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Managing small natural features: A synthesis of economic issues and emergent opportunities

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ABSTRACT

Small natural features (SNFs), landscape elements that influence species persistence and ecological functioning on a much larger scale than one would expect from their size, can also offer a greater rate of return on conservation investment compared to that of larger natural features or more broad-based conservation. However, their size and perceived lack of significance also makes them more vulnerable to threats and destruction. We examine the management of SNFs and conservation of the associated ecosystem services they generate from an economics perspective. Using the economic concept of market failure, we identify three key themes that explain prevailing threats to SNFs and characterize impediments to and opportunities for SNF management: (1) the degree to which benefits derived from the feature spillover, beyond the feature itself (spatially and temporally); (2) the availability and quality of information about the feature and those who most directly influence its management; and (3) the existence and enforcement of property rights and legal standing of the feature. We argue that the efficacy of alternative SNF management approaches is highly case dependent and relies on four key components: (1) the specific ecosystem services of interest; (2) the amount of redundancy of the SNF on the landscape and the level of connectivity required by the SNF in order to provide ecosystem services; (3) the particular market failures that need correcting and their scope and extent; and (4) the magnitude and distribution of management costs.

1. Introduction

A small natural feature (SNF) is a site with ecological importance that is disproportionate to its size; sometimes because it provides resources that limit key populations or processes that influence a much larger area; sometimes because it supports unusual diversity, abundance, or productivity (Hunter, 2017–in this issue). Examples of SNFs include desert springs supporting endemic fish and other native species (Davis et al., 2017–in this issue), large old trees supporting cavity-dependent mammals (Lindenmayer, 2017–in this issue), caves supporting large colonies of bats (Medellin et al., 2017–in this issue), and coral bommies supporting myriad marine life (Lundquist et al., 2017–in this issue).

As argued throughout this special issue (see Hunter et al., 2017–in this issue), SNFs have both ecological and socio-economic importance. Because SNFs are relatively small and often represent distinct ecosystems, they are surprisingly diverse and contribute to overall biodiversity (Lambertucci and Ruggiero, 2016; Davis et al., 2017–in this issue; Fitzsimons and Michael, 2017–in this issue). SNF-supported species often provide services to human enterprises such as agriculture, for example, by pollinating crops and controlling agricultural pests (Medellin et al., 2017–in this issue; Poschlod and Braun-Richert, 2017–in this issue). SNF-supported processes also generate human-valued services. For example, a modest riparian zone in a larger river valley can reduce the pollutant load entering the river and help moderate flooding peaks through the valley (Watson et al., 2016; González et al., 2017–in this issue) and some temporary water bodies provide groundwater recharge (Acuña et al., 2017–in this issue; Calhoun et al., 2017–in this issue). SNFs also provide recreational values (e.g., spelunking and snorkeling [Huth and Morgan, 2011; Trujillo et al., 2016]), resource extraction (e.g., drinking water [Amondo, 2013]), and tourism and cultural amenities (e.g., aboriginal sites and cave art ([Rossi and Webb, 2007; Daniel et al., 2012]). While we can generally describe SNFs and the ecosystems services they support (see Table 1 and the SNF case studies in this issue), socio-economic aspects of SNF management and consequent impacts on the interactions among ecological and human systems remain poorly understood.

Because small natural features support ecosystem services of value disproportionate to their size, a focus on SNF management presents opportunities for cost-effective conservation, especially compared to larger natural features or more broad-based conservation efforts. However,

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Table 1
Ecosystem services provided by small natural features.

Small natural feature	Direct use values (recreation, tourism, resource extraction, research/education)	Indirect use values (regulating/supporting ecosystem services)	Non-use values (biodiversity)
Caves	• Caving • Show caves, cave art • Access to groundwater • Guano extraction • Sacred sites/temples	• Support beneficial species (bats that provide pollination, pest control, and nutrient cycling) • Genetic materials and medicines	• Endemic species, some species at risk
Rocky outcrops	• Rock climbing • Rock art, scenic vistas • Shelter for livestock • Rock, reptile extraction • Sacred sites/temples	• Support beneficial species (top predators and pollinators)	• Rare species, endemic fauna, specialized flora (adapted to extreme temperatures)
Springs	• Swimming, "bathing" • Scenic vistas	• Water for livestock	• Endemic species
Temporary wetlands	• Wildlife viewing • Duck hunting	• Flood mitigation • Groundwater recharge • Pollution absorption, sediment retention • Nutrient cycling – nitrogen • Carbon sequestration • Aquatic stepping stones, duck habitat	• Some species at risk, specialized invertebrates and amphibians
Temporary streams	• Wildlife viewing	• Flood mitigation • Groundwater recharge • Stream flow connectivity	• Connectivity, corridors
Riparian zones	• Scenic walkways • Fishing	• Flood mitigation • Groundwater recharge • Pollution absorption, nutrient retention • Local climate regulation • Carbon sequestration • Supports beneficial species (fish stocks)	• Microclimate • Corridors
Large old trees	• Scenic feature • Special sites • Shade	• Support beneficial species (pollination, seed dispersal, pest control) in agroecosystems • Carbon sequestration • Water regulation	• Rare and endangered species • Stepping stones • Microclimate
Remnant forest		• Support beneficial species (pollination, seed dispersal, pest control) in agroecosystems	
Coral Bommies	• Snorkeling, scuba diving, wildlife viewing • Fishing	• Supports beneficial species (fish stocks)	• Endemic species • Stepping stones

the management of SNFs and the conservation of associated ecosystem services are proving to be complex. First, their small stature means their over-sized contribution to the landscape's provision of ecosystem services is often unrecognized. Second, most conservation practices and polices used today are designed for landscape-sized conservation and are mal-adapted for SNF-scale conservation. Third, as made clear by the feature-specific articles of this issue (e.g., Davis et al., 2017–in this issue; Fitzsimons and Michael, 2017–in this issue; Medellin et al., 2017–in this issue), formal targeted protections of these landscape elements have thus far been limited, making the promise of cost-effective conservation from well-managed SNFs a non-trivial task. This synthesis is intended to complement the articles of this special issue and call attention to management issues and research needs.

In this paper, we examine the management of SNFs from an economics perspective. In particular, we use the economic concept of market failure to explain the human behavior behind prevailing threats to SNFs and to characterize impediments to and opportunities for SNF management. Market failure is the key concept used by economists and other policy scientists to inform environmental policy and natural resource management (Hackett, 2010; Sterner and Coria, 2013). Briefly, most goods and services such as apples, cell phones, and haircuts are exchanged through well-functioning markets. In contrast, goods and services provided by nature are not typically exchanged in markets because one or more conditions prevent their formation or undermine their functioning. Here, we explain the concept of market failure in more detail to lay the foundation for discussion of SNF challenges and management opportunities.

We also assess the efficacy of alternative SNF management approaches. We argue that efficacy is a function of: (1) the types of ecosystem services generated; (2) the amount of redundancy of the SNF on the landscape and the level of connectivity required by the SNF in order to provide ecosystem services; (3) the market failures that need correcting and their scope and extent; and (4) the magnitude and distribution of management costs. We consider the potential mismatch between traditionally used conservation approaches (e.g., large-scale reserves) and SNFs, and explore the usefulness of under-utilized approaches (e.g., tradable development rights, impact fees, and payments for ecosystem services). While we draw on an economic perspective, our arguments acknowledge and appreciate other social science perspectives (Ostrom et al., 2002; Dietz et al., 2003; Saunders et al., 2006; Schlüter et al., 2017) and their important contributions to environmental conservation (Berkes, 2007; Daniel et al., 2012; Hilbig et al., 2013). Although full consideration of these contributions is beyond the scope of this paper, we incorporate insights from these other fields into our synthesis. Further, by evaluating the need for and efficacy of distinct conservation approaches for SNFs, we strive to initiate new policy discussions and lines of scientific research, as well as foster collaboration among natural and social scientists (Saunders et al., 2006; Heberlein, 2012; Calhoun et al., 2014).

2. Market failures and issues in SNF management

The economic concept of market failure provides a useful means to examine the need for SNF management and to assess the performance of alternative conservation approaches. Economists identify several characteristics of well-functioning markets (Hackett, 2010; Sterner and Coria, 2013). Market failures occur when one or more of these characteristics are missing. Of particular importance to SNFs are situations in which