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Valuing the ecosystem service changes from catchment restoration: A practical example from upland England

Stewart J. Clarke [a,*], Julian Harlow [a], Alexandra Scott [b], Mark Phillips [c]

[a] Natural England, Unex House, Bourges Boulevard, Peterborough PE1 1NG, United Kingdom
[b] Yorkshire Water, Western House, Western Way, Halifax Road, Bradford BD6 2LZ, United Kingdom
[c] Natural England, Lateral, 8 City Walk, Leeds LS11 9AT, United Kingdom

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ABSTRACT

The application of ecosystem services to management requires simple approaches that can be applied with minimal data. We present a practical example of a low input approach for a small upland catchment. Two land management scenarios were developed in consultation with a group of partners with interest in management of the catchment. Currently, many habitats in the catchment are in poor ecological condition limiting the provision of some ecosystem services. The two scenarios were 'improve' (investments are made to deliver a balance of ecosystem services through habitat restoration and less intensive land management) and 'decline' (future ecological decline due to a general withdrawal of public investment in land management and applying only the minimum environmental regulations). The ecosystem service (dis-)benefits of each scenario were quantified and valued using two different value transfer approaches. The ecosystem services assessed were carbon storage, biodiversity (or wildlife value) and water quality. Both valuation approaches showed positive benefit-cost ratios for the 'improve' scenario and negative ratios for the 'decline' scenario. Even with this limited suite of ecosystem services the analysis provides a convincing case for investment in the catchment. The sensitivity of the analysis to assumptions made through the valuation is explored and improvements suggested.

1. Introduction

The ecosystem approach has been developed and adopted by the Convention on Biological Diversity (CBD) as a framework for the sustainable management of land and sea. The approach consists of twelve principles that focus on scales of management, governance models, systems thinking and the socio-economic contexts of environmental management. The ecosystem approach recognises that people receive a range of benefits from the natural environment and these ecosystem services are increasingly the focus of assessment (Millennium Ecosystem Assessment, 2005; UK NEA, 2011) and policy (Defra, 2011). The logical conclusion from recognising these benefits is that they have value to society and that this value can be incorporated into decision making (TEEB, 2010).

Ecosystem goods and services which have traditionally been traded in markets (food, timber, fuel) are already well represented in decisions about the natural environment but non-market goods and services have largely been neglected (Turner et al., 2003). Frequently, these non-market benefits have been degraded in favour of those for which markets already exist (Pretty et al., 2000; Millennium Ecosystem Assessment, 2005; UK NEA, 2011). The basic premise of the ecosystem approach and the component of ecosystem services is that by properly recognising and valuing these non-market goods, decision making that affects the natural environment can be improved (Mooney, 2010). There are a growing number of studies in the environmental economics literature which attempt to value the marginal benefit of ecosystem services as a result of a particular management action or policy intervention (e.g. Posthumus et al., 2010; Luisetti et al., 2011, Christie and Rayment, 2012; Bateman et al., 2013). As befits a relatively young field of scientific study there are currently a wide range of approaches being adopted and no clear consensus on which techniques should be employed (see Seppelt et al. (2011)).

Marginal valuation, in which small changes in the stock of natural assets or flow of ecosystem services are valued, is arguably of greater practical use than attempts to estimate the total value of particular ecosystems (*sensu* Costanza et al., 1997). Marginal valuation can help with decision making about the natural environment by estimating the relative gains and losses to human

* Correspondence to: National Trust, c/o East of England Regional Office, Westley Bottom, Bury St Edmunds, Suffolk IP33 3WD, United Kingdom.
E-mail address: stewart.clarke@nationaltrust.org.uk (S.J. Clarke).

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wellbeing associated with adopting particular policies (Bateman et al., 2011). Nevertheless, valuing ecosystem service changes is a multi-disciplinary field at the interface of natural and social sciences. Valuation requires two distinct steps (a) quantifying changes in natural assets and in turn changes in the ecosystem services that these provide; and (b) placing a value on the benefits derived from these changes in ecosystem services. The first task is rooted in the realms of the natural science (ecology, hydrology, soil science, geomorphology) whilst the second task is a question for the social sciences. Determining the value that beneficiaries place upon ecosystem services can be approached in a number of ways; the application of environmental economics is just one approach to this second step. In practical applications, methods which simplify both steps of the process and still yield meaningful results are a prerequisite for more informed decision making.

Predicting changes in ecosystem services is confounded by a number of issues: understanding the relationship between natural assets (structures that underpin flows of services e.g. habitats) and ecosystem services; understanding how marginal changes in management or use might alter this; and being able to quantify changes in meaningful units for valuation. Whilst not all would agree that the level of prediction required is beyond the current reach of ecological science (Norgaard, 2010) these gaps in our scientific understanding are recognised as perhaps the most serious problems for effective and robust valuation of ecosystem services (Bateman et al., 2011). A range of models are being developed to provide simple approximations and estimates to help managers and affected communities understand the potential synergies and trade-offs between ecosystem services (e.g. the INVEST model, see Nelson et al. (2009) and Volk (2014)). However, given the extent to which ecosystem services are location specific and data availability varies, it is likely that more tailored and bespoke approaches to quantifying potential changes may be required to underpin valuation studies.

Once changes in ecosystem services have been established, providing some estimate of the resulting change in value may help inform decisions. Economic valuation is one way of approaching this and is currently the main way in which policy decisions are assessed (see Bateman et al. (2011)). Primary valuation, in which values are determined through qualitative research techniques such as stated preference studies, is costly and time consuming and hence there is increasing interest amongst practitioners in using 'value transfer' techniques. Value transfer applies monetary values determined from other studies (primary valuations or meta-analysis) to a new situation following appropriate adjustments that take account of the characteristics of the new situation. Value transfer significantly reduces the burden of data required to undertake monetary valuation of marginal changes in the natural environment as a result of a policy intervention or change in use or management. The UK Government have published guidelines on value transfer (Eftec, 2010) and there is increasing interest in using this relatively simple approach to help make environmental management decisions.

Despite the difficulties associated with predicting, quantifying and valuing ecosystem services, policy and management decisions about the natural environment need to be made and any attempt to incorporate the value of hitherto ignored non-market goods and services should result in more informed outcomes or at least highlight where uncertainties lie. Widespread adoption of ecosystem services valuation in decision making is dependant upon the development of simple methods for the quantification of ecosystem service flows that can be combined with the growing body of value transfer information.

In response to growing scientific and policy interest in the ecosystem approach and ecosystem services, Natural England, the statutory adviser for the natural environment in England, undertook three pilot projects in the English uplands (Waters et al., 2012) to test how the approach might be delivered in practise. The English uplands are widely recognised as important places for the provision of a range of valuable ecosystem services (carbon storage, water supply, timber, food and recreation) (Bonn et al., 2009) and the ecosystem approach offers a potential framework to manage the provision of these multiple benefits. Managing the uplands as an integrated socio-ecological system (Folke et al., 2010) is increasingly important as traditional land management is threatened by social and economic change (Bonn et al., 2009a). In particular, the upland catchments in the north of England are important sources of drinking water for a number of large conurbations and extensive areas are owned or managed by water supply companies. Although upland catchments are important, supplying around 70% of Britain's drinking water (Natural England, 2009), there is a growing problem with deteriorating water quality. Increased levels of dissolved organic carbon (DOC) and particulate organic carbon (POC) are leading to discolouration of the raw water supply and increased water treatment requirements to mitigate the potential impact on drinking water quality (aesthetic, taste and public health issues); this problem is related to some land management practises and may be exacerbated by climate change (Yallop et al., 2010). More and more water supply companies are seeking to maintain or improve raw water quality through catchment management rather than end of pipe treatment solutions (Grand-Clement et al., 2013). The Natural England pilots presented the opportunity to develop and test approaches to quantifying ecosystem service benefits under different land management options or future scenarios and value these through value transfer techniques. Here we describe a study undertaken in a small water supply catchment in the South Pennines pilot. The aim of this study was to quantify and then value key ecosystem services benefits likely to arise from two different future land management scenarios in the hope that this information could feed into future decision making for the catchment.

2. Methods

2.1. Study area

The Keighley and Watersheddles catchment (hereafter referred to as the Keighley catchment) is located in the centre of the South Pennines National Character Area (Natural England, 2012) in the county of West Yorkshire. It is approximately 4348 ha in area and predominantly rural with only 8%, classified as urban. The dominant land use is extensive sheep farming, although the catchment is important for drinking water supply. The catchment is typical of many upland areas in England in that attempts were made in latter 20th century to drain the blanket bog and wet heath to make the land more productive for sheep grazing. Burning of the heath vegetation occurs periodically, both as a result of deliberate management action and also wildfires.

The catchment has high conservation value with 38% of the area being designated as of national (Sites of Special Scientific Interest) and European Union importance (Special Protection Areas and Special Areas of Conservation). This conservation interest is largely centred on the blanket bog and upland heath habitats and associated breeding bird assemblages. The high wildlife value of the catchment and large area of semi natural habitat is reflected by a very high uptake of agri-environmental schemes. In 2009, 57% of the catchment was under some form of environmental management through such schemes (typically 10 year agreements providing payments to land managers in return for delivering environmental benefits), representing more than £1.7 m of investment. Despite this management investment, large