-user population(s)</i> <i>The types of economic value (and ecosystem services) the policy good is likely to generate</i>	
	<u>Step 3</u> <i>The magnitude, direction, the timing and the spatial nature of the change</i> <i>Quantitative estimates of the change</i> <i>Uncertainties and gaps in supporting data (e.g. socio-economic characteristics of affected population, patterns of use, availability of substitutes)</i>	
	<u>Step 4</u> <i>The selection of evidence from existing studies such as unit values, value functions and empirical relationships (e.g. distance decay)</i>	
	<u>Step 5</u> <i>Best estimates and confidence intervals for unit value of change</i> <i>Best estimates and confidence intervals for value function coefficients</i> <i>Adjustment factors that are applied to unit value estimates or function coefficients</i> <i>Policy good values of explanatory variables in value functions</i>	

	<i>Step 6</i> <i>Discount rate and time horizon</i>	
Which sensitivity analysis approach should be adapted?	<i>Changing one key parameter at a time to see the effect on the resulting value estimate</i>	
	<i>Scenarios to account for sensitivity in multiple parameters</i>	
	<i>Assigning probabilities to outcomes</i>	
	<i>Monte Carlo Analysis</i>	
	<i>Switching analysis</i>	
	<i>Benefits threshold</i>	
What is the nature and significance of the effects of key parameters on the results?	<i>Record annual and/or present value estimates of value for each run of sensitivity analyses</i>	
What is the switching value?	<i>Record the switching value:</i>	
What is the benefit threshold?	<i>Record the benefit threshold:</i>	
STEP 8 - Reporting		
Unit and aggregate results	<i>Summarise</i>	
Sensitivity analysis	<i>Summarise</i>	
Key parameters and caveats (Steps 2-6)	<i>Summarise</i>	

GLOSSARY

Adjusted unit value transfer	Transfer of a mean average (or median) value estimate for a study good that is adjusted to account for some factor (or factors) to estimate the value of policy good.
Affected population	The population of the users and non-users that are affected by the change in the provision of a market or non-market good or service. See also ' <i>economic jurisdiction</i> '.
Altruistic value	Non-use benefit derived from the knowledge that contemporaries are able to enjoy the goods and services related to natural resources.
Appraisal	The process of defining objectives, examining options and weighing up the costs benefits, risks and uncertainties of proposed policies, programmes or projects before a decision is made.
Benefits transfer	See ' <i>value transfer</i> '.
Bequest value	Non-use benefit associated with the knowledge that natural resources will be passed on to future generations.
Choice experiment	A form of choice modeling in which respondents are presented with a series of alternatives and asked to choose their most preferred.
Choice modelling	An umbrella term for a variety of stated preference techniques that infer willingness to pay or accept indirectly from responses stated by respondents (as opposed to directly asking as in a contingent valuation survey). Includes choice experiments, contingent ranking, contingent rating and paired comparisons.
Consumer surplus	The difference between price paid and the maximum amount an individual is willing to pay to obtain a good; this reflects the additional benefit that is gained by consumers in consumption of a good or service.
Contingent ranking	A form of choice modelling in which respondents are presented with a number of scenarios and asked to rank them individually on a semantic or numeric scale.
Contingent valuation	A stated preference approach to valuing non-market goods and services where individuals are asked what they are willing to pay (or accept) for a change in provision of a non-market good or service.
Cost-benefit analysis (CBA)	A decision-making tool that compares costs and benefits of a proposed policy or project in monetary terms.
Cost-effectiveness analysis (CEA)	A decision-making tool that compares the cost of different options for achieving the same or similar outcomes.
Cost function approach	A production input method which relates the output of a given good (e.g. agricultural products) to the cost of its factor inputs (e.g. the quantity or quality of water).

Cost of alternatives	A market pricing approach that considers the cost of providing a substitute that would provide a similar function to a resource.
Cost of illness	A market pricing approach where a proxy value can be inferred from the cost of illness (e.g. medical treatment, loss of earnings from work days lost, etc.) incurred when it is not available.
Cultural services	A category of ecosystem services that relates to the non-material benefits obtained from ecosystems, for example through recreation.
Decision-making context	This is relates to the wider policy or project objective that is subject to appraisal and for which economic valuation evidence is required. It covers the issue under consideration and the rationale for intervention, the objective and the intended effects of intervention, and the policy or project options that are to be considered.
Direct use value	Economic value associated with use of a resource in either a consumptive manner or non-consumptive manner.
Discounting	The process of expressing future values in present value terms. This allows for the comparison of flows of cost and benefit over time regardless of when they occur.
Distance decay	Pattern of declining unit values for a non-market good or service as distance from it increases.
Econometrics	Empirical economic analysis via the application of quantitative or statistical methods (e.g. estimating a WTP function).
Economic efficiency	A concept that relates to allocating resources to maximize wellbeing to society.
Economic jurisdiction	The spatial area over which some positive economic value is associated with the use of a resource and the services provided or supported by it.
Economic value	The monetary measure of the wellbeing associated with the change in the provision of some good. For market goods this is ordinarily measured by market price; for non-market goods this ordinarily measured by willingness to pay (WTP) or willingness to accept (WTA).
Economic valuation evidence (monetary valuation evidence)	Economic values, value functions and other empirical evidence available from existing (primary) studies that provides the source of evidence for value transfer. Previous value transfer analyses may also provide evidence for current applications.
Ecosystem services approach	A term that is used to describe a framework for analyzing how human populations are dependent upon the condition of the natural environment. The approach explicitly recognizes that ecosystems and the biological diversity contained within them contribute to individual and social wellbeing.

Environmental impact assessment (EIA)	Identification and assessment of environmental impacts resulting from a proposed policy or project.
EVRI	The Environmental Valuation Reference Inventory. A database of existing economic valuation evidence (i.e. secondary evidence) for the purpose of facilitating value transfer.
Evaluation	Retrospective analysis of a policy, programme or project to assess how successful or otherwise it has been, and what lessons can be learnt for the future. The terms 'policy evaluation' and 'post-project evaluation' are often used to describe evaluation in those two areas.
Existence value	Non-use value derived from knowing that a resource continues to exist, regardless of use made of it by oneself or others now or in the future.
Frequency decay	Pattern of declining unit value for a non-market good or service due to diminishing marginal utility; e.g. for recreational visits to a site.
Geographic information system (GIS)	An information system that captures, stores, analyzes, manages, and presents data that is linked to geographic location.
Green accounting	The modification of national (income or corporate) accounts to include environmental capital within the measure of wealth (alongside man-made, human and potentially social capital).
Health-risk assessment (HRA)	Assessment of adverse health outcomes from proposed actions (e.g. the number of people affected and risk of illness).
Hedonic pricing method	A revealed preference valuation method that estimates the use value of a non-market good or service by examining the relationship between the non-market good and the demand for some market-priced complementary good (e.g. property or land prices).
Indirect use value	Economic value associated with the services supported by a resource as opposed to the actual use of the resource itself; e.g. key ecosystem services such as nutrient cycling, habitat provision and climate regulation.
Life-cycle analysis (LCA)	A technique for measuring the environmental impacts of any product, process or activity according to each stage of its life cycle from the extraction of raw materials to final disposal.
Marginal change	An incremental change (ordinarily a 'unit change') in the provision of a market or non-market good or service.
Market goods	Goods and services traded in formal markets.
Market price	The value of the provision of goods and services that may be directly observed from markets.

Market price methods	Approaches to economic valuation that provide proxy estimates - which may be observed directly from actual markets - for use values that arise in relation to the provision of goods and services.
Mitigation costs	A market pricing approach that considers costs incurred to mitigate against particular outcomes associated with the degradation of a resource.
Monetisation	The assignment of a monetary value to a change in the provision of a non-market good or service.
Multi-criteria analysis (MCA)	A decision-making tool that normally combines both quantitative and qualitative assessments of alternative policy and project outcomes.
Net present value (NPV)	The difference between the present value of costs and the present value of benefits.
Meta-analysis	An empirical study that collates data from multiple valuation studies on a particular good, with the purpose of identifying the key factors that influence estimated economic values.
Multi-site recreation demand model	A revealed preference method that infers the value of changes in the characteristics of goods and services from the choices individuals make between similar alternatives. May also be termed 'random utility model' or 'discrete choice model'.
Non-market goods and services	Goods and services that are not traded in markets and are consequently 'un-priced' (e.g. environmental goods and services).
Non-use value (passive use value)	Economic value not associated with any use of a resource, but derived altruistic, bequest and existence values.
Non-users	Population group(s) that derives economic value from a resource even though they do not make direct or indirect use of it (i.e. non-use value).
Opportunity cost	The value of the next best alternative use of resource.
Option value	Benefits associated with retaining the option to make use of resources in the future.
Policy good	A value transfer term. The good or service for which monetary valuation evidence is required. It could be a physical commodity and market good (e.g. timber), it could be a non-market amenity (e.g. recreation) or service (e.g. water quality), or environmental impact (e.g. a reduction in water quality, an increase in air pollution).
Political jurisdiction (administrative jurisdiction)	The national, regional or local boundary of the decision-making context.
Present value	A future value (cost or benefit) expressed in present terms by means of discounting.

Primary study (primary valuation)	An economic valuation study specifically designed to estimate the value of the change in a policy good; it provides primary evidence for decision-making, rather than relying on secondary evidence as is the case for value transfer.
Producer surplus	The difference between the minimum amount a seller is willing to accept for a good and the actual price received; this reflects the additional benefit in exchange gained by the producer (e.g. 'profit').
Production function approach	A production input method which relates the output of a given good (e.g. agricultural products) to its factor inputs (e.g. the quantity or quality of water).
Production input methods	Economic valuation methods that focus on the indirect relationship that exists between a particular resource (e.g. water) and the production of a market good (e.g. agricultural products).
Provisioning services	A category of ecosystem services which relates to products obtained from ecosystems, such as food, fiber and fuel, natural medicines and genetic resources.
Public good	A good or service that is non-rival and non-excludable. This consumption of the good by one individual does not reduce availability of the good for consumption by others, and that no one can be effectively excluded from using the good.
Quasi-option value	A use value related to option value, which arises through avoiding or delaying irreversible decisions, and where technological and knowledge improvements can alter the optimal management of a natural resource such as water.
Regulating services	A category of ecosystem services which refers to the regulation of ecosystem processes such as climate regulation, air quality regulation, water regulation (e.g. flood control), water quality regulation (purification/detoxification) and erosion control.
Revealed preference methods	Economic valuation methods that estimate the use value of non-market goods and services by observing behavior related to market goods and services (e.g. travel cost method and hedonic pricing method).
Shadow price	The opportunity cost to society of some activity, relating to situations where market prices do not reflect the scarcity value (i.e. opportunity cost) of the use of a good or service.
Shadow project costs	A market pricing approach that focuses on the cost of compensating for the loss of an environmental resource at a particular site by assessing the cost of providing an equal resource at an alternative site.
Stated preference methods	Economic valuation methods that use questionnaire surveys to elicit individuals' preferences (i.e. willingness to pay and/or willingness to accept) for changes in the provision on non-market goods or services.
Study good	A value transfer term. The good or service for which economic valuation evidence is available.

Subsidy cost	A market pricing approach where a proxy value for non-environmental goods may be inferred from subsidies paid to provide them.
Supporting services	A category of ecosystem services which are necessary for the production of all other ecosystem services, such as soil formation and retention, nutrient cycling, water cycling and the provision of habitat.
Total economic value (TEV)	The economic value of a resource comprised of its use and non-use values.
Transfer error	The difference between predicted policy site WTP and observed policy site WTP as estimated by studies assessing the accuracy of value transfer.
Travel cost method	A revealed preference and survey based valuation method that uses the cost incurred by individuals traveling and gaining access to a recreation site as a proxy for the recreational use value of that site.
Unit value transfer	Transfer of a mean average (or median) value estimate for a study good to estimate the value of policy good.
Use value	The economic value that is derived from using or having potential to use a resource. It is the net sum of direct use values, indirect use values and option values.
Users	Population group(s) that composed of individuals making direct use of a resource or indirect use of a resource.
Value function transfer	A statistical relationship between the value of a study good and a set of explanatory variables that is transferred to estimate the value of the policy good.
Value transfer (benefits transfer)	Process by which readily available economic valuation evidence is applied in a new context for which valuation is required.
Welfare (wellbeing)	A measure of satisfaction or 'utility' gained from a good or service.
Willingness to accept compensation (WTA)	The monetary measure of the value of forgoing a gain in the provision of a good or service or allowing a loss.
Willingness to pay (WTP)	The monetary measure of the value of obtaining a gain in the provision of good or service or avoiding a loss.

REFERENCES

Bateman, I.J., Munro, A., Rhodes, B., Starmer, C. and Sugden, R. (1997a) 'Does part-whole bias exist? An experimental investigation', *Economic Journal*, 107(441): 322-332.

Bateman, I., Carson, R.T., Day, B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Ozdemiroglu, E., Pearce, D.W., Sugden, R. and Swanson, J. (2002) *Economic Valuation with Stated Preference Techniques: A Manual*, Edward Elgar, Cheltenham, UK.

Bateman, I.J., Day, B.H., and Lake, I. (2004) *The Valuation of Transport-Related Noise in Birmingham*, Non-Technical Report to Department for Transport.

Bateman et al. (2006). 'The aggregation of environmental benefit values: Welfare measures, distance decay and total WTP'

Beaumont, N., Townsend, M., Mangi, S. and Austen, M.C. (2006) *Marine biodiversity: An economic valuation*, Final Report to Defra.

Bockstael, N.E. and McConnell, K.E. (2006) *Environmental and Resource Valuation with Revealed Preferences: A Theoretical Guide to Empirical Models*, Springer.

Brouwer, R. and Bateman, I.J. (2005) 'The temporal stability and transferability of models of willingness to pay for flood control and wetland conservation', *Water Resource Research*, Volume: 41.

Champ, P., Boyle, K.J., Brown, T.C. (2003) *A Primer on Non-Market Valuation*, Kluwer Academic Press, Dordrecht.

Chilton, S., Covey, J., Jones-Lee, M., Loomes, G. and Metcalf, H. (2004) *Valuation of Health Benefits Associated with Reductions in Air Pollution*, Report to Department for Environment, Food and Rural Affairs.

Crabtree, B., Willis, K. and Osman, L. (2005) *Economic Benefits of Accessible Green Spaces for Physical and Mental Health: Scoping Study*, Report to the Forestry Commission.

Crabtree, B., Willis, K., Selman, P. and Tucker, G. (2005) *A Review of Evidence for the Formulation of Forestry Policy in England*, Report to Department for Environment, Food and Rural Affairs.

Christie, M., Warren, J., Hanley, N., Murphy, K., Wright, R., Hyde, T. and Lyons, N. (2004) *Developing Measures for Valuing Changes in Biodiversity*, Report to Department for Environment, Food and Rural Affairs.

Christie, M., Hanley, N., Garrod, B., Hyde, T. and Lyons, N., Bergman, A. and Hynes, S. (2006) *Valuing Forest Recreation Activities*, Phase 2 Final Report, Report to Forestry Commission.

Christie et al (forthcoming) *Economic Valuation of the Benefits of the UK Biodiversity Action Plan*, Defra funded research project.

Danish Environmental Protection Agency (2007) *Practical tools for value transfer in Denmark - guidelines and an example*.

DECC (2009) *Carbon Valuation in UK Policy Appraisal: A Revised Approach*, Department of Energy and Climate Change, July 2009.

Defra (2007a) *An introductory guide to valuing ecosystem services*, Department for Environment, Food and Rural Affairs, December 2007.

Defra (2007b) *Economic Analysis to Inform the Air Quality Strategy*, Department for Environment, Food and Rural Affairs.

Defra (2008) *Air quality damage costs guidance*, Department for Environment, Food and Rural Affairs.

DfT (2007) *Departmental estimates of the value of the prevention of road casualties*, published in Highways Economic Note No.1: 2005 (HEN1).

Drew Associates (2003) *Research into the Economic Contribution of Sea Angling*, Report to Department for Environment, Food and Rural Affairs.

eftec (2002) *Valuation of Benefits to England and Wales of a Revised Bathing Water Quality Directive*, Report to Department for Environment, Food and Rural Affairs.

eftec (2004) *Framework for Environmental Accounts for Agriculture*, Report to Department for Environment, Food and Rural Affairs, Department of Agriculture and Rural Development (Northern Ireland), Scottish Executive, The Welsh Assembly Government.

eftec (2005) *The Economic, Social and Ecological Value of Ecosystem Services: A Literature Review*, Report to Department for Environment, Food and Rural Affairs.

eftec (2006) *Valuing our natural environment*, Report to Department for Environment, Food and Rural Affairs.

eftec (2006) *Economic Valuation of Environmental Impacts in the Severely Disadvantaged Areas*, Report to Department for Environment, Food and Rural Affairs.

eftec (2009) *Valuing Transport's Impact on the Natural Landscape: Phase 2*, Report to Department for Transport.

eftec (2009) *Economic valuation of upland ecosystem services*, report to Natural England.

Fisher et al (2008) *'Defining and classifying ecosystem services for decision making'*.

Freeman (2003) *The Measurement of Environmental and Resource Values: Theory and Methods*, Resources for the Future, Washington D.C.

Garrod (2002) *Landscape Benefits*, Report to Forestry Commission.

GHK Consulting Ltd and GFA-Race Partners Ltd. (2004) *Revealing the Value of the Natural Environment in England*, Report to Department for Environment, Food and Rural Affairs.

Haab, T.C. and McConnell, K.E. (2002) *Valuing Environmental and Natural Resources: the Econometrics of Non-Market Valuation*, Edward Elgar Publishing.

Haines-Young, R., Potschin, M. and Cheshire, D. (2006) *Defining and Identifying Environmental Limits for Sustainable Development, A Scoping Study*. Report to Department for Environment, Food and Rural Affairs.

Hanley, N., Willis, K., Powe, N. and Anderson, M. (2002) *Valuing the Benefits of Biodiversity in Forests*, Report to Forestry Commission.

Hensher, D. and Rose, J. (2005) *Applied choice analysis: a primer*, Cambridge University Press.

Hoehn, J.P. and Randall, A. (1989) 'Too many proposals pass the benefit cost test', *American Economic Review*, 79, 544-551.

Hoehn, J.P. and Loomis, J. B. (1993) 'Substitution effects in the valuation of multiple environmental programs', *Journal of Environmental Economics and Management*, 25, 56-75.

Hökby, S. and Söderqvist, T. (2003) 'Elasticities of demand and willingness to pay for environmental services in Sweden', *Environmental Resource Economics*, 26:361-383.

HM Treasury (2003) *The Green Book: Appraisal and Evaluation in Central Government*, Treasury Guidance, The Stationary Office.

Jacobs (2008) *A Valuation of England's Terrestrial Ecosystem Services*, Report to Department for Environment, Food and Rural Affairs.

Jacobs in association with Scottish Agricultural College and Cranfield University (2008) *Environmental Accounts for Agriculture*, Report to Department for Environment, Food and Rural Affairs, Welsh Assembly Government, Scottish Government, Department of Agriculture and Rural Development (N. Ireland).

Jacobsen, J.B. and Hanley N. (2009) 'Are There Income Effects on Global Willingness to Pay for Biodiversity Conservation?' *Environmental Resource Economics*, 43:137-160.

Jones, A., Bateman I. and Wright, J. (2003) *Estimating Arrival Numbers and Values for Informal Recreational Use of British woodlands*, Report to the Forestry Commission.

Kanninen, B. (2006) *Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice*, Springer.

Kriström, B. and Riera, P. (1996) 'Is the income elasticity of environmental improvements less than one?' *Environmental Resource Economics*, 7:45-55.

Lawrence and Spurgeon (2007) *Economic Evaluation of Inland Fisheries: Welfare Benefits of Inland Fisheries in England and Wales*, Report to the Environment Agency for England and Wales.

Luisetti et al (2009) '*An ecosystem services approach to assess managed realignment coastal policy in England*'.

Louviere J.L., Hensher D.A and Swait, J.D. (2000) *Stated Choice Models: analysis and application*, Cambridge University Press, Cambridge.

MacMillan (2001) *Valuation of Air Pollution Effects on Ecosystems*, Report to Department for Environment, Food and Rural Affairs.

Macmillan (2002) *The Value of Managing Forests to Protect Archaeology*, Report to Forestry Commission.

Nera (2007) *The Benefits of Water Framework Directive Programmes of Measures in England and Wales*, Collaborative Research Programme On River Basin Management Planning Economics Report.

ODPM/CLG (2002) *The External Benefits of Undeveloped Land: A Review of the Economic Literature*. Department for Communities and Local Government.

Oglethorpe (2005) *Environmental Landscape Features (ELF) Model Update*, Report to Department for Environment, Food and Rural Affairs.

Powe and Willis (2002) *Mortality and Morbidity Benefits of Air Pollution Absorption by Woodland*, Report to Forestry Commission.

Radford, A., Riddington, G. and Tingley, D. (2001) *Economic Evaluation of Inland Fisheries Module A: Economic Evaluation of Fishing Rights*, Report to Environment Agency for England and Wales.

Santos, J.M.L. (1998) *The Economic Valuation of Landscape Change: theory and policies for land use and conservation*, Edward Elgar, Cheltenham.

Scarpa (2003) *The Recreation Value of Woodlands*, Report to Forestry Commission.

Social and Economic Research Group (2008) *A Valuation of the Economic and Social Contribution of Forestry for People in Scotland*, Forestry Commission Scotland.

Spurgeon, J., Colarullo, G., Radford, A. and Tingley, D. (2001) *Economic Evaluation of Inland Fisheries Module B: Indirect Economic Values Associated with Fisheries*, Report to Environment Agency for England and Wales.

Swanwick, C., Hanley, N. and Termansen, M. (2007) Scoping Study on Agricultural Landscape Valuation, Report to Department for Environment, Food and Rural Affairs.

Scottish Agricultural College (2008) *Determining Monetary Values for Use and Non-use Goods and Services - Marine Biodiversity - Primary Valuation*, Report to Department for Environment, Food and Rural Affairs.

University of Edinburgh and Scottish Agricultural College (2001) *Estimating the Value of Environmental Features*, Report to Department for Environment, Food and Rural Affairs.

Ward, F. A. and Beal, D.J. (2000) *Valuing nature with travel cost models: a manual*, Edward Elgar Publishing.

Willis et al (forthcoming) *Estimating the Non-market Benefits of Environmental Stewardship*. Defra funded research project.