



Research Report

Insights from behavioural economics for ecosystem services valuation and sustainability

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Darren Moseley and Gregory Valatin

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Contents

Summary	v
Introduction	1
Methodology	3
Results	4
Information processing	4
Information presentation	5
Context	7
Learning and preference formation	8
Loss aversion	10
Lexicographic preferences	11
Discussion	12
Conclusions	15
Recommendations for future research	15
References	17
Appendix: Instances of cognitive variables within references	20
Glossary	22

Summary

This Research Report provides a review, drawing on evidence from the behavioural economics literature, to examine how cognitive factors influencing people's choices and preferences can affect the values that they place upon ecosystem services and upon ecosystem sustainability. The review focuses on recent studies published from 2001 to 2012. Ecosystem services are broadly defined as the benefits humans obtain from ecosystems. Failure to account for their value to society in making decisions is a primary driver of environmental degradation and lack of sustainability.

A broad literature search on ecosystem value or valuation, combined with one of a range of terms used in behavioural economics, was initially used, but the scope of most of the studies identified was relatively narrow. They relate primarily to stated preference approaches that use survey methods to elicit values for changes in particular ecosystem services or stocks of ecological capital. A wide range of impacts on stated preference values are identified in the literature. However, the evidence base on cognitive factors that influence ecosystem services valuation is currently relatively thin, with only a few studies investigating each type of impact.

Accumulating evidence shows that the values placed on particular ecosystem services vary depending upon how survey questions are framed (e.g. due to framing effects), the setting in which questions are posed (e.g. individual or group), and due to a range of other factors.

The studies are discussed under six categories covering different types of impacts on cognition and decision making: information processing, information presentation, context, learning and preference formation, loss aversion and lexicographic preferences (see Glossary for explanation of this and other terms used):

- Information processing issues (the ability of individuals to process information in an efficient and consistent manner) can result in 8 times higher variance in respondent values when more complex formats are used. The prominence of species focused on can be an influence, as higher values may be expressed for flagship and 'charismatic' species (e.g. otters) than less popular ones (e.g. hares), partly as a consequence of respondents being more familiar with associated conservation issues due to the greater publicity these receive.
- How information is presented can affect the values respondents place on ecosystem services, with evidence that textual information can elicit 2.5 to 4 times higher stated values than if the same information is in a tabular format. Framing information in different ways can result in different values being given by respondents, such as when habitat restoration is couched in terms of impacts on species rather than functions (e.g. water levels), individual species are named, or labels (e.g. 'national park') are used.
- The context in which valuation studies are undertaken can affect values individuals place on ecosystem services, with higher values given if the respondent is asked to consider themselves as a citizen (i.e. part of the wider community), rather than as an individual. Respondent's values are also affected by the survey method and time-frame, and also by responses to preceding questions. As is well known in the valuation literature, large impacts (2 to 10 times) can result from the hypothetical nature of valuation questions as respondents may overestimate what they would be prepared to pay (e.g. to protect a habitat) where they do not actually have to make a payment.
- Evidence shows how the values people place upon ecosystem services and sustainability can change following a period of learning and preference formation as preconceptions, prior knowledge and levels of understanding are updated.
- If a zero value is given, this may reflect a preference for protection of particular ecosystem services before other goods are considered. Where this is the case, the inclusion of these responses will tend to bias value estimates downwards.

A variety of methods have been proposed to mitigate these impacts. Although further work is needed to provide evidence of the extent to which these are effective (and questions as to the validity of existing approaches and whether they are sufficiently robust for policy purposes remain), general recommendations for designing future valuation studies include the following:

- As ecosystem service concepts can be complex, care needs to be taken to prevent information overload and to help respondents make use of the information through good experimental design.

- As people tend to value losses more than gains, willingness to pay (WTP) responses may provide underestimates and willingness to accept (WTA) responses can provide a better guide for conserving ecosystems.
- As strong beliefs (lexicographic preferences) can result in either a refusal to provide a value for a particular ecosystem service or a refusal to consider trade-offs between services, studies that focus on a basket of ecosystem services and substitution between them need to take account of the potential for such responses (e.g. by ranking choices and using follow-up questions).
- As valuation can be complicated by protest answers, where a zero or no vote is given because the respondent does not think the good should be valued or substituted, and by 'free-riding' (if respondents expect they will get the good anyway), a follow-up question should be used to determine why they have indicated a particular value.

This review has highlighted ways in which cognitive factors influence the values people place upon ecosystem services. These have implications for gauging the robustness of existing estimates and for the design of future research to elicit values for the wide range of ecosystem services woodland and other habitats provide, especially those for which markets do not currently exist and surveys are used. Further research is needed to:

- investigate how values expressed by respondents change over time;
- explore how values vary depending upon the spatial perspective adopted by respondents;
- draw out evidence on the cognitive factors influencing the effectiveness of different levels of incentives in promoting ecosystem sustainability;
- investigate how the way sustainability issues are framed affects values;
- explore how to capture any shared social values for ecosystem sustainability not covered by aggregating individual values, including influences of cognitive factors.

The evidence shows that individual preferences are not fixed. This makes optimality difficult to define and has practical significance for the implementation of policies to promote ecosystem sustainability. Akin to public health strategies to reduce smoking and lung cancer, tackling problems such as global climate change and biodiversity loss to ensure ecosystem sustainability may require directly influencing values and behaviour, rather than simply relying upon more traditional regulatory approaches and institution building.

Introduction

Ecosystem services are broadly defined as benefits of ecosystems (MEA, 2005), or outputs of ecosystems from which people derive benefits (UK NEA, 2011), where an ecosystem is defined as 'a dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit' (MEA, 2005, p. 29). Ecosystem services can be considered as flows, which are generally dependent upon natural capital stocks (ecosystems) remaining above critical thresholds. At present such thresholds are often not well defined, with assessments of values often focusing primarily upon the ecosystem service flows (e.g. Bateman *et al.*, 2011), rather than natural capital stocks and sustainability issues.

Although not a sufficient basis by itself for achieving wider societal goals such as ecological sustainability or distributional justice, economic (e.g. monetary) valuation provides information fundamental to the pursuit of resource efficiency. (For a discussion of different types of values and their role in decision making, see Fanning, 2012.)

Valuation has generally been founded upon preferences expressed by individuals. Valuation of ecosystem services for which no market currently exists can be based upon a variety of non-market methods. These include 'stated preference' approaches that use survey methods such as contingent valuation (CV) and choice experiments (CE) – see the Glossary for explanation of these and other terms used – to elicit values. They also include 'revealed preference' approaches that estimate implicit values from wider economic relationships (e.g. amenity values from models of the determinants of property prices).

In some cases, instead of being based directly upon existing individual values (whether elicited using such techniques or, where markets exist, based upon market values), other approaches to determining values to society may be considered more appropriate to take account of the interests of others (e.g. future generations). These may be based upon damage costs, for example, or the cost of meeting existing government targets consistent with environmental sustainability objectives (as is the case currently in the UK with social values of carbon applying to sectors not covered by the EU Emissions Trading System).

Before considering insights from behavioural economics (the application of psychological insights to economics), it is useful to briefly review the main behavioural assumptions underpinning mainstream economic theory, and

fundamental to associated exercises to value ecosystem services and ecosystem sustainability.

Economic theory has traditionally been based upon a simplistic view of human behaviour. This embodies the critical assumptions listed in Box 1 (after Langlois, 1998; O'Neill & Spash, 2000; Chee, 2004; Fanning, 2012):

Box 1 Critical assumptions applied as a traditional economics view of human behaviour.

1. The individual is self-interested and purposeful.
2. The individual's values are expressed by his/her preferences.
3. The individual has a single, stable, invariant set of preferences which are ordered, internally consistent and structured – transitive, reflexive, complete and continuous.
4. The strength of the individual's preferences is measurable by his/her willingness to pay (WTP) for satisfaction or willingness to accept compensation (WTA) for benefits forgone.
5. Individuals have preferences for outcomes, but not for how these are achieved (i.e. are instrumentalists).
6. Individual preferences are essentially fixed and lie outside the scope of economic analysis.
7. The individual is omniscient – has complete information and perfect structural knowledge about a choice/decision.
8. The individual has reliable subjective probabilities about the likelihood of different outcomes.
9. The individual has unbounded cognitive power and will power.
10. The individual acts to maximise his/her 'utility' (satisfaction of preferences), given budget constraints and the assignments of probabilities to different possible states of the world.

However, this characterisation of individual knowledge and decision making (the mainstream conception of economic 'rationality') has increasingly been shown to be inadequate. Behavioural economics is a growing field drawing upon insights from psychology and experimental research that aims to provide a more accurate and relevant account of economic behaviour by taking account of social, cognitive and ethical factors influencing decisions.*

Although previous reviews have explored existing evidence on the values of ecosystem services provided by woodlands

* For example, see: www.econlib.org/library/Enc/BehavioralEconomics.html, http://en.wikipedia.org/wiki/Behavioral_economics, www.neweconomics.org/publications/behavioural-economics.

(e.g. Saraev, 2012), there has been less exploration of how cognitive factors can influence preferences and values. A number of the papers examining how people value ecosystem services are discursive (e.g. Chee, 2004; Spash, 2008; Balmford *et al.*, 2011). Others provide specific evidence on elements affecting preferences (e.g. White, Bennett and Hayes, 2001; Christie *et al.*, 2006; Milon and Scrogin, 2006).

This review aims to pull together the findings from these and other studies and to consider how cognitive factors can affect preferences and values expressed. In particular it aims to review recent evidence from the literature on bounded rationality (e.g. cognitive biases), framing, context, familiarity and learning, loss aversion, mental accounting and other factors influencing people's choices and preferences, focusing upon how these influence values placed upon ecosystem services and ecosystem sustainability.

This initial review will be followed by a case study. This is expected to examine the relevance of insights from behavioural economics and 'nudge' type policies for meeting woodland creation objectives for climate change mitigation, also drawing upon recent research by Forest Research on landowners' motivations and behavioural change.

Methodology

A literature search was undertaken using two major online databases used for academic research: Web of Knowledge and Google Scholar (Box 2). The search focused on recent evidence, published from 2001 to 2012, with an emphasis on evidential studies over conceptual or discursive papers.

Box 2 Search terms included in the literature search

Ecosystem plus either Value OR Valuation

Plus separately one of the following:

Behavioural economics (alternative spelling behavioral economics)

Anchoring

Bounded rationality

Cognitive bias(es)

Context

Familiarity

Framing (effect)

Heuristic

Learning

Lexicographic preferences

Loss aversion

Mental accounting

Priming

Reference state

Saliency

Starting point bias

See Glossary for explanation of these and other terms used.

Each paper was entered into a table to identify relationships to the cognitive factor(s) and methods used (See Appendix). The papers were also entered into reference manager software (Mendeley) and 'tags' were added in relation to these factors and methods. Evidence was reported quantitatively where possible to show differences in preferences, for example comparing monetary values, magnitude of differences (2 x, etc). Some of the studies examining influences on preferences in behavioural economics cover a number of different search terms.

To help structure the evidence review, a typology of six main categories of impacts was developed. To minimise overlaps and repeat reporting the search terms were grouped and placed into the sub-headings in Box 3.

The literature search using the two online databases was then supplemented using a 'snowballing approach' by drawing upon references cited in the articles identified initially, and those on shared values cited in chapter 24 of the *UK National Ecosystem Assessment* (Fish *et al.*, 2011), as well as other relevant studies identified coincidentally.

A total of 134 studies were identified and from these 47 studies provided an indication of the magnitude of the impacts upon people's choices and the values placed upon ecosystem services and ecosystem sustainability.

Box 3 Search terms ordered into six main categories of impacts

1. Information processing

Bounded rationality [Complexity]

Heuristic [Complexity]

Mental accounting [Complexity; Familiarity]

Cognitive bias(es) [Saliency]

2. Information presentation

Heuristic [Format]

Mental accounting [Format]

Framing (effect) [Extent; Naming effects; Identity effects; Response options]

3. Context

Mental accounting [Hypothetical bias]

Cognitive bias(es) [Anchoring; Priming; Reference state;

Starting point bias]

Setting

4. Learning and preference formation

Learning

5. Avoiding losses

Loss aversion

6. Lexicographic preferences

Results

The following sections contain reviews of relevant literature on factors influencing people's choices and preferences and how these may influence the values placed upon ecosystem services and upon ecosystem sustainability. The studies are discussed under six categories covering different types of impacts: information processing, information presentation, context, learning and preference formation, loss aversion and lexicographic preferences (Box 3). The impacts are summarised in Tables 2 to 6.

Information processing

The ability of individuals to process information in an efficient and consistent manner is affected by a number of factors identified in behavioural psychology. These include cognitive limitations, heuristics, mental accounting, salience and a number of cognitive biases. For example, cognitive psychology has demonstrated that people struggle to fully consider the likelihood of different outcomes (Chee, 2004).

The ability of people to receive and process information is known to be subject to limits. When these limits are exceeded people tend to filter out and aggregate information (Hoehn, Lupi and Kaplowitz, 2010). In these situations people use information processing shortcuts (heuristics) to simplify decision making. These may result in a simplified rather than optimal solution (Kahneman, 2003).

Both cognitive limits and time availability may lead to people simplifying choices (through heuristics) to seek a satisfactory solution rather than an optimal one. This sort of behaviour has been termed 'satisficing' and is based upon a conception of 'bounded rationality'. The process may involve the active or passive elimination of data that the person views as less relevant, and a focus upon what is seen as the important factors. This process of simplification can be facilitated by approaches to evaluating choices that initially involve the person coding and categorising economic outcomes (mental accounting).

'Bounded rationality' is behaviour that cannot be wholly explained in terms of the satisfaction of complete and consistent preferences, and is considered by behavioural economists to be the form of rationality most characteristic of human decision making. By contrast, cognitive biases are specific patterns of deviation from optimal decision making that can result from perceptual distortions, inaccurate

judgement, or illogical interpretation (aspects often broadly considered forms of irrational behaviour).

This section considers three aspects relating to Information processing: complexity, familiarity and salience. Issues relating primarily to how information is presented, and context, are covered in the two following main sections. The section on Information presentation includes impacts related to format, while the section on Context includes impacts of cognitive biases related to contextual issues (anchoring, priming, reference state and starting point bias), as well as mental accounting issues related to hypothetical bias.

Complexity

Unfamiliarity with concepts such as ecosystem services and their complex interactions requires careful construction of questions and information provision to allow participants to make an informed decision. Breffle and Rowe (2002) and DeShazo and Fermo (2002) found that increases in the complexity of stated choice information result in larger choice equation error variances, reflecting difficulties people have in making choices that are consistent with their preferences. Exploring the restoration of a polluted wetland, Breffle and Rowe (2002) discovered referendum-style questions (where respondents choose between one of two scenario options) had greater variance (times 8) than resource to resource questions, suggesting that respondents could trade off different resource improvements more easily than they could trade off site characteristics for money. In addition to identifying more appropriate formats to address information complexity, DeShazo and Fermo (2002) suggested that model design (e.g. pre-testing and attempting to identify and control for complexity) could help reduce negative effects of complexity within stated choice experiments. The authors, examining respondent valuation of recreation in two national parks, one in Costa Rica and another in Guatemala, showed that, if sources of complexity can be identified, parameterised and properly controlled for, then their detrimental impacts may be minimised when modelling welfare changes.

However, there is evidence that people can cope with increasing amounts of information and that it is the relevance of the information that is important (Hensher, 2006). Rolfe and Bennett (2009) explored model complexity by comparing the impact of offering two versus three alternatives in choice modelling experiments, concluding

that the three-alternative split approaches could produce more robust models. They observed that respondents tended to display serial non-participation in the two-alternative format, that is they chose an alternative consistently without regard for changes in the attributes. To avoid this the authors advise offering more than two alternatives in a choice set that includes a status quo option.

Familiarity

People often use familiarity as a mental heuristic or shortcut to use past behaviour and decision making from a previous situation and apply it to the circumstances around a new situation. When respondents have a greater familiarity with terms or awareness of issues, such as the 'threatened' status of species, their willingness to pay (WTP) can be affected. For example, White, Bennett and Hayes (2001) found that a higher proportion of respondents who were aware of the general and specific threats to different species were willing to pay a specified amount towards the Action Plans (68%) than those who were not aware of the threats (40%).

Salience

There is some evidence that people place different values on more identifiable (salient) ecosystem services or parts of an ecosystem, compared to less distinguishable ones. White, Bennett and Hayes (2001), examining the influence of species characteristics on WTP for UK Biodiversity Action Plan implementation, concluded that charismatic and flagship species such as the otter attract significantly higher WTP values than less charismatic species such as the brown hare. Model calculations indicated a WTP of £11.91 for the otter when the value for the brown hare was truncated to zero (from a negative value). WTP was negatively related to the presence of the brown hare. Although the effect is not separated out, the authors hypothesise that the high value attached to the otter may partly reflect the level of publicity given to associated conservation programmes over the past 20 years.

Information presentation

Many studies have examined how the way information is presented to people influences their choices and have identified patterns of inconsistencies (e.g. Tversky and Kahneman, 1981; Milon and Scrogin, 2006; Groeneveld, 2010; Hoehn, Lupi and Kaplowitz, 2010). Information presentation covers a range of issues. These include the format used in presenting information (e.g. tabular or

textual), the categories and order of choices set out for respondents, the order of questions, the format of delivery (e.g. questionnaire, face-to-face, focus group), use of positive or negative questions (e.g. do you ..., do you not ...), time to respond and the background information supplied (framing).

Format

Hoehn, Lupi and Kaplowitz (2010) examined how information format (textual and tabular) affects stated choice outcomes using pairwise choices between a wetland scheduled to be drained and a restored wetland to be developed as compensation for the drained wetland. Respondents were asked whether or not the restored wetland was adequate compensation for the loss of the drained wetland through a series of five different wetland pairs. Nine attributes described the wetland pairs: wetland size, type, public access, presence of trails and signs, and five attributes relating to how good the habitat was for wildlife species groups (in terms of poor, good or excellent). Respondents were presented with the information in either textual or tabular format.

Significantly different responses were produced for the text data than the tabular data, providing strong evidence that respondents dealt with the text information format through greater use of heuristics (attribute elimination and attribute aggregation) than with the tabular format. This was particularly the case when respondents were asked about changes in habitat quality involving an excellent state than was the case for changes involving a poor state. This may indicate that the respondents with the textual data used less heuristics (and perhaps spent more time) considering the least desirable (poor) state. This focus may have resulted in the much higher requirements for compensatory habitat acreage for a change from a good to a poor state (2.5 to 4 times as much) in the textual format than in the tabular format.

Framing

Framing relates to how information presented to a respondent in different ways can result in different decisions. For example, Milon and Scrogin (2006) examined the individual's preferences and values for wetland restoration, describing restoration in terms of either functional (water levels) or structural (relating to three wildlife species group) attributes. The structural attribute description elicited a significantly larger share of respondents who favoured proposed restoration plans than the functional attribute description, resulting in a higher WTP (\$59.26 versus \$29.33).

How information is framed can be viewed as providing a heuristic, or mental shortcut (or 'rule of thumb') for people to quickly process information. This effect places a great responsibility on the information framer to present questions on valuation in a non-biased format and not unduly influence how the receivers will interpret the message.

Framing impacts people in part because individuals perceive losses and gains differently, with a tendency for people to be risk averse when a positive frame (a potential gain) is presented but risk taking with a negative frame (a potential loss) (e.g. Tversky and Kahneman, 1981). Related effects associated with context, setting, starting point and reference state, as well as loss aversion, are considered in subsequent sections.

Response options

The number and structure of response options can affect survey results. Examining respondents' WTP for wetland mitigation for example, Fenichel *et al.* (2009) explored 'no opinion' options in questionnaires through a binary stated choice survey using a web-based method with a split-sample design. The study examined two alternative answer formats 'too close to call' (TCC) and 'not sure' (NS) in an attribute-based choice experiment through the following combinations:

1. 'Yes' and 'no' [yes/no treatment]
2. 'Yes', 'no' and 'too close to call' (TCC) [TCC treatment]
3. 'Yes', 'no' and 'not sure' (NS) [NS treatment]
4. 'Yes', 'no', TCC and NS [all-options treatment]

Comparison of treatments 1, 2 and 3 indicates that, when provided with an alternative to yes/no, there is little effect on the proportion choosing yes; rather the respondents choosing a no opinion option seem to be from the group that would have otherwise chosen no (Table 1).

Respondents were more likely to choose a no opinion response when both the TCC and NS options are available

than if just one no opinion option is available. Use of multiple no opinion responses may enable differentiation between respondents who choose these due to satisficing and those expressing utility indifference. Comparison of the TCC and NS response options suggests that they are not viewed as equivalent options by respondents, indicating that the wording of no opinion options influences responses.

Implying that response options are also closely linked to information processing issues, Fenichel *et al.* (2009) note that cognitive challenges may occur in questionnaires offering a 'no opinion' option. Respondents may also choose this option for a range of reasons: rejecting the scenario, declining to answer, being unsure as they have not processed the information, or being truly unsure.

Extent

There is a need to consider if questions are related to a single ecosystem service, all those within a study area, or a combination of ecosystem services and how these combine. Ring *et al.* (2010), examining the challenges in framing the economics of ecosystems and biodiversity found that most studies to date have either focused on one service or compared one against another (e.g. food versus water quality and quantity). They found little quantitative evidence characterising multiple ecosystem services and biodiversity across the same region, and mixed conclusions from existing studies.

Naming effects

How an ecosystem service is presented may affect responses. Czajkowski and Hanley (2009) found that respondents' WTP for an environmental good may be explained not only by the physical characteristics but also partly as a function of a 'label' under which the environmental good is 'sold'. They suggest that such a label is dependent on the respondent's perception regarding the brand, rather than the physical (quantifiable) characteristics of the good and that this notion is in line with framing dependence. A scope test can examine whether the prediction that respondents would be willing to pay more as

Table 1 Wetland mitigation choice experiment survey responses.

Survey version	Responses	Proportion				
		Yes	No	TCC	NS	No opinion
Yes/no	1586	0.590	0.410			
TCC	1683	0.537	0.272	0.191		0.191
NS	1619	0.553	0.288		0.159	0.159
All options	3000	0.467	0.287	0.164	0.082	0.246

Source: Fenichel *et al.*, 2009.
TCC = too close to call; NS = not sure.

the amount or quality of environmental good to be provided increases holds true for a particular study. Failure to meet the scope test suggests the study lacks validity. The authors used the label 'National Park' in a labelled choice experiment exploring WTP for improvements in ecosystem components, rare species and natural ecological processes in Białowieża Forest in Poland. They found a statistically significant scope effect (although at a relatively weak 10% significance level) associated with using the label 'National Park'. The authors conclude that the label can constitute an important share of total value (judged to be around 30% in their study) and that acceptance of the value of labels as components of estimated value of a good can contribute to explaining the sources of potential problems with the scope test.

Another effect of using a 'label' was observed by Jacobsen *et al.* (2008), undertaking a choice experiment of biodiversity protection of Danish heathland using a split sample, one a quantitative listing of species and the other with a focus on two of the 25 endemic species. The species named (spring anemone: *Pulsatilla vernalis* (L.) Mill. and the moth : *Euxoa lidia* (Stoll.)) were considered by the authors to be almost unknown to the public and therefore have no inherent iconic status. Using the marginal rate of substitution (MRS) as the attribute 'extra income tax' to be paid for preserving species (i.e. the marginal WTP), the authors found that the option of preserving two named species produced much higher value estimates than the choice of preserving 5 or 12 species, being comparable to all 25 species. The MRS values were: spring anemone, 281; moth, 298; both species, 591; 5 species, 164; 12 species, 247; all 25 species, 300). The authors concluded that using 'iconised' species for valuing biodiversity at the habitat level may lead to overestimates. Czajkowski and Hanley (2009) state that, as this effect was independent of the respondents' familiarity with the names of the species to be protected, respondents appeared to process the information differently, and that it was the utilisation of the name (label) that influenced their choices.

Macmillan *et al.* (2002), investigating the non-market benefits of wild goose conservation, found that mean household WTP varied depending on whether the project was described as focused upon all wildlife species or endangered species only.

Re-labelling a valuation exercise with a name that suggests community cooperation has been shown to affect the generosity and fair-mindedness of participants, although the framing effect can sometimes alter subjects' beliefs about the actions of others rather than their own preferences (Bowles and Polania-Reyes, 2011).

Context

The values individuals place on ecosystem services and ecosystem sustainability can depend upon the context in which stated preference (valuation) studies are undertaken. This includes the perspective respondents are encouraged to take and the environment in which the exercise takes place.

Hypothetical bias

One criticism levelled at stated preference studies is that, unless respondents have to actually make a payment, their responses tend to overestimate what they would actually pay (see Murphy *et al.*, 2005a and references therein; Hein *et al.*, 2006). This is termed hypothetical bias and it has been suggested to lead to an increase in WTP values of a factor between 2 and 10 (Macmillan *et al.*, 2002 and references therein). This effect (and also instances of 'protest answers') may be lessened by the use of a full explanation of the hypothetical nature of the exercise, but also by asking the respondents to complete the valuation task as if it were real (a process termed 'cheap talk'). However, cheap talk has limitations and may only affect higher payment levels (Murphy, Stevens and Weatherhead, 2005b) and the mean value, rather than the range of values (Mahieu, Riera and Giergiczny, 2012).

Reference state, anchoring and starting point

The reference state refers to the condition or location against which a value is compared. This may be a current state or it can relate to a comparable place, for example a state park in relation to the larger Atlantic rainforest area in which it is situated (Adams *et al.*, 2008). When this comparison is relied upon too heavily, an anchoring effect is implicitly included. Priming can occur when a recently encountered item of information is subconsciously recalled when forming preferences and starting point biases can result from initial questions and responses.

Pouta (2004) discusses how some contingent valuation methods of asking respondents to provide values for environmental goods have context effects such that responses in the preceding questions may lead to respondents forming a perception of themselves (as environmentalists) and influence the responses to subsequent questions in line with these self perceptions. For example, Pouta (2004) reported that respondents who were questioned about their beliefs and values in relation to environmentally orientated tree-felling practices were willing to pay 1.8 times more than those who were not. This effect may be explored in terms of a starting point

bias, where the first question in a choice experiment or the first bid in a contingent valuation method question influences the respondent's eventual WTP (Groeneveld, 2010). The first bid may be interpreted as the anchor or reference point (see Flacheire and Hollard, 2006 and references therein), although DeShazo (2002) suggests this is the case only when answering 'yes' to an initial choice (and subsequent responses are then more likely to be negative). Groeneveld (2010) found that the use of an iterative process increased respondents' sensitivity to WTP for sustainable fishing methods by reducing their bids by a factor of 1.3 to 2.7, when compared with respondents who only completed one choice experiment. Flacheire and Hollard (2006) found a similar effect when asking respondents their WTP to preserve a nature reserve, with respondent bids being 1.3 times higher for single-bound (one question) than double-bound (initial question with a follow-up question) choice experiments.

Attempts to address the starting point bias have had mixed success. DeShazo (2002) recommend only including responses to questions from 'descending sequences' as the initial 'no' response is not interpreted as a reference (or starting) point. Flacheire and Hollard (2006), using data from a wetland conservation contingent valuation study, suggest a model that can incorporate starting point bias and allow the additional information for iterative questions to be included. Groeneveld (2010), in examining the sustainability of fishing stocks, introduced two methods to try to improve respondents' ability to reduce starting point bias in choice experiments, firstly using a payment ladder and secondly by framing in a more familiar context. However, he found neither method produced a significant effect and they may even enhance starting point bias. The explanation could be that the payment ladder made respondents more sensitive to costs and the framing (in relation to an election) complicated rather than simplified the task, making respondents more prone to starting point bias.

Respondent perspective

The formation of preferences can also be influenced by the perspective respondents are asked to consider. Ovaskainen and Kniivila (2005), comparing WTP for respondents encouraged to take a 'citizen role' (i.e. consider the wider community) against those respondents asked only to consider personal implications, found the former produced substantially higher (times 2.1 to 2.4) mean WTP for preservation. It is argued that this displays how respondents may display more altruistic behaviour in the context of considering community values.

Individuals may also make decisions as a confirmation of their own self-perceived beliefs, termed cultural polarisation (Kahan *et al.*, 2011), with the effect that already held beliefs are reinforced. When issues are discussed collectively, these beliefs can sometimes result in a barrier to converging on the best scientific evidence to achieve the greater common good (Kahan *et al.*, 2011).

Setting

Macmillan *et al.* (2002) found that mean household WTP depends on the method of survey implementation in their study of the non-market benefits of wild goose conservation, with group-based 'market stall' estimates around 3.5 times lower than individual estimates. The 'market stall' approach involved two meetings held a week apart, giving participants more time to consider and discuss their underlying preferences and WTP with other household members and friends (Macmillan *et al.*, 2002). This difference may be explained, in part, by the format in which questions regarding valuation of ecosystem services are set, as this can have a large influence on the values stated by individuals. Macmillan *et al.* (2002) criticise some contingent valuation surveys that may present a range of unfamiliar environmental goods to participants through face-to-face interviews in which the time to respond can limit the ability to consider the overall project, identify their preferences, and then form and state a WTP value. In their study, the interview respondents only had one brief opportunity to evaluate their WTP, whereas the market stall participants had up to 2 hours at each of two meetings and a week in between these meetings to consider their preferences, form a value and reconsider. They found that 37% of participants used the week-long interval between meetings to re-evaluate their WTP (20% upwards, 17% downwards), with some participants being influenced by current media and many by discussions with family and friends.

These results raise two issues. Firstly, they suggest that there is a trade-off between asking respondents for values within a controlled environment or allowing natural information-seeking behaviour to supplement existing knowledge. Secondly, they may reflect different starting assumptions: fixed preferences in the case of the individual interview respondents and preference formation by the market stall respondents.

Learning and preference formation

Contrary to standard assumptions in mainstream economics (Box 1), evidence suggests that people do not have all the knowledge required to make valuations and may be

uncertain or ignorant about specific pieces of information and about the nature of the decision situation they face (Langlois, 1998). Furthermore, applying values to benefits derived from ecosystems is likely to be unfamiliar for many people (Spash, 2008), particularly those who do not work within land-based organisations. Unfamiliarity may be an issue with the concept of ecosystem services itself, or with individual elements that respondents are asked to value.

Learning

A process of learning may be applied in processing information, shaping how preconceptions, prior knowledge and levels of understanding affect preferences. The process of learning can also help update preconceptions, prior knowledge and levels of understanding. Some studies have attempted to fill gaps in knowledge and resolve misunderstandings through group discussion. For example, Kenter *et al.* (2011), in examining values for ecosystem services in the Solomon Islands, found that after discussion participants solely based their decisions on the level of environmental improvements and began to ignore the monetary costs. Macmillan *et al.* (2002) asked individuals to state their individual WTP/A values for wild goose conservation in a group context, and suggest the process allowed respondents to learn about conservation issues in order to inform their valuations. The mean WTP for those respondents who stated they would 'definitely pay' increased from £3.67 to £4.49 (a factor of 1.2).

Christie *et al.* (2006) applied choice experiment and contingent valuation methods to value the diversity of biological diversity using focus groups. The choice experiment used a range of biological diversity attributes, including familiarity of species, their rarity, habitat and ecosystem processes, while the contingent valuation examined WTP for biodiversity enhancements. They noted that valuations seemed to become less variable once group deliberations had taken place, concluding that 'a learning effect seems to be present' from before (with existing knowledge) and after (with additional knowledge). Christie *et al.* (2006) found that the focus group's existing familiarity with precise terms (biodiversity) was low, but the concepts were readily understood when explained. They suggest that the extra discussions in workshops, while not significantly influencing WTP, improved respondents' understanding of biodiversity thereby allowing them to state the WTP more precisely (suggesting a reduction in the variance in individual response). Although focus groups allow individuals to learn and subsequently further engage in discussions, Kaplowitz and Hoehn (2001), undertaking a comparison of individual and focus group responses, found

that individuals may contribute additional knowledge that they may feel uncomfortable about contributing in a group situation. They concluded that both methods should be employed to gather the full range of information.

Preference formation

Tastes and preferences are not fixed. Costanza (2004) notes that preferences are being manipulated every day under influences such as education, advertising, changing cultural assumptions, and variations in abundance and scarcity. There is some evidence that WTP preferences may remain consistent over short time periods – up to 5 years (e.g. Brouwer, 2006; Bliem and Getzner, 2012), and are subject to greater variation (both low and high) over longer time periods (Skourtos, Kontogianni and Harrison, 2009).

Over longer time-frames relevant to ecosystem services and sustainability, lack of stable preferences implies that what is 'optimal' is difficult to define, with Costanza (2004) proposing a change from the conventional approach based upon consumer sovereignty to a 'community sovereignty' approach that mixes efficiency, equity and sustainability criteria.

Impacts of regulation on preference formation

In response to theories explaining the overexploitation of natural resources as the competitive outcome of self-interested individuals each depleting a common property (e.g. Hardin, 1968) or open access resource despite this outcome not being in their long-term interests, governments have often introduced incentives and disincentives aimed at influencing such behaviour for the collective good. Evidence of the impacts of incentives on preference formation is mixed. There is some evidence that incentives can 'crowd out' intrinsic motivations (e.g. to 'do the right thing') and thus be counterproductive, while other studies have found that incentives may result in altruistic behaviour while disincentives may result in people actively changing their preferences to oppose the disincentive. Reviewing this literature, Bowles and Polania-Reyes (2011) suggest that it is how the fines or subsidies are interpreted that result in 'crowding out' non-economic motivations, with incentives targeted to foster pro-social behaviour more likely to be complements rather than substitutes for individual social preferences, crowding them in rather than out.

An example where incentives and disincentives were found to 'crowd in' intrinsic motivations is given in Cardenas (2004), who used an experimental setting to examine how different governance and incentive mechanisms influence

individuals and group choices. The study found that Colombian ecosystem users, without explicit incentives, would on average extract 44% less of the experimental 'resource' than would have maximised their individual payoffs, providing evidence of a significant willingness to sacrifice individual gain so as to protect the resource and raise group-average payoffs. While introduction of a fine reduced the amount extracted (by 25%), changing the magnitude of the fine had little effect. Reviewing this study, Bowles and Polania-Reyes (2011) argue that the presence of the fine provided a signal that alerted subjects to the public good nature of the interaction (which could be viewed as a salience effect).

Time inconsistency issues

Individuals may apply hyperbolic discounting (a requirement for more compensation for waiting one time period in the near future than is required for waiting one time period subsequently) and also discount the value of future losses at a lower rate than they use to discount the value of future gains. However, such choices are not always consistent over time, as in the future individuals may no longer be as willing to wait as their current preferences imply, but display a similar preference for immediate utility over delayed utility. Preference reversals can occur when respondents are given similar offers over different time periods; for example, someone may prefer \$110 in 31 days over \$100 in 30 days, but also prefer \$100 now over \$110 tomorrow (Frederick, Loewenstein and O'Donoghue, 2002).

Loss aversion

Loss aversion theory suggests people strongly prefer avoiding losses to acquiring gains, with some studies suggesting that losses are weighted by respondents twice as strongly as gains (Kahneman, Knetsch and Thaler, 1990; Tversky and Kahneman, 1992). Bergseng and Vatn (2009) examined compensation and loss aversion in relation to voluntarily setting aside forest land for conservation in Norway. Owners usually only receive compensation for economic losses if conservation measures are imposed and compensation payments are made as lump sums, in contrast to the typical income stream of a forest owner, with smaller and more frequent payments. One group was asked at what compensation level they would be willing to set aside land; 83% of the respondents demanded higher compensation than the present level available. A different group were asked how much less compensation than the present level they would demand in the case of voluntary protection. In this group, 68% were not willing to lower

their demand for compensation. Bergseng and Vatn (2009) suggest that 'loss aversion' may lead to higher compensation claims for conservation purposes than income forgone, especially when protection is imposed by the authorities. However, a main inference is that the current level of compensation is viewed as being low by forest owners and it is difficult to separate this and other issues from whether loss aversion is being displayed (in relation to the loss of the regular income payments).

Loss aversion can be observed in relation to status quo bias, the effect where attachment to the present situation and aversion to loss limits a person's enthusiasm for change. For example, a study in the Solomon Islands found that the preference for the traditional practice of subsistence (which results in higher environmental sustainability than managing land for cash crops) over cocoa gardens as a land use was supported by a WTP of approximately 30% of mean annual monetary income per household (Kenter *et al.*, 2011). Again, it is difficult to determine whether respondents are displaying loss aversion when presented with substituting the regular supply of goods and services provided through subsistence for a cash payment for cocoa. For example, Kenter *et al.* (2011) reported that choices were influenced by people's preference for home-grown food and its traditional cultural significance (including its use in feasting) and greater nutrition than substitute imported food. Respondents are likely to display loss aversion when presented with scenarios that indicate a change to a poorer state even when the information is presented in a different format. Hoehn, Lupi and Kaplowitz (2010) found more instances of statistically significant differences across both textual and tabular formats associated with habitat change from a higher level to a poorer level (e.g. good to poor and excellent to good).

However, loss aversion does not always appear to apply. Christie *et al.* (2006), studying ecological concepts of biodiversity in Cambridgeshire, England, found that WTP was highest for agri-environmental schemes (£74.27), and lowest for preventing development loss (£45.30), while habitat re-creation was valued at £54.97. However, potential reasons for loss of habitat being valued less than habitat re-creation in such cases may be associated with extraneous factors, such as potential benefits of land development for housing creation, and with associated employment generation.

Knetsch (2005) asserts that the process where people discount the value of future losses at a lower rate than they use to discount the value of future gains is influenced by the compensating variation WTA and WTP measures (i.e.

the amount required to make the individual indifferent to the change in value). The likelihood of a future loss occurring does not necessarily change the reference state; it is likely to be viewed as a loss from the current state regardless of any forewarning.

Lexicographic preferences

Studies considering a range of environmental goods or ecosystem services often approach valuation as an exercise involving choice between different levels of provision, where losses of one good can be compensated by an increase in others (e.g. Farber *et al.*, 2006; Raudsepp-Hearne, Peterson and Bennett, 2010). Contingent valuation methods for example, generally make an assumption that individuals are able and willing to consider trade-offs in relation to the quantity and/or quality of public goods. However some individuals refuse to make these trade-offs. In some cases individuals may consistently express a preference for one particular good over another, regardless of the quantity of another good or when considering a trade-off against a range of goods. This is the case with 'lexicographic' preferences, where goods are ranked in a manner akin to an ordering of words in a dictionary and the requirements for higher ranked goods must be met before other goods are considered. Some goods may be considered 'protected' due to their cultural, or moral or ethical value (Pearson, Kashima and Pearson, 2012). Reasons include beliefs based upon inviolable rights and often a significant proportion of survey respondents treat the environment in a manner which is inconsistent with conventional economic theory (Spash, 2006). Key ecosystem services effectively become priceless where participants are unwilling to trade them off in the choice experiment scenarios, regardless of financial cost.

Knetsch (2005) classifies substitutability of resources into hard and soft categories, with the former having low substitutability among resource outputs and the latter allowing for a greater accommodation of substituting gains in the productivity of one resource for losses in the productivity of another. However, lexicographic preferences may instead give rise to hard sustainability, where people seem adverse to losses either per se or for a particular ecosystem service, rather than accepting that losses in one resource may be balanced by a gain in another resource.

Pearson, Kashima and Pearson (2012) suggest that the concept of trade-offs can be particularly controversial for those resources that are culturally or psychologically 'protected'. These views are often associated with communities and may require more effort to reach a

consensus on which resources are considered to be the most critical, a process which may be facilitated by ranking the different elements based upon their protected or utilitarian values (Pearson, Kashima and Pearson, 2012).

If an individual does not think the good should be valued or substituted at all, they may respond with a 'protest answer', where a zero or no vote is given. Inclusion of these responses can bias average WTP estimates downwards. Dziegielewska and Mendelsohn (2007), examining WTP for measures to reduce air pollution, found protest answers decreased the median WTP by a factor of 3.

Identity effects

Pouta (2004) found that the inclusion of attitude and belief items increased the probability of choosing the environmentally orientated alternative. For example, respondents with strong support for the conservation of species may express a WTP far above (2.4 times more) those who do not (Spash *et al.*, 2006). Other respondents may have a homo-centric approach to altruism; Christie *et al.* (2006) stated that in their survey of biodiversity and ecosystem services, respondents expressed a preference for (or 'cared' about) ecosystem functions that directly affect humans, such as flood defence, rather than the other ecosystem services.

Discussion

The literature review identified several strands of cognitive influences affecting people's valuations of ecosystem services. These were categorised into six broad types. In each case the studies relate primarily to the use of stated preference methods to elicit non-market values. Evidence on cognitive factors influencing ecosystem services valuation is relatively thin, with only a few studies investigating each type of impact. The 47 most relevant studies identified (out of a total of 134 included in a Mendeley database) from the initial search are included in the references.

Accumulating evidence shows that the values placed on particular ecosystem services vary depending upon how survey questions are framed (e.g. due to framing effects), the setting in which questions are posed (e.g. individual or group), and a range of other factors.

The review found evidence that impacts could be relatively large; some of the largest associated with the different strands are summarised below. While the range of estimates non-market valuation surveys produce raises questions as to the validity of these approaches and whether they are sufficiently robust for policy purposes (see also discussion in White, Bennett and Hayes, 2001), answers will depend partly on the relative merits of alternative approaches, a wider discussion that lies outside the scope of the current report.

Recommendations for using surveys in future valuation studies, based upon approaches in the literature, are summarised below.

Information processing

Contrary to the traditional approach, the review has highlighted evidence indicating how, due to cognitive limits, individuals do not always behave according to the conventional model of economic rationality. The values they place upon ecosystem services can be strongly influenced by cognitive limits. This may manifest itself in the use of heuristics to filter out and aggregate information (Hoehn, Lupi and Kaplowitz, 2010), resulting in simplified, rather than optimal, solutions (Kahneman, 2003), particularly when large amounts of data are presented, or if the data are complex (Brefle and Rowe, 2002; DeShazo and Fermo, 2002). Although in some cases the use of heuristics may appear to provide a more efficient approach, reducing the need for complex and therefore costly computation, information processing is also subject to

some systematic biases. For example, there is evidence that in filtering information individuals may give a higher value for one element or option because it is more salient than the others, an effect White, Bennett and Hayes (2001) suggest can increase willingness to pay (WTP) for charismatic species. Similarly, use of overarching scenarios has been found to increase the variance of WTP estimates by up to 8 times compared to simpler resource-specific trade-offs (Brefle and Rowe, 2002). Table 2 summarises information processing impacts on values expressed and mitigation measures proposed.

Information presentation

How information is presented can have a major influence on values expressed. For example, textual information was found by Hoehn, Lupi and Kaplowitz (2010) to result in WTP estimates 2.5 to 4 times higher than presenting the same information in a tabular format. Similarly, Milon and Scrogin (2006) find that using structural descriptions (species groups) doubles WTP values compared with using functional descriptions (water levels). Table 3 summarises information presentation impacts on values expressed and mitigation measures proposed.

Context

The context in which values are elicited can have a marked impact, with Macmillan *et al.* (2002) finding that lack of a payment mechanism by which respondents' values are expected to be reflected in practice, increases the values expressed by a factor of between 2 and 10. Surveys of groups have also been found to increase WTP values elicited by a factor of 3.5 compared to values elicited in surveys of individuals (Macmillan *et al.*, 2002). Table 4 summarises the impact of context on values expressed and mitigation measures proposed.

Learning and loss aversion

Although ecosystem service and sustainability terms and concepts may be unfamiliar to many respondents, there is evidence that discussion through workshops (Christie *et al.*, 2006) or with friends and family in between workshop sessions (Macmillan *et al.*, 2002) can increase knowledge and allow more precise WTP to be stated (Table 5). Loss aversion suggests people require higher payments for compensation to give something up (WTA), such as a wetland, than they would be willing to pay to protect the same thing (WTP) (Bergseng and Vatn, 2009). Therefore, asking for WTP may

result in underestimates and WTA, although potentially inflated by an endowment effect, may provide a better approach for valuing ecosystems (Knetsch, 2005). Table 5 summarises learning and loss aversion impacts on values expressed and mitigation measures proposed.

Lexicographic preferences

Valuation exercises can be complicated by 'protest' answers, where a zero or no vote is given because the respondent does not think the good should be valued or substituted. This, as well as other unrelated reasons for zero or no value being given (e.g. due to free-riding if the respondent

expects to get the good anyway if others pay), can be mitigated by follow-up questions asking why respondents made particular choices and by providing a range of responses. The concept of trade-offs can be particularly controversial for those resources that are culturally or psychologically 'protected'. These views are often associated with communities and may require more effort to reach a consensus on which resources are considered to be the most critical. This process may be facilitated by ranking the different elements based upon their protected or utilitarian values (Pearson, Kashima and Pearson, 2012). Table 6 summarises lexicographic preferences impacts on values expressed and mitigation measures proposed.

Table 2 Summary of information processing impacts on values expressed and of mitigation measures proposed.

Aspect	Focus	Impact on stated values		Mitigation	Key references
		Level	Variance		
Complexity	Use of overarching scenarios or simpler resource-specific trade-offs		8 times higher variance for more complex formats	Pre-testing and attempt to identify and control for complexity, including by restricting options to different levels of resources	Breffle and Rowe, (2002); DeShazo and Fermo (2002)
Familiarity	Awareness of threatened status of species	68% if aware versus 40% if unaware*		Need for initial assessment of awareness of what is being valued, but cautiously (see perception of own identity impacts (Pouta, 2004))	White, Bennett and Hayes (2001)
Salience	Focus upon charismatic species as a proxy for biodiversity value	6 times higher		Use less iconic species or less familiar terms (e.g. scientific name for species)	White, Bennett and Hayes (2001)

* Proportion of respondents willing to pay a stated amount.

Table 3 Summary of information presentation impacts on values expressed and of mitigation measures proposed.

Aspect	Focus	Impact on stated values		Mitigation	Key references
		Level	Variance		
Format	Textual compared to tabular information	2.5 to 4 times higher*	2 times higher	Present information in a tabular rather than textual format	Hoehn, Lupi and Kaplowitz (2010)
Framing	Structural (species groups) compared to functional (water levels) description	2 times higher		Ensure questionnaires are framed in relation to attributes respondents can relate to/care about	Milon and Scrogin (2006)
	Named species compared to a group of five unnamed species	1.7 to 1.8 times higher marginal rate of substitution		Care needs to be taken to treat all attributes to be valued in a similar way (as naming a species can alter stated value relative to unnamed species)	Jacobsen et al. (2008)
	Label effect	1.3 times higher when 'National Park' label used		Ensure the attribute is not being valued on its association with another factor or identify by the use of follow-up questions	Czajkowski and Hanley (2009)

* Acreage of new habitat considered sufficient to compensate for lost habitat.

Table 4 Summary of impacts of context on values expressed and of mitigation measures proposed.

Aspect	Focus	Impact on stated values	Mitigation	Key references
		Level		
Anchoring (starting point bias)	One question ('single-bound') compared to initial question with follow-up ('double-bound') choice experiment	1.3 times higher	Use a model to account for anchoring effects. For example, DeShazo (2002) suggests removing all answers which could be influenced by framing effects	Flachaire and Hollard (2006)
	Participation in single-choice experiment compared to a series of choice experiments	1.3 to 2.7 times higher	Use of a payment ladder	Groeneveld (2010)
Hypothetical bias	Lack of payment mechanism compared to expectation of payment based upon response	2 to 10 times higher	Using 'cheap talk' to make respondents aware of hypothetical bias and thus take this into account in their bids	Macmillan <i>et al.</i> (2002)
Setting	Individual compared to group values	3.5 times higher	Both approaches are useful. The group setting provides good context and refinement of WTP as it enables a wider range of information to be considered. However, the individual setting allows private information to be disclosed and therefore both approaches should be used	Macmillan <i>et al.</i> (2002); Kaplowitz and Hoehn (2001)
	Citizen compared to individual values	2.1 to 2.4 times higher	Ensure respondents answer consistently with either community or individual views	Ovaskainen and Kniivila (2005)
Reference state	Initial question on environmental beliefs and values	1.8 times higher	Attitude and belief items should not be used as warm-up questions in contingent valuation questionnaires	Pouta (2004)

Table 5 Summary of learning and loss aversion impacts on values expressed and of mitigation measures proposed.

Aspect	Focus	Impact on stated values		Mitigation	Key references
		Level	Variance		
Learning	Workshop discussion compared to no discussion		Reduce	Discussion preferable because it can improve understanding of concepts, allowing WTP to be stated more precisely	Christie <i>et al.</i> (2006)
	Discussion with friends and family compared to no discussion	1.2 times higher		Need to consider where respondents already have sufficient knowledge and consider time required to make choices	Macmillan <i>et al.</i> (2002)
Loss aversion	WTP may provide underestimates			Use WTA for ecosystem services and ecosystem sustainability valuations	Knetsch (2005)
	Losses in the future are often undervalued			Application of different discount rates to values provided by respondents	Knetsch (2005)

Table 6 Summary of lexicographic preferences impacts on values expressed and of mitigation measures proposed.

Aspect	Focus	Impact on stated values		Mitigation	Key references
		Level	Variance		
Lexicographic preferences	Trade-offs for culturally or psychologically 'protected' resources			Ranking the different elements based upon their protected or utilitarian values	Pearson, Kashima and Pearson (2012)
	Protest votes	Median 3 times lower		Asking respondents to rank choices and use follow-up questions	Pearson, Kashima and Pearson (2012) Dziegielewska and Mendelsohn (2007)

Conclusions

This review has highlighted ways in which cognitive factors influence the values people place upon ecosystem services. These have implications for gauging the robustness of existing estimates and for the design of future research to elicit values for the wide range of ecosystem services woodland and other habitats provide, especially those for which markets do not currently exist and surveys are used.

A number of research gaps were identified in relation to: the breadth of ecosystem services considered by previous studies; how values are elicited and applied across different spatial and temporal scales; preference formation; societal values; framing of sustainability; and the role of regulation and incentives in encouraging the sustainable use of ecosystem services.

Recommendations for future research

Ecosystem service trade-offs

Most of the studies reviewed focus upon either one or a small number of ecosystem services, yet sustainable management of (often complex) ecosystems requires consideration of a wide range of ecosystem service trade-offs. Further research is needed to address the issue of how best to elicit values for multiple ecosystem services from respondents while minimising imprecision in values due to the added complexity.

Application of values across spatial scales

Although this review has highlighted evidence that respondents' answers may be affected by anchoring, there has been little research into how the values provided by respondents vary depending upon the spatial lens they use to generate these values and how different spatial scales are viewed to relate to each other. For example, aspects relating to biodiversity may be important at a national or regional scale, but other resources may be regarded as key components by local communities and thus valued much higher. This then has implications for how values gathered for ecosystem services at one scale are applied to another scale and consequently reported. Research should assess how values for different ecosystem services can be captured and integrated across spatial scales (national, regional, local) for a range of respondents.

Time inconsistency issues

Further research is required to investigate how preferences for ecosystem services and ecosystem sustainability change over time. This has implications for policy appraisals, including estimating the climate change impacts such as flood risk, pollution and heat islands associated with different options.

Preference formation and values

Traditionally in economics preferences are characterised as being essentially fixed, but a substantial body of evidence shows them to be subject to learning and a range of other cognitive influences. While lack of stable preferences makes optimality difficult to define (Costanza, 2004), more fundamentally, individual preferences are likely to be partly social constructs as a consequence of social context moulding individual values (Atkinson, Bateman and Mourato, 2012). The biggest research challenge for economic theorists may be to develop more consistent frameworks that adequately account for this social endogeneity of preferences and values. However, the practical significance for policy of such endogeneity will also be important to consider. This could support the view that, akin to public health strategies to reduce smoking and lung cancer, tackling problems such as global climate change and biodiversity loss to ensure ecosystem sustainability may require directly influencing values and behaviour, rather than simply relying upon more traditional regulatory approaches and institution building. Initiatives to address public behaviour change are a focus of the Behavioural Insights Team (also known as the 'nudge' unit) set up with a remit to 'find innovative ways of encouraging, enabling and supporting people to make better choices for themselves' (Cabinet Office, 2012). In tailoring incentive policies to encourage environmental sustainability, there is scope to incorporate some of the wider findings from research on behavioural economics – including work suggesting that citizens can be 'nudged' into changing their behaviour (Thaler and Sunstein, 2008).

Regulation and incentives

Policy approaches to encourage the sustainable use of ecosystem services often take the form of incentives to encourage practices that enhance their provision. There is a suggestion that small incentives work most

effectively, while large incentives may be counterproductive as individuals can react against these tools if they are interpreted as compromising their autonomy (Bowles and Polania-Reyes, 2011). However, evidence on the impact of these reactions is sparse. Further research is needed to draw out evidence of these impacts and of levels of incentives and types of regulation that are most effective in promoting ecosystem sustainability.

risks and problems (Hopkins, 2012). However, systematic evidence of the importance of framing in tackling ecosystem sustainability issues currently appears to be lacking.

Societal values

The UK National Ecosystem Assessment includes a recognition that the contribution of ecosystem services to human well-being cannot be reduced simply to individual preferences and motivations, noting limitations in capturing shared social values for ecosystem services using conventional approaches (Fish *et al.*, 2011). Further research is needed to explore how such shared social values could best be captured, including the influence of associated cognitive factors relating to the framing of survey questions and context effects (e.g. use of individual or group settings). Similarly, White, Bennett and Hayes (2001) note that species with a high charisma status are likely to command higher willingness to pay (WTP) values than less charismatic species that may be under a relatively greater threat or be of more biological significance in the ecosystem. This suggests that the use of charismatic species as a proxy for ecosystem sustainability may be somewhat limited as an area of poor biodiversity with an iconic species present would be valued higher than another area that has a richer and more sustainable ecosystem but lacks an iconic species. Further research is needed to explore how shared social values for ecosystem sustainability can best be captured, especially where iconic species are not present.

Framing sustainability

Accumulating evidence demonstrates the importance of framing in eliciting values for ecosystem services. However, there appears relatively little evidence on the impact of framing on the effectiveness of policies aiming to incorporate ecosystem services values and sustainability issues in decision making. A topical example is the impact of the way in which climate change mitigation policies are framed in relation to their potential to help meet existing targets, including whether reaching the internationally agreed target of limiting the average global temperature rise to no more than 2°C above pre-industrial levels is still feasible. Evidence such as the rapid expansion of the 'transition towns' movement and associated climate change mitigation and adaptation activities testifies to the importance of framing issues and focusing upon possibilities and opportunities rather than

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Appendix: Cognitive variables within references

Reference	Bounded rationality	Cognitive biases	Context	Framing	Familiarity	Heuristic	Learning	Loss aversion
Adams <i>et al.</i> (2008)			X					
Bliem and Getzner (2012)							X	
Bowles and Polania-Reyes (2011)				X				
Breffe and Rowe (2002)	X	X					X	
Brouwer (2006)							X	
Cardenas (2004) *								
Chee (2004)				X			X	
Christie <i>et al.</i> (2006)				X			X	X
Costanza (2004)							X	
Czajkowski and Hanley (2009)				X				
DeShazo (2002)				X				X
DeShazo and Fermo (2002)	X	X					X	
Farber <i>et al.</i> (2006)								
Fenichel <i>et al.</i> (2009)							X	
Flachaire and Hollard (2006)			X					
Frederick <i>et al.</i> (2002) *								
Groeneveld (2010)			X	X	X		X	
Hardin (1968) *								
Heberlein <i>et al.</i> (2005)				X				
Hein <i>et al.</i> (2006)	X		X					
Hensher (2006)	X	X					X	
Hoehn <i>et al.</i> (2010)	X	X	X	X		X	X	X
Jacobson <i>et al.</i> (2008)			X	X				
Kahan <i>et al.</i> (2011) *								
Kahneman (2003)	X							
Kaplowitz and Hoehn (2001)			X				X	
Kenter <i>et al.</i> (2011)							X	X
Knetsch (2005)								X
Langlois (1998) *					X		X	
Macmillan <i>et al.</i> (2002)			X				X	
Mahieu <i>et al.</i> (2012)			X					
Milon and Scrogin (2006)			X	X				
Murphy <i>et al.</i> (2005a)			X					
Murphy <i>et al.</i> (2005b)			X					
Ovaskainen and Kniivila (2005)			X	X				
Pearson <i>et al.</i> (2012)								
Pouta (2004)			X				X	
Raudsepp-Hearne <i>et al.</i> (2010)								
Ring <i>et al.</i> (2010)				X				
Rolfe and Bennett (2009)	X	X					X	
Skourtos <i>et al.</i> (2009)							X	X
Spash (2006)			X					
Spash (2008)					X			
Spash <i>et al.</i> (2006)							X	
Tversky and Kahneman (1981) *				X				
Tversky and Kahneman (1992) *								X
White <i>et al.</i> (2001)	X				X		X	

'X' means the reference relates to the cognitive variables in the column headings. '*' means not identified by online database search

Mental accounting	Other factors	Methods used
	Reference state	Contingent valuation, WTP
	Temporal changes, Preference formation	WTP
	Labelling and incentives	
	Complexity	Stated choice experiments
	Temporal preferences, Preference formation	Contingent valuation, WTP
	Incentives	
		Contingent valuation
		Choice experiments, Focus groups, WTP, Contingent valuation
	Temporal effects, Preference formation	
	Scope effect, Labels	Choice experiment
	Reference point	
	Complexity	Stated choice experiments
	Resource substitution, Lexicographic preferences	
		Choice experiment, Response options
	Anchoring, starting point bias	Contingent valuation
	Temporal issues, Time inconsistency	
	Starting point bias, Information presentation	Choice experiment
	Resource exploitation, Self-interest	
	Scope, Naming effects	Contingent valuation
X	Spatial and temporal issues, Hypothetical bias	Contingent valuation method
X	Format, Information presentation	Stated choice experiment
	Naming effects	Choice experiment, Split sample
	Cultural polarisation, Lexicographic preferences	
	Setting	Focus groups and individual comparison
	Preference formation	
	Temporal preferences, Discounting, Lexicographic preferences	
	Group and individual discussions, Hypothetical bias, Naming effects	Market stall group interviews
	Hypothetical bias	Contingent valuation, WTP
	Information presentation	
	Hypothetical bias	Contingent valuation
	Hypothetical bias	Contingent valuation
	Citizen versus individual values	WTP
	Ethics, Lexicographic preferences	
	Reference state, Identify effects	Contingent valuation
	Ecosystem services bundles and trade-offs, Lexicographic preferences	
	Extent	
	Complexity	Choice modelling experiments – two and three-way splits
	Temporal preferences, Preference formation	WTP
X	Rights and beliefs, Identity effects, Lexicographic preferences	
	Ethics, Lexicographic preferences, Identity effects	WTP
	Information presentation	
	Salience	WTP

Glossary

Anchoring the tendency to rely too heavily, or 'anchor', on a past reference or on one trait or piece of information when making decisions (also called 'insufficient adjustment', see Kahneman (1992).

Behavioural economics the application of psychological insights to economics (Camerer and Loewenstein, 2002).

Bounded rationality a conception of decision making as limited by the cognitive power and capacity of the mind, available information and time constraints. Individuals are viewed as lacking the ability and resources to arrive at an optimal solution and/or as acting to limit the costly and time-consuming deliberation that would be required in seeking to identify optimum behaviour. Instead they make decisions by simplifying the choices available, accounting for relatively few alternatives. They may be characterised as 'satisficers', seeking a satisfactory solution rather than an optimal one (Bannock, Baxter and Davis, 2003; Black, Hashmzade and Myles, 2012), with decision making characterised as a search process guided by aspiration levels (Simon, 1957; Selten, 1999), or as using 'fast and frugal' heuristics that require relatively little information or computation (Gigerenzer and Todd, 1999).

Choice modelling a stated preference method that attempts to model the decision process of an individual or population segment in a particular context, and is often used to estimate non-market environmental benefits and costs (Wikipedia, 2012a). Also referred to as **conjoint analysis or choice experiment**, the method asks respondents to score, rank, rate or select the most preferred set of alternatives which are described by several attributes, usually including price.

Cognitive bias a systematic pattern of deviation in judgement that occurs in particular situations, leading to perceptual distortion, inaccurate judgement, illogical interpretation, or what is broadly called irrationality (Wikipedia, 2012b). Cognitive bias is a general term used to describe a range of effects and phenomena that are studied in cognitive science and social psychology.

Context the surroundings, circumstances, environment, background or settings which determine, specify, or clarify the meaning of an event (Wiktionary, 2012). It can further be defined as:

1. The part of a text or statement that surrounds a particular word or passage and determines its meaning.
2. The circumstances in which an event occurs; a setting (Free Dictionary, 2012).

Contingent valuation a stated preference method used to obtain an economic valuation of a non-market good or service based upon the use of a consumer survey where respondents are asked their willingness to pay or accept compensation for a specific change (e.g. in an ecological service) such as, for example, 'How much would you be willing to pay for reduced flooding?' or 'Would you be willing to pay £XX for cleaner air?', with answers contingent on the scenario presented (Black *et al.*, 2012).

Familiarity a mental heuristic where individuals assume the circumstances around a new situation are the same as for a previous situation and thus retain past behaviour and decision making.

Framing (effect) the influence of how an option is presented on people's choices. For example, individuals have a tendency to make inconsistent choices, depending on whether a question is framed to concentrate on losses or gains (Plous, 1993). In this case framing affects people because individuals perceive losses and gains differently, as illustrated in prospect theory (Tversky and Kahneman, 1981). The value function, founded in prospect theory, illustrates an important underlying factor to the framing effect: a loss is more devastating than an equivalent gain is gratifying (Tversky and Kahneman, 1981). Thus, people tend to be more risk averse when presented with a potential loss than when questioned about a potential gain.

Heuristic a decision-making rule based upon an information processing shortcut, an intuitive approach drawing upon similarities to other situations (Selten, 1999), or an experience-based approach to problem solving. It has the characteristics that it is simple relative to an individual's evolved or learned capacities, and it is designed to solve a particular class of problem in a specific environment. It may also lead to behaviour that differs systematically from that expected were optimisation applied (Gigerenzer, 2004).

Learning the processing of information and experience to shape preconceptions, prior knowledge and levels of understanding.

Lexicographic preferences where there is always a preference for one good over another, regardless of the quantity of another good. Categories may be lexicographically ordered, in a similar way to words in a dictionary, and higher levels must be satisfied before lower levels are considered (Farber, Costanza and Wilson, 2002).

Loss aversion people's tendency to strongly prefer avoiding losses to acquiring gains. Some studies suggest that losses are weighted by respondents twice as strongly as gains (Tversky and Kahneman, 1992). Note that whether a transaction is framed as a loss or as a gain is very important to this calculation: would you rather get a \$5 discount, or avoid a \$5 surcharge? The same change in price framed differently has a significant effect on consumer behaviour.

Marginal rate of substitution the rate at which a consumer is ready to give up one good in exchange for another good while maintaining the same level of utility (Wikipedia, 2012c).

Mental accounting a concept first developed by Richard Thaler (Thaler, 1980) to describe the process whereby people code, categorise and evaluate economic outcomes (Wikipedia, 2012d). In mental accounting theory, the way a person subjectively frames a transaction in their mind determines the utility they receive or expect.

Payment ladder a method of determining the amount a respondent would be willing to pay using a series of monetary values, starting at low numbers and ending in reasonably high numbers (Hanley and Kristrom, n.d.). The respondent is asked if they would pay the first specified amount, and if they would whether they would pay the next amount, until they reach an amount they would not pay.

Priming the influence of a recently encountered word or item of information that is subconsciously recalled when forming preferences.

Reference state the benchmark, condition or location against which a value, or gains and losses, are compared (Knetsch and Wong, 2009).

Salience the state or quality by which something stands out relative to its neighbours (Wikipedia, 2012e).

Scope test a test that examines whether the prediction that respondents would be willing to pay more as the amount or quality of environmental good to be provided increases holds true for a particular study. Potential problems with

the scope test include a failure to consider that respondents may prefer a part to the whole (e.g. a small area rather than a larger region); individuals are better placed to put a value on familiar concepts (e.g. on water quality than biodiversity); and, more widely, values are strongly affected by emotive issues, such as who receives payments (Heberlein *et al.*, 2005).

Starting point bias a phenomenon where the initial question or response/valuation affects the respondent's eventual choice or valuation (Flachaire and Hollard, 2006).

Stated preference methods/models survey-based techniques for estimating the economic value of non-market resource through responses to hypothetical questions, such as environmental preservation or the impact of contamination (Wikipedia, 2012f).

Willingness to accept (WTA) the minimum sum an individual would be willing to accept to give up a good (Knetsch, 2005) or to accept something undesirable for.

Willingness to pay (WTP) the maximum sum that an individual would be willing to pay to gain an entitlement (Knetsch, 2005) such as a good or service.

Ecosystem services refer to the benefits or outputs that people derive from ecosystems. Following the publication of the UK National Ecosystem Assessment there has been a growing interest in assessing the flows of such services and valuing the contribution they make to human well-being. This Research Report draws upon recent evidence (years 2001 to 2012) from the behavioural economics literature to examine how cognitive factors influencing people's choices and preferences can affect the values that they place upon ecosystem services and upon ecosystem sustainability. The Report shows that there can be a wide variation in the values placed on particular ecosystem services due to a range of factors. For example, the ability of individuals to process information can result in eight times higher variance in respondent values when more complex formats are used. The Report covers methods used to mitigate these effects and highlights where addressing research gaps on how people value ecosystem services could contribute to ecosystem sustainability.



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