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Valuing ecosystem services across water bodies: Results from a discrete choice experiment

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ABSTRACT

As demands on the environment and associated ecosystem services increase, the need for a more integrated approach to managing the exploitation of these natural resources also increases. This is particularly true for the alternative types of water bodies such as a sea, river and/or a lake. The purpose of this paper is to explore the preferences of residents in the Republic of Ireland for a number of ecosystem services provided by Irish water bodies. In particular the paper examines whether, and how, preferences for the same ecosystem services differ when the public is asked to consider the alternative water body types (sea, river and lake). This is relevant as the ecosystem services' economic benefits are not necessarily uniform across water bodies, a factor that has not been explored in detail previously.

1. Introduction

The assignment of economic values to ecosystem services requires an understanding of how human welfare is affected by change in those ecosystem services. Humans use a variety of goods and services provided by ecosystems, which may be classified as provisional, regulatory or cultural services (UKNEA, 2011a). In addition to producing goods and services for human use, ecosystems also provide supporting services. Water bodies supply, for example, resistance and resilience to surrounding ecosystems, wild species diversity and biogeochemical cycling. They also contribute to biological and genetic diversity (UKNEA, 2011b). Although these services are not used directly by humans, they nonetheless increase human welfare (Bateman et al., 2002).

The Millennium Ecosystem Assessment (MA), which was initiated by the United Nations and took place between 2001 and 2005, provides evidence of interest at the supra-national level of establishing frameworks for better management of ecosystem services. The findings of the MA highlighted that over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any other period in history, showing the need for strong action to combat irreversible changes to ecosystems. With regard to European Union (EU) policy, in 2012 the EU adopted the 'EU Biodiversity Strategy to 2020', which aims to halt the loss of biodiversity and the degradation of ecosystem services in the EU by 2020.

Within the context of water policy the implementation of the Water Framework Directive (WFD) in 2000 laid the foundations for European action in the specific area of water-based ecosystem management (Official Journal of the European Community, 2000). The WFD aimed at a minimum for a 'good' and 'non-deteriorating status' for all freshwater bodies in EU member states. Thus it provides a framework to achieve '*good ecological status*' (GES) in all EU waters by 2015. The directive takes a 'source to sea' approach in assessing freshwater ecosystems, defining planning, management and reporting on River Basin Districts rather than administrative regions, and it calls for social participation and transparency in the implementation of each step of the directive (WFD, 2013). Unlike previous narrowly-defined water directives, the WFD is concerned with estimating the impact of all human activity on biological, hydro-morphological and physio-chemical elements on water bodies (Norton et al., 2012).

The objectives of a more recent marine waters related directive, the Marine Strategy Framework Directive (MSFD) 2008 (Official Journal of the European Community, 2008), are also complementary with those laid down by the WFD. The MSFD requires that "*good environmental status*" be achieved based on 11 indicators encompassing an ecosystems approach to management. Broadly, the WFD applies to freshwater and transitional water while the MSFD applies to deep water and there is overlap between the WFD and the MSFD in respect to coastal waters. One of the key aspects of these directives from an environmental economics perspective is that they call for full consideration of the economic costs and

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benefits arising from the impact of the proposed environmental protection measures on the water bodies' ecosystem service provision. This is challenging, particularly from the environmental benefits perspective, because assessing the benefits arising from changes in complex ecosystem services is not a straightforward task. Nevertheless, various methods exist for the purposes of valuing such benefits.

Within this context, this paper aims to assess the economic values of Irish residents' for a number of ecosystem services from Irish water bodies as identified though focus group discussions and by the Environmental Protection Agency in Ireland (EPA, 2012). This study uses the method of discrete choice experiments (DCEs) which can represent the multifaceted and complex nature of ecosystems and therefore makes them capable of estimating how a combination of changes to one or more ecosystem services affects human welfare. Broadly speaking, this study adheres to the objectives of the WFD by modelling members of the publics' preferences with regard to different management scenarios for a variety of Irish water bodies. The choices presented to individuals within the DCE remain true to the holistic concept of ecosystem assessment required under the directive. A particular aim of this study is to understand if and how, preferences for the main ecosystem services provided differ across rivers, lakes and sea. This is an important consideration since the value of ecosystem services may not be uniform across different water bodies.

In what follows, the next section reviews the international literature on water body ecosystem service valuation as well as provides an overview of previous valuation studies conducted in Ireland. This is followed by an outline of the econometric methodology employed in the study and a description of the survey design. We then present a number of results and conclude the paper with a discussion of the implications of our findings.

2. Review of the water valuation literature

The DCE literature evaluating ecological improvements in water bodies as a consequence of the introduction of policy differ in terms of the purpose of the study and hence the affected population. Authors may solely be interested in ascertaining the perceptions of users of the water body (Can and Alp, 2012; Hynes et al., 2008) or of those residing near the water body (Kataria et al., 2012; Stithou et al., 2012). They may also be interested in estimating the value of improvements to water bodies for an entire region or country (Kataria, 2009; Metcalfe et al., 2012), in which case a nationally representative sample is required. They may address the impact of changes to different water body types at many geographic scales. The majority of the literature focuses on singular water body types, particularly rivers. Within this category, rivers may be evaluated in terms of their administrative regions (Birol et al., 2008a), as single stretches (Hanley et al., 2006a) or as entire river catchments (Robinson et al., 2002; Brouwer et al., 2010; Poirier and Fleuret, 2010). DCEs focussing on the evaluation of ecosystem services provided by lakes or coastal waters are less common than those for rivers. Exceptions include evaluations of Cheimaditida lake (as part of the wetlands) in Greece (Birol et al., 2008b); Lake Champlain in New York and Quebec (Smyth et al., 2009), coastal waters off the west coast of Ireland (Hynes et al., 2013) and Gocek Bay in Turkey (Can and Alp, 2012). Even fewer papers combine the evaluation of more than one water body type into one study. Metcalfe et al. (2012) carried out a large-scale investigation of the value of the implementation of the WFD for all water bodies in the UK, which included a DCE. However, the authors did not differentiate between varying water body types in their survey but kept them as one combined entity. Glenk et al. (2011), on the other hand, kept their description of the impact on rivers and lochs separate when they investigated the impact of the WFD in Scotland.

Both Metcalfe et al. (2012) and Glenk et al. (2011), use an ecological status approach to ecological water valuation in their studies. The four attributes used in their DCEs' are descriptions of the potential status of the water body in a number of years' time. For example, Glenk et al. (2011) include two variables for lochs, as well as two for rivers, each described as having differing environmental standards in 7 and 20 years' times, respectively. The levels for the attributes in both studies are varying quantities of the water bodies that will be at the achieved environmental standard by the end of the given time frame. A consequence of focusing on just the ecological status of the water bodies being analysed is that the marginal value of a specific characteristic of a water body (e.g. the marginal value of a change in the recreational, aesthetic or ecological attribute) cannot be estimated. Conversely, in accordance with Lancaster's characteristics theory of demand (Lancaster, 1966), the total value of water bodies may be viewed as the sum of the marginal values of their many attributes, and, combined with welfare theory and consumer theory, DCEs may be used to elicit the marginal benefit of the many characteristics of water bodies separately. In this paper, we use this multidimensional approach to water body valuation to estimate, amongst other things, the preference parameters for attributes such as recreational potential, ecosystem health and the state of banks or shoreline across rivers, lakes and seas separately.

The majority of multidimensional DCE surveys contain attributes that relate to the ecology of the water body, to recreational opportunities and to the aesthetics of the water body, although the manner by which these categories are included in studies varies greatly throughout the literature. Ecology may be described solely in terms of the type of biodiversity found in the water body. The former typology may include attributes for specific groups of species, such as native fish, whose levels are described quantitatively (Morrison and Bennett, 2004; Kragt et al., 2011). Alternatively, they may include attributes that are more general in their description of the biodiversity on the water body and are qualitative in their measurement of change (Hanley et al., 2005; Alvarez-Farizo et al., 2007; Birol et al., 2008a). Similarly, recreational activities may be included in DCEs as solo attributes, such as angling (Kataria et al., 2012) or as attributes for recreation in general. In this latter case, levels tend to be defined as different combinations of the possible activities (Morrison and Bennett, 2004; Stithou et al., 2012). The most commonly used attribute for estimating values for regulatory services provided by water bodies, as defined by the UKNEA (Assessment, 2011), is water flow (Willis et al., 2002; Hanley et al., 2006b; Tait et al., 2012). An exception to this is the inclusion by Birol et al. (2008a) of an attribute for the likelihood that flooding will occur in Sosnowiec, Poland, in the next 10 years. Aesthetics is often described as a conglomerate of the effects of litter, smell and clarity (Alvarez-Farizo et al., 2007), sewage (Hanley et al., 2006a) and pollution (Stithou et al., 2012) on water body status. Additionally previous studies have used overlapping characteristics to describe particular attributes. Examples include the use of water clarity (Alvarez-Farizo et al., 2007), smell (Hanley et al., 2006b) or erosion (Robinson et al., 2002; Hanley et al., 2006a; Stithou et al., 2012) to denote the ecological attribute. Some studies have used potential threats to human health in their description of the recreation attribute (Bennett et al., 2008; Smyth et al., 2009). Consequently, the previous DCE literature also highlights the potential interaction between different water bodies attributes.

Valuation studies with a specific focus on water body improvements in Ireland are limited. The majority focus on valuing water-based leisure activities on rivers. The travel cost method has been used to estimate the demand for, and economic value of, salmon