Journal of Environmental Management 175 (2016) 76–86

Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Research article

The contribution of nature to people: Applying concepts of values and properties to rate the management importance of natural elements

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ARTICLE INFO

Article history:
Received 8 June 2015
Received in revised form
10 January 2016
Accepted 5 February 2016
Available online 5 April 2016

Keywords:
System element
Element property
Human value
Natural resource management

ABSTRACT

An important, and yet unresolved question in natural resource management is how best to manage natural elements and their associated values to ensure human wellbeing. Specifically, there is a lack of measurement tools to assess the contribution of nature to people. We present one approach to overcome this global issue and show that the preferred state of any system element, in terms of realising human values, is a function of element properties. Consequently, natural resource managers need to understand the nature of the relationships between element properties and values if they are to successfully manage for human wellbeing. In two case studies of applied planning, we demonstrate how to identify key element properties, quantify their relationships to priority human values, and combine this information to model the contribution of elements to human wellbeing. In one of the two case studies we also compared the modelling outputs with directly elicited stakeholder opinions regarding the importance of the elements for realising the given priority values. The two, largely congruent outputs provide additional support for the approach. The study shows that rating sets of elements on their relative overall value for human wellbeing, or utility, provides critical information for subsequent management decisions and a basis for productive new research. We consider that the described approach is broadly applicable within the domain of natural resource management.

1. Introduction

Given the fundamental connection between human wellbeing and nature (Millennium Ecosystem Assessment, 2005), it is vital that we judiciously manage our natural resources to ensure they continue to satisfy human values and thus wellbeing (Wallace et al., 2016). In response to increasing competition amongst those using natural resources, recent papers have highlighted the need for conservation personnel to better manage conflicts over resource distribution (Redpath et al., 2013; Madden and McQuinn, 2014). At the same time, Mace (2014) has noted the lack of measurement tools to assess the contribution of nature to people. That is, there is a dearth of methods for explicitly and consistently linking human values and wellbeing with the natural biotic and abiotic elements of systems. Yet having this information is crucial to planning the long-term management of natural resources, including the related trade-offs and synergies. Additionally, if decision processes are based on transparent links between system elements and human values, then this should encourage broader understanding and engagement among all stakeholders in land management, thus increasing the likelihood of wise resource use.

To address this methodological gap, we present a method for linking the natural elements to human values in an applied planning and decision context. Specifically, we propose that: (a) the 'state' of any system element is described by its properties, such as size, rarity, species composition (sometimes referred to as attributes or criteria; e.g., Margules and Usher, 1981, Pouwels et al., 2011); (b) these properties may be directly linked to human values; and (c) quantifying this link provides a means for estimating the wellbeing, or utility, that may be derived from any given element or set of elements. If this proposition is sound, then, where the goal is human wellbeing, natural resource managers need to

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http://dx.doi.org/10.1016/j.jenvman.2016.02.007

understand and plan to shape system structure and composition accordingly. Such knowledge could also provide a powerful tool for informing debates and decision-making where there are conflicts over resource allocation.

Two lines of evidence support the proposition that human values may be consistently linked to elements through element properties. Firstly, many scientists and resource managers have expounded the importance of properties to the management of natural resources in a more general sense (Armstrong and Bradley, 2012; Keeney, 1992), and a range of element properties – such as size, rarity and intactness – have been routinely applied to quantify some specified or unspecified 'value' when selecting conservation reserves (e.g., Pressey et al., 1994; Scholes and Biggs, 2005; Wilson et al., 2009). This demonstrates that the properties of elements are widely used to calculate conservation 'value'. Often the meaning of the term 'value' is not defined, and as such it is implicit that some form of philosophical-spiritual value (Wallace, 2012), taken here to include the concepts of biodiversity ethics and intrinsic value, is involved.

Secondly, numerous researchers have directly linked specific properties of elements to particular values. For example, properties such as naturalness, accessibility, species richness and vegetation structure have been variously used to score the importance of areas for recreational satisfaction and management (e.g., Horne et al., 2005; Shelby et al., 2005; Pouwels et al., 2011; Edwards et al., 2012; Paracchini et al., 2014). Furthermore, Lindemann-Matthies et al. (2010) produced experimental evidence of a relationship between plant diversity (a property of the studied grassland systems) and peoples aesthetic pleasure (a value). Similarly, other researchers have found relationships between aesthetic pleasure and landscape properties including vegetation and landscape structure (Ribe, 2009; Arnberger and Eder, 2011; Junge et al., 2011; Qiu et al., 2013). In relation to adequate resources value (e.g., food and potable water), the interaction between vegetation structure and water yield and other properties is well-documented (e.g., Hawthorne et al., 2013; Burt et al., 2015), and the relationship between wild food production and the composition (type and number of each type) of biotic elements is uncontroversial. Nevertheless, although many authors have explored some aspects of the interactions among properties and values (e.g., Chapin et al., 2000; Montgomery, 2002; Garcia-Llorente et al., 2011; Schlacher et al., 2014), we have not found an example where multiple properties of elements have been explicitly and consistently linked to a defensible classification of multiple human values and then analysed to drive management priorities (but see Smith et al., 2015a for a qualitative assessment of the relationship between properties and values within a natural resource context).

The above review supports the proposition that linking natural elements to human values via element properties is a sound way to incorporate human values into planning and decision-making. This approach builds on existing concepts (Keeney, 1992; Margules and Usher, 1981); provides an important, novel and broadly applicable tool to assess the contribution of nature to people; and provides a framework within which human wellbeing can be linked directly to management targets. Consequently, we present an approach that draws on expert opinion to quantify the relationships between properties and values (and associated uncertainty), information which can then be used to rate the importance of a given set of elements to specified human values. Because the relationships between properties and values have rarely been quantified in absolute terms, eliciting informed opinions is often the only method for assessing these relationships. By following this approach, planners and managers can better communicate the importance of natural elements to human wellbeing and also use the new information to underpin ensuing planning steps such as risk assessment (Burgman, 2005) and benefit-cost analyses (Robinson, 1993).

The approach described in this paper also aims to capture and preserve the uncertainty inherent in information elicited from multiple people. For the case studies that we use in this paper, we focus on biotic elements, but the approach is equally applicable to abiotic elements and thus to natural resources in general.

2. Methods

2.1. The case study areas

Two case studies from south-western Australia are presented in this paper. In each case, the aim was to assess the importance of individual biotic elements for realising human values, and thus their utility in supporting wellbeing. One case study was conducted in the Lake Bryde Catchment and the other the Buntine-Marchagee catchment (Walshe et al., 2004; who provide a location map). Importantly, some of the properties and values overlapped between the two case studies, providing an opportunity to compare results generated by two expert groups. Both case study catchments were accorded a high management priority by the Western Australian State Government for their significance in terms of their biotic elements and the high risk to these elements due to changes in hydrological processes (Walshe et al., 2004).

The Lake Bryde catchment is about 1400 km^2 in area and is around 300 km south-east of Perth, Australia. The Buntine-Marchagee catchment is around 1810 km^2 in area and around 130 km north-east of Perth. The catchments are used for agriculture (largely wheat and sheep production), with around 25% (Lake Bryde) and 11% (Buntine-Marchagee) remaining as natural vegetation which is mostly managed by the Western Australian State Government Department of Parks and Wildlife (the department). For Lake Bryde, fifteen biotic elements were identified by technical experts and stakeholder representatives. In Buntine-Marchagee, an initial list of biotic elements was identified by departmental project officers, which was then amended by an expert group, resulting in thirty-four elements. Each case study incorporated a one-day workshop with an expert group, followed by email discussions where required.

2.2. Eliciting property-value relationships

Opinions were sought from expert groups to identify a relevant set of element properties and to quantify their relationships with the priority values; for example, how does knowledge-heritage value change with increasing species richness? The approach used for selecting and working with experts will depend on the management context (Reed et al., 2009). For this work, an expert was taken to be someone with skills, experience, education, training, and/or knowledge concerning the issues to be discussed and resolved (adapted from Burgman, 2005). We identified and secured the participation of eight experts for Lake Bryde and seven experts for Buntine-Marchagee who met these criteria.

Importantly, a number of factors may significantly influence the results produced from expert elicitation processes, and these must be managed to ensure useful information is generated. In particular, results can be influenced by framing and anchoring (Luchini and Watson, 2013), over- and under-confidence (Metcalf and Wallace, 2013; Speirs-Bridge et al., 2010), halo effects (Australian Centre for Excellence in Risk Analysis, 2010) and linguistic uncertainty (Burgman, 2005). A number of techniques were employed to manage these issues. Firstly, during initial explanations and training the workshop facilitators avoided any commentary on values, elements or properties that might anchor or frame the responses of experts (Luchini and Watson, 2013; Page et al., 2012). When training participants, examples were based on content that was not relevant to the case at hand, for example, using examples of values and properties unrelated to the biotic elements in the case studies.