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Reconciling community ecology and ecosystem services: Cultural services and benefits from birds in South African National Parks

Graeme S. Cumming [a,b,*], Kristine Maciejewski [b]

[a] ARC Centre of Excellence in Coral Reef Studies, James Cook University, Townsville, Queensland 4811, Australia
[b] Percy FitzPatrick Institute, University of Cape Town, Rondebosch, Cape Town 7701, South Africa

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ABSTRACT

The ecosystem services paradigm has been used to bridge disciplinary boundaries and to justify conservation action. Protected areas are now expected to both meet species-level conservation objectives and provide ecosystem services. The relationships between species composition and cultural benefits to people are, however, poorly understood. We quantified benefit-biodiversity relationships between birders and bird communities in South African National Parks to test four hypotheses: 'more is better', the threshold hypothesis, the rarity hypothesis, and the contextual hypothesis. Data were collected along 293 routes in a paired sampling design. Expert birders, collecting classical point count data, followed (24 h later) the GPS-tracked routes of amateur birders. Amateurs completed satisfaction surveys after each route. Bird-related variables, such as diversity and activity, explained c. 27% of variance in birder benefits; other variables, such as the weather and landscape beauty, increased this to 57%. Linear models partially supported 'more is better', but indicated that birders adjust expectations and resulting benefits with location. Cultural benefits are delivered at scales ranging from organisms to landscapes. Conserving cultural ecosystem services is not equivalent to conserving species composition. Rigorous measurement of cultural ecosystem services and benefits demands a multi-scale, multi-level perspective that links people to species, ecological communities, and landscapes.

1. Introduction

Ecological degradation and related collapses of human livelihoods have been documented in a number of systems, including forests, rangelands, and fisheries (Rasmussen and Reenberg, 2012; Essington et al., 2015). As the human population and its impacts continue to grow, analyses of the ways in which ecosystems contribute to human wellbeing have become a major theme in conservation biology and environmental science (Kates et al., 2001; Millennium Assessment, 2003). Their underlying logic is that if we can identify and measure the value of nature, we will be better able to make informed decisions in situations where tradeoffs exist between different ecological, economic, and societal values (Daily et al., 1996).

Recognition that ecosystems provide goods and services to people has become an important justification for conservation action (Daily and Ehrlich, 1999; Daily et al., 2000; Ingram et al., 2012). For example, near the city of Cape Town in South Africa, ensuring a steady supply of water for the region's inhabitants has been one justification for the conservation and restoration (from introduced pine trees to indigenous fynbos vegetation) of mountainous catchment areas (Gaertner et al., 2016). The ecosystem services concept also offers a useful link between ecological and economic perspectives; by achieving a compromise between different approaches (valuation and markets versus biodiversity and system functioning), it helps ecologists and economists to communicate (Daily et al., 2000).

According to the Common International Classification of Ecosystem Services (CICES), Ecosystem Services (ES) are commonly categorised into three main groups framed around human needs and the kind of benefits that they provide: (1) provisioning services, (2) regulating and maintaining services, and (3) cultural ecosystem services, or CES (Haines-Young and Potschin, 2012). Provisioning services include such goods as food, fresh water, fuel wood, and fibre. Regulating services include services like climate-, flood-, and disease-regulation, and water purification. CES include the "non-material benefits people obtain from ecosystems" (Haines-Young and Potschin, 2012).

Contributions to all of the different kinds of ES are increasingly being used to justify the establishment and continued existence of national parks and other forms of protected areas (Palomo et al.,

* Corresponding author at: ARC Centre of Excellence in Coral Reef Studies, James Cook University, Townsville, Queensland 4811, Australia.

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2013; Cumming, 2016). As areas that are set aside for nature, protected areas are expected to benefit local human communities as well as a global community of people who may both depend on remotely provided ES (e.g., climate regulation or fish recruitment) and value nature as tourists or distant spectators (Burger, 2000; Naughton-Treves et al., 2005; Berkes, 2007). At the same time, protected areas are typically created in biodiverse areas to conserve rare species and/or representative examples of biodiversity (Rodrigues et al., 2004; Forest et al., 2007), and their conservation effectiveness is measured using changes in animal population sizes and species composition (Craigie et al., 2010; Selig and Bruno, 2010; Geldmann et al., 2013). It is currently unclear how the conservation outcomes of species-focused and ecosystem service- or benefit-focused approaches compare. Is conserving ES equivalent to conserving species composition, or are ES whole-landscape phenomena that have relatively weak links to species diversity? The potential tradeoffs between a focus on ecological communities and a focus on ES provision have not been explored in the conservation literature, in part because the role of individual organisms in producing ES is poorly understood for many services (Kremen, 2005).

The most widely applied approaches for measuring and mapping ES provision use habitat as a surrogate measure for the species composition of ecological communities (Crossman et al, 2013; Sharp et al., 2014). Since biodiversity is a multi-scale concept (Noss, 1990), ES provisioning should also relate predictably to classical ecological data sets and be explained by theories that explain species abundance and richness within assemblages and communities of organisms (Rosenzweig, 1995). However, despite longstanding recognition of the need to better incorporate ecological perspectives into ES analyses (Kremen, 2005), ES research has not yet solved the problem of how to explicitly quantify the connections from ecological communities, which are composed of individual organisms that live in populations of species, to the benefits that people receive from ecosystems. If species composition can be mapped onto ES by understanding and quantifying steps in the 'ecosystem services cascade' from ecosystems to people (Potschin and Haines-Young, 2011; Spangenberg et al., 2014; Daw et al., 2016; our conceptualisation is presented in Fig. 1), what are the typical mathematical and statistical forms of relationships in this cascade and how do they vary in space and time?

To explore the relationships between species composition and the provision of ES and benefits, we collected data on the provision of CES by bird communities to birders in 19 national parks in South Africa. In addition to providing a useful test case for exploring more general principles, birding and related outdoors activities are a potentially valuable source of income in southern Africa (Turpie 2003; Biggs et al., 2011; Simango, 2011) and our analysis has practical implications for conservation and the tourism industry. We collected classical taxonomic data and cultural benefit data at the same times and places for ecological communities and people respectively. We focused our analysis around four hypotheses.

Our first hypothesis (H1, the 'more is better' hypothesis) proposes that because birders typically like to see a variety of species of birds, the cultural benefits they experience from bird communities should be directly and linearly proportional to taxonomic bird diversity (species richness and abundance) at each location. This mechanism would lead to a linear relationship between satisfaction with a birding trip and taxonomic diversity. Alternatively, we speculated (H2, the threshold hypothesis) that if birders become satiated or feel content after they have seen a certain number of birds, the relationship might follow a logarithmic or power function; (H3, the rarity hypothesis) that birders might prioritise new and rare species and gain satisfaction primarily from seeing these; or (H4, the contextual hypothesis) that the cultural benefits derived from birding experiences might depend more heavily on the surrounding landscape and socioeconomic context. Also of potential importance in understanding our data was the question of whether birders would adjust their expectations to fit the environment in which they were birding, in which case results would be locally but not globally consistent across different national parks (H5, the spatial conditioning hypothesis). H5 in particular is not exclusive of the other hypotheses.

2. Methods

There are many ways in which individual species and ecological communities could potentially be more rigorously included in analyses of ES. We first clarify our usage of terminology and then describe our sampling approach, data, and analysis.

2.1. Clarification of usage

The services described by CICES are usually applied to ecosystem outputs as used by the beneficiary (Haines-Young and Potschin, 2012). Many analyses use the umbrella term 'ecosystem services' to include both services and benefits. We follow Chan et al. (2012) by treating ecosystem services as the production of benefits, which are of value to people; or to rephrase, services describe what ecosystems offer to people (explicitly, given that people must be present in order for an ecosystem output to be considered a service) while the benefit is the actual return that people get (whether financial or subjective) from the utilisation or experience (i.e., whether consumptive or not) of ESs. The number and nature of services that will be experienced as benefits by a given human community is strongly contingent on the values and beliefs of community members, as well as their economic status. For example, Daw et al. (2011) have shown that the same food provisioning service, in the form of captured fish, can lead to different benefits for different members of the same community, underlining the need to maintain a clear distinction between services and benefits.

Little is known about the direct and indirect benefits of birdwatching. Ament et al. (2016), in an extensive survey of visitors to South African protected areas, found that people who strongly agreed with the statement 'I enjoy watching birds' were also interested in seeing other organisms (reptiles, plants, frogs) and in learning more about natural history. Birders were distinct from visitor groupings of people who enjoyed nature primarily for religious or spiritual reasons, as a venue for active outdoor recreation, as a place to relax with friends, or because of a sense of place. Birders thus appear to engage in birding primarily because it involves learning about the natural world and applying and testing their knowledge of it. In the absence of a more rigorous measure of benefit, we measured post-birding satisfaction as a surrogate for benefit.

2.2. Field data collection protocol

To test our hypotheses, we collected field data on bird communities and birding experiences from all 19 of South Africa's National Parks: Addo, Agulhas, Augrabies, Bontebok, Camdeboo, Garden Route, Golden Gate, Karoo, Kgalagadi, Kruger, Mapungubwe, Marakele, Mokala, Mountain Zebra, Namaqua, Richtersveld, Table Mountain, Tankwa-Karoo, and West Coast (Fig. 2). We invited knowledgeable 'amateur' birders (henceforth described as 'amateurs') to visit parks for periods of three days to a week. During this period we asked them to go birding twice a day for at least two hours while wearing a Garmin GPS Forerunner 310XT wristwatch. At the end of each birding experience, their route was downloaded from the wristwatch and they gave us a copy of their

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