Valuing the water environment in Scotland

This overview note provides a background to assigning monetary values to the environment, it describes key aspects of a study conducted by Metcalfe et al[1] to determine monetary values for improvements to the water environment by implementing the Water Framework Directive (WFD) in England and Wales and it describes how the values developed have been transferred to develop values for improvements to the water environment in Scotland.

Background on environmental valuation

The monetary valuation of environmental impacts is an area of environmental economics that has been developing over many years. While developing monetary values for the environment is very challenging it is certainly not impossible and there is now widespread acknowledgement that it is useful[2], particularly when environmental benefits need to be compared with monetised costs.

Economists describe the environment as having a total economic value (TEV). This is different to a price which is paid for goods in shops. Many environmental benefits are provided free of charge, but people still attach value to them (as is partly demonstrated by the fact that they spend their precious time visiting and enjoying them). Environmental economists describe the following values as making up the TEV for the environment:

- Direct use values – where individuals make actual or planned use of the environment. This could be consumptive use through extracting resources (food or timber) or non-consumptive use where use doesn't involve extraction (recreation, landscape, amenity). Some of these activities are routinely bought and sold in markets (e.g: food) and some are not (eg: landscapes).

[1]Paul J Metcalfe, William Baker, Kevin Andrews, Giles Atkinson, Ian J Bateman, Sarah Butler, Richard T Carson, Jo East, Yves Gueron, Rob Sheldon, Kenneth Train (2012), *An assessment of the non-market benefits of the Water Framework Directive for households in England and Wales*, Water Resources Research 48(3)

[2] See for example: Bateman IJ, Mace GM, Fezzi C, Atkinson G and Turner K (2010), *Economic Analysis for Ecosystem Service Assessments*, Environmental and Resource Economics

- Indirect use values – where individuals benefit from the environment without directly using it. This can include vicarious use such as enjoyment of nature on television, via webcams or through pictures. Regulating ecosystem services (such as climate regulation, water regulation, pollutant filtering, pollination) are often associated with these types of value and they are often not noticed until they are lost. Indirect use values are rarely bought and sold.

- Option values – these are where people place value on the option to use a resource even if they aren't currently users. These may be future direct or indirect uses.

- Existence value – benefit derived from knowing an environmental resource exists even if there is no intention to use it.

- Bequest value – values associated with the availability of environmental benefits for future generations.

- Altruistic values – value associated with the availability of the ecosystem resource to others in the current generation

Table 1 relates the different values to the four main categories of ecosystem service. Economists do not value supporting ecosystem services as well as provisioning, regulating and cultural services because to do so would result in double counting.

Table 1: Values for different categories of ecosystem service

Ecosystem services framework (MA relevant)		Total Economic Value framework					
MA Group	Service	Direct use	Indirect use	Option value	Existence values	Bequest values	Altruistic values
Provisioning	Food, fibre, fuel, water etc	*		*		*	*
Regulating	Air quality,		*	*		*	*

	water quality, climate, flood						
Cultural	Recreation, landscape, amenity	*	*	*	*	*	*
Supporting	Primary production, soil formation etc	Valued through the other categories of ecosystem services					

Determining total economic value for environmental goods

There are two main groups of techniques for determining monetary values for environmental goods and services:

- Revealed preferences – determine values for goods, which include an environmental component, in markets. Techniques include hedonic pricing (where property prices are enhanced as a result of proximity to environmental features) and travel cost method (where the cost of travelling to visit a site is taken as an indicator of its value). Revealed preference techniques only work for use values and where there is a market of some kind for the good in question, for many environmental goods these requirements do not apply.

- Stated preferences – use carefully constructed questionnaires to elicit individuals' preferences for a change in the environment. These surveys elicit respondents' willingness to pay for an environmental improvement (or their willingness to accept compensation for a deterioration). In principle, stated preference methods can be applied in a wide range of contexts and are the only methods that can provide monetary estimates of non-use values (which can be considerable in relation to environmental benefits).

The value elicitation method to be used will depend heavily on the type of environmental change being valued. Implementation of the WFD is likely to give rise to changes in all the value categories set out above, some of which could be elicited through actual markets (for example impacts on provisioning services), some through other revealed preferences (for example though travel distance to improved water bodies) and many of which will require stated preference methods to capture the value (for example changes in provision of many cultural and regulating services).

Economists have trialled and developed stated preference elicitation methods over many years. Questionnaires are subject to extensive pre-testing to ensure that respondents understand and believe what they are being asked about. Surveys are also conducted on representative samples of the target population and findings are subject to thorough statistical analysis. Statistical analysis of findings serves two main purposes, it helps to ascertain levels of confidence in the findings, to discount outliers and test sensitivity of findings to elicitation methods and question ordering for example. The statistical analysis associated with stated preference surveys also routinely examines the impact of other variables (such as respondent age, income, employment status and gender) on the findings of the survey, it then controls for these and makes sure that they are representative of the whole survey population in any final values that are derived.

Metcalfe valuation techniques

The Metcalf study examined a number of different WFD environmental improvement scenarios (more details below) and employed three different stated preference elicitation techniques, as follows:

- Dichotomous choice contingent valuation (DCCV) – respondents were offered to select one of two scenarios, one of which was no change (with zero additional cost) and one with some level of environmental change and an additional associated cost.
- Payment card contingent valuation (PCCV) – respondents were presented with a single improvement scenario and a range of payments and asked

which payment level or any in between they would be willing to make to achieve it.

- Discrete choice experiment (DCE) – respondents were presented with three different choices, one no change scenario and two change scenarios with different prices attached, and asked to select their preference.

Research has shown that DCE tends to lead to correct relative valuations but over-estimates of absolute valuations. The Metcalfe study therefore calibrates the absolute scale of the DCE estimates of value by using the CV studies. Contingent valuation studies lead to many different types of bias depending on the elicitation method used and question order. The Metcalfe study employed three different elicitation techniques in different orders to isolate and test sensitivities to these effects.

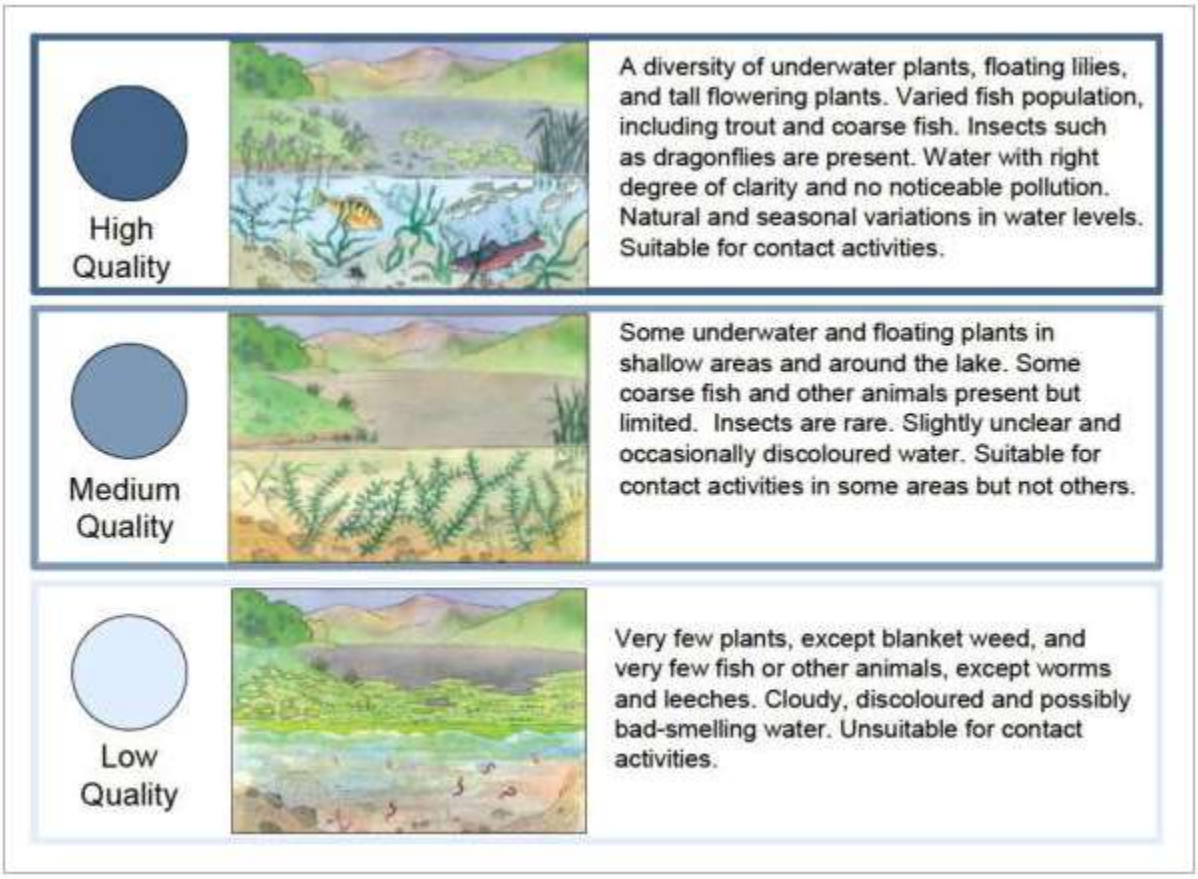
Metcalfe survey and environmental change scenarios

The Metcalfe survey was carried out in 50 different locations in England and Wales with 30 respondents in each location, so 1500 respondents in total, each of whom was offered an incentive (£8) to participate. The design and development of the questionnaire conformed to best practice in stated preference elicitation, as set out by environmental economists. The ‘description of the good’ (or the environmental change to be valued) was informed by a stakeholder survey, work with a team of scientists and focus groups with members of the public.

Respondents were shown two cards containing three descriptions of water quality (high, medium and low). High quality was developed to represent high or good ecological status; medium quality moderate or poor ecological status; and low quality bad ecological status. The first card contained generic descriptions of water quality at each level and the second card provided illustrated descriptions specific to one randomly assigned water body type (rural river, urban river, lake or estuary/coastal). Due to survey time it was only possible to describe one type of water body to each respondent though statistical tests suggested that the water body type shown did not influence findings. The generic and the lake quality cards are reproduced in Figure 1 and Figure 2 below.

Figure 1: Generic water quality card

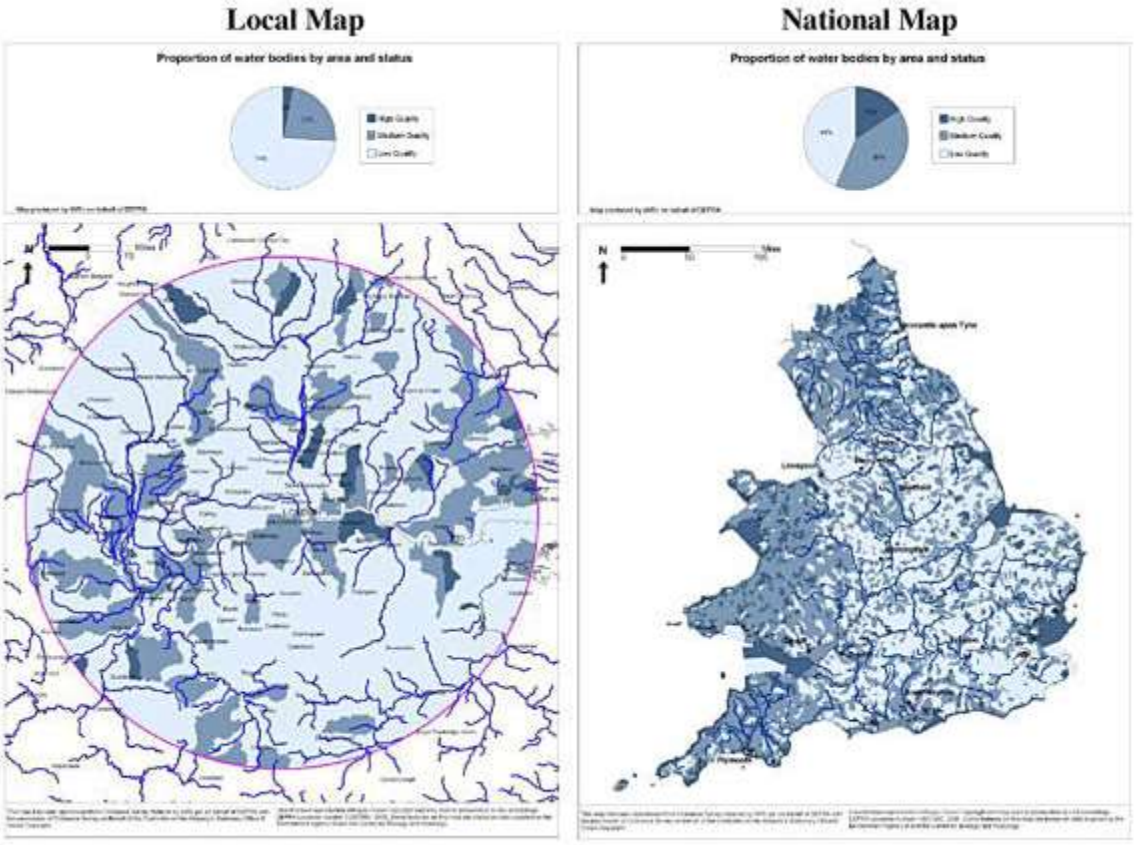
Figure 2: Lake water quality card



The cards explain changes in recreation, amenity and non-use benefits associated with improvements in water body status so these are the only elements of value that are included in the monetised benefit values that are developed.

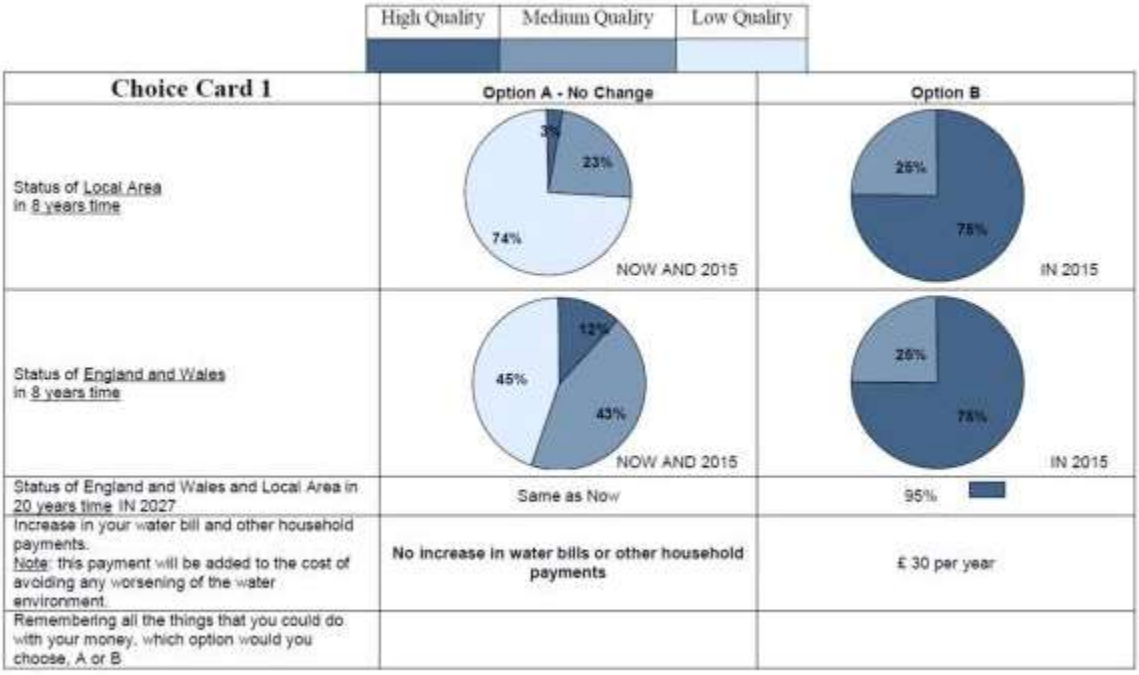
Respondents were then shown two maps with current water quality levels, the first in their local area and the second for the whole of England and Wales. An example map is reproduced in Figure 3.

Figure 3: Example maps



Respondents were then presented with a series of valuation questions: seven DCE questions; one DCCV question and one PCCV question. They were asked how much they would be willing to pay through increased water bills and other household payments each year to secure the improvements shown. An example showing a DCCV question presentation is shown in Figure 4.

Figure 4: Example DCCV question card



A large range of treatments were presented in the survey so the design was complex. The treatments presented a range of different WFD policy improvement scenarios in terms of the proportion of respondents' local area (within 30 miles) and of the national area (England and Wales) that will be high, medium and low quality in 8 and 20 years time (2015 and 2027 respectively). The levels of payment were also varied, under DCCV and DCE payments of £5, £10, £20, £30, £50, £100 and £200 per household/year were presented. The PCCV question asked respondents to select from 28 different payments ranging from £0 to £1000/household/year. The range of scenarios presented allowed for the generation of statistically significant values for the environment[3].

Findings from the Metcalfe study

The study determined the value of individual water body improvements as a function of the size of the area improved, the scope of the improvement (i.e.: whether low to medium or medium to high) and the size of the population surrounding the improved water body. The study goes on to translate the values to values for %age point

[3] For more details refer to the paper http://onlinelibrary.wiley.com/enhanced/doi/10.1029/2010WR009592/

improvements in the national and local area of the water environment improved to different status. High (DCCV) and low (PCCV) scaled values are shown Table 2.

Table 2: Summary of Metcalfe study findings (values expressed in £/household/year expenditure on a 1% (by catchment area) improvement in the local or national water environment)

Water quality change	Local value		National value	
	Low value (PCCV scaled)	High value (DCCV scaled)	Low value (PCCV scaled)	High value (DCCV scaled)
Low to Medium	0.11	0.28	0.16	0.41
Medium to High	0.16	0.41	0.20	0.51

Update of the Metcalf values

The Environment Agency commissioned Paul Metcalf to update the original benefit values in spring 2012. The final values (for all river and lake catchments in England and Wales) are shown in this document, which describes the update and a peer review that was undertaken.

Transferring Metcalfe values to Scottish water bodies

The method that was used to transfer the England and Wales values to Scottish water bodies is described in the supporting document (Estimating monetary values for improvements to the Scottish water environment).