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Targeting the management of ecosystem services based on social values: Where, what, and how?

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ABSTRACT

Whilst biophysical and economic values are often included in spatial planning for conservation and environmental management, social values are rarely considered. This study demonstrates a method for targeting the management of ecosystem services based on social values within the South Australian Murray-Darling Basin region, Australia. A total of 56 community representatives were interviewed and their values for ecosystem services were elicited and mapped. Spatial indicators of abundance, diversity, rarity, and risk were adapted from ecological science and applied to the mapped social values for ecosystem services. Those areas with the highest social value abundance, diversity, rarity, and risk scores were defined as priority areas for the management of ecosystem services. Four hotspots were located in overlapping areas of high priority for multiple spatial indicators. The ecosystem services contributing to high abundance, diversity, rarity, and risk were identified for management in these focal areas. Community suggestions for managing specific ecosystem services in focal areas were collated and synthesized. The results of this study enable the targeting of management of ecosystem service values in the landscape by identifying where high priority management areas are, specifying what services should be managed, and summarizing how they should be managed. This information can complement biophysical and economic information in systematic landscape planning studies.

1. Introduction

To achieve maximum benefit from investment of limited budgets, environmental management needs to be targeted at specific problems in high priority areas in the landscape (Newburn et al., 2005). Typically, high priority areas for management have been identified by the assessment of environmental values including the spatial distribution of biological (Prendergast et al., 1999; Magurran, 2004), land (Crossman and Bryan, 2009), and water resources (Bryan and Kandulu, 2009). Increasingly, economic values have been also been considered in planning cost-effective and targeted environmental management (Naidoo et al., 2006; Bryan and Crossman, 2008). However, the social values that people attach to the landscape are also important to consider in planning for environmental management (Brown, 2005; McIntyre et al., 2008). Here we adapt a suite of spatial indices from ecological science to social values to better target the management of ecosystem services.

Natural capital assets such as land, water, and biota produce a range of ecosystem services which, when combined with other forms of capital, directly contribute to human well-being (Costanza et al., 1997; Daily, 1997; Millennium Ecosystem Assessment, 2005; Boyd and Banzhaf, 2007; Fisher et al., 2009). The value of ecosystem services has largely been measured in economic terms as a basis for increasing investment in environmental management (Daily et al., 2009). However, ecosystem services encompass the many ways society benefits from nature and hence, the many reasons for which it may be valued by people. The ecosystem services framework (Costanza et al., 1997; de Groot et al., 2002; Millennium Ecosystem Assessment, 2005) provides a useful mechanism for capturing the social values people attribute to the environment (Raymond et al., 2009). Inclusion of social values in spatial planning can increase the benefits of targeted environmental management beyond biophysical and economic values and enhance the engagement of local communities and stakeholders in the planning process (Cowling et al., 2008). There is a need to develop methods for quantifying the spatial distribution of social values as a basis for integration with environmental and economic data to target the management of ecosystem services.

There are many views on the definition and philosophical basis of social values towards the environment (Rokeach, 1973; Brown, 1984; Kellert, 1996; Lockwood, 1999; McIntyre et al., 2008; Fisher et al., 2009). In this study we use the concept of assigned values which are those values that people attach to things such as

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goods, activities, and services (Brown, 1984; Lockwood, 1999). Assigned values incorporate a person's perception of the thing under valuation, their held values and associated preferences, and the context of the valuation (Brown, 1984). We focus on values that people assign to ecosystem services. Values may be assigned heterogeneously by people over the landscape (Norton and Hannon, 1997). In this study, we term these place-based, assigned values for ecosystem services, *social values*. As a corollary, *ecosystem service values* in this study are social values, rather than economic or biophysical values. Further, Relph (1985, p. 27) notes that social values "need not be strong and positive"—they can be also associated with negative experiences (Manzo, 2005). In this study, negative values were interpreted and discussed as *threats* to ecosystem services.

Social values have been mapped to inform the planning and management of conservation areas (Kliskey, 1994; Brown et al., 2004; Raymond and Brown, 2006; Alessa et al., 2008), forestry land (McIntyre et al., 2008), and urban forests and green areas (Tyrväinnen et al., 2007). These studies have developed and applied typologies which measure a broad suite of values including biodiversity and wilderness, life sustaining, therapeutic, learning and knowledge, historical and intrinsic values. Raymond et al. (2009) adapted the Millennium Ecosystem Assessment (2005) ecosystem services typology to identify and map social values (termed *community values*) towards ecosystem services. These studies have found that social values vary in type and abundance (variously measured as a count, magnitude, or intensity score) across the landscape. However, social values mapping studies have typically used a single spatial measure of value abundance (e.g. Brown, 2005; Raymond and Brown, 2006; Alessa et al., 2008; McIntyre et al., 2008; Raymond et al., 2009) to integrate spatially heterogeneous information on multiple value types. New quantitative measures are required to better capture the spatial characteristics of the multiple social values over the landscape.

In ecology, the targeting of conservation and management has been based on ecological values commonly measured by species distributions which also vary in type and abundance over the landscape in a similar way to social values. Objectives used in ecology to target management have moved beyond abundance to capture several other characteristics of ecological value such as species diversity, rarity, and risk (Magurran, 2004; Suter, 2006). Maximizing species diversity is a common management objective in conservation. The aim is to ensure that the greatest number of species is protected (May, 1988; Howard et al., 2000) and that individual abundance is relatively even across all species rather than dominated by a few species (Gaston and Williams, 1993). The objective of rarity aims to ensure that the few remaining examples of uncommon and rare species are conserved thereby maintaining biodiversity (Gaston, 1994). Managing risk is another common objective in ecology (Suter, 2006) where those species with a high likelihood of exposure to a degrading process (e.g. a hazard, threat, or stressor) and having a serious consequence (e.g. extinction) are attributed high risk and hence, are a higher priority for management (Standards Australia, 2006).

Objectives used to target management based on ecological values for species may be directly applicable to social values for ecosystem services. Areas of abundant social values for ecosystem services are a valid management priority as these areas hold greater value for more people. Areas of diverse social values may also be a priority for management as a greater range of social values for ecosystem services can be protected in the same area. Similarly, areas of rare social values may be a priority for management as they are the only representatives of that ecosystem service value occurring in the region. Lastly, areas where social values for ecosystem services are at high risk may also be considered to be a management priority. High risk areas are those assigned both high value (consequence) and high threat (likelihood) to ecosystem services (Standards Australia, 2006).

Quantitative spatial indices have been developed to describe species distributions which operationalize ecological management objectives and enable the spatial targeting of management. These include indices of abundance such as biomass (Tilman and Downing, 1994), evenness (Pielou, 1969), dominance (Simpson, 1949), rarity (Gaston, 1994), richness (Magurran, 2004), and diversity (Shannon and Weaver, 1949). Spatial indices of ecological risk have also been developed to identify management priorities (Mattson and Angermeier, 2007; Walker et al., 2008). These objectives (e.g. abundance, diversity, rarity, and risk) and the associated spatial indices may be adapted to target the management of ecosystem services based on social values.

However, a single measure can never capture the full suite of ecological values (Purvis and Hector, 2000), nor in all likelihood, of social values. The identification of hotspots provides a way to integrate multiple spatial indices into an understanding of management priorities (Gimona and van der Horst, 2007; Crossman and Bryan, 2009). Hotspots are areas of spatial coincidence between management priorities for multiple indices. Hotspots of high priority for multiple spatial indices of social value can enable the identification of focal areas for the management of ecosystem services.

In this study, spatial indices from ecological science were applied to mapped social values for ecosystem services in order to identify priorities for environmental management in the South Australian Murray-Darling Basin. Place-based, assigned values for ecosystem services were elicited from a sample of community members in the study area based upon a modified version of the Millennium Ecosystem Assessment (2005) framework. Interviews were conducted which included a mapping task where participants allocated values to ecosystem services across the study area and suggested management actions to enhance these values. Spatial indices of the abundance, diversity, rarity, and risk of ecosystem service values were calculated using a Geographic Information System (GIS). Areas of high index scores were mapped and overlayed to identify focal areas of high priority for multiple indices (hotspots) and pinpoint *where* ecosystem service values should be managed. Specific ecosystem services contributing to the high priority areas were identified to specify *what* ecosystem services should be managed. Community suggestions for management were then interpreted, synthesized and summarized for each focal area in describing *how* these ecosystem services should be managed. By engaging the community in environmental decision-making, this method can be used to target spatially explicit and ecosystem service-specific environmental management that protects and enhances social values and mitigates threats towards ecosystem services.

2. Methods

2.1. Study area

The South Australian Murray-Darling Basin (SAMDB) Natural Resources Management (NRM) region covers an area of just over 56,000 km^2 at the lower end of the Murray-Darling system (Fig. 1) with a population of around 81,000 people. The region has a Mediterranean to semi-arid climate. The River Murray is the main geographical feature of the region and is the major source of fresh water for South Australia. The region contains many ecologically important wetlands and estuaries including the Ramsar listed lower lakes, Coorong, and Murray mouth. Recent record-low inflows and a history of over-extraction of water for consumptive purposes have critically threatened the riparian ecology of the system.