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Scaling up from protected areas in England: The value of establishing large conservation areas

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ABSTRACT

Protected areas (PAs) are vital for conserving biodiversity, but many PA networks consist of fragmented habitat patches that poorly represent species and ecosystems. One possible solution is to create conservation landscapes that surround and link these PAs. This often involves working with a range of landowners and agencies to develop large-scale conservation initiatives (LSCIs). These initiatives are being championed by both government and civil society, but we lack data on whether such landscape-level approaches overcome the limitations of more traditional PA networks. Here we expand on a previous gap analysis of England to explore to what extent LSCIs improve the representation of different ecoregions, land-cover types and elevation zones compared to the current PA system. Our results show the traditional PA system covers 6.37% of England, an addition of only 0.07% since 2001, and that it is an ecologically unrepresentative network that mostly protects agriculturally unproductive land. Including LSCIs in the analysis increases the land for conservation more than tenfold and reduces these representation biases. However, only 24% of land within LSCIs is currently under conservation management, mostly funded through agri-environment schemes, and limited monitoring data mean that their contribution to conservation objectives is unclear. There is also a considerable spatial overlap between LSCIs, which are managed by different organisations with different conservation objectives. Our analysis is the first to show how Other Effective Area-Based Conservation Measures (OECMs) can increase the representativeness of conservation area networks, and highlights opportunities for increased collaboration between conservation organisations and engagement with landowners.

1. Introduction

Terrestrial biodiversity is under unprecedented pressure, despite intensifying conservation efforts. Protected areas (PAs) have long been used to mitigate these threats by separating biodiversity and incompatible land uses, and now cover 14.6% of the global terrestrial realm (Watson et al., 2014). Moreover, PA networks are continuing to expand, as most national governments have committed to increase the proportion of their land surface under conservation to 17% by 2020 (CBD, 2011). However, even with this new commitment, conservation success is far from guaranteed (Venter et al., 2014). This is because PA networks have often developed in an ad hoc manner and have three features that limit their effectiveness. First, many PAs are small and isolated, and so cannot maintain broad-scale ecological processes or sustain viable populations of wide-ranging species (Armsworth et al., 2011). Second, PAs are often placed in remote areas with little economic potential (Joppa and Pfaff, 2009), leaving many ecosystems and species poorly represented (e.g. Iojă et al., 2010; Jackson and Gaston,

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2008). Third, PAs fix conservation efforts in space based on conditions at a certain time, while ecosystems and their threats are dynamic (e.g. Araújo et al., 2011).

These problems are evident in England, where much biodiversity is restricted to small, privately owned fragments of semi-natural habitats. Most of these habitats have been shaped over thousands of years by anthropogenic use and management, but have suffered significant fragmentation and degradation in the last century (Lawton et al., 2010). The English PA network is based on a restrictive zoning approach (Lawton et al., 2010), which uses planning legislation to identify National Natural Reserves (NNRs) and Sites of Special Scientific Interest (SSSIs) and then limit damaging development within them. Historically, this network has comprised of mostly small ($< 1km^2$) and isolated PAs (the median size of SSSIs and NNRs are 0.2 km^2 and 1.1 km^2 respectively), typically confined to uplands and ecoregions with low agricultural potential (Oldfield et al., 2004). To overcome these limitations, the United Kingdom (UK) has adopted a complementary approach based on agri-environment schemes and other incentive-based payment schemes. These pay landowners for income foregone and to cover the costs of management actions designed to improve landscape quality for conservation or other objectives, thereby providing an important source of funding for conservation inside and outside PAs. In England, the European Union's Common Agricultural Policy has funded agri-environment schemes since 1987 (Bright et al., 2015). Until recently, these schemes included Higher-Level Stewardship (HLS), which supported intensive habitat maintenance and restoration within target areas in production landscapes (Natural England, 2012), and English Woodland Grants that funded projects to restore and manage woodlands (Raum and Potter, 2015). Both of these were replaced in 2016 by the new Countryside Stewardship scheme (Natural England, 2015) and the UK's departure from the European Union could bring further changes.

Past research has shown that the English PA network is relatively effective at representing species and plays a major role in supporting species in response to climate change (Gaston et al., 2006; Gillingham et al., 2015; Jackson et al., 2009). However, 56% of species in the UK have declined since 1970 (Hayhow et al., 2016), underlining the limitations of the PA network and agri-environment schemes. Recognising this problem, the UK government commissioned work on how to improve nature conservation and ecosystem service provision (Lawton et al., 2010; NEA, 2011). These recommended a more proactive approach to improving England's ecological networks, based on landscape-scale habitat restoration (Defra, 2011) with five key steps identified to help achieve this objective: (i) improve habitat quality; (ii) increase the size of habitat patches; (iii) enhance connectivity; (iv) create new sites, and; (v) improve the wider environment (Lawton et al., 2010).

These government reviews provided renewed impetus to a trend that had been developing across the UK conservation sector. In particular, several conservation non-governmental organisations (NGOs) recognised the need for new large conservation areas, which should extend beyond the boundaries of existing PAs to encompass whole landscapes. These NGOs have established their own schemes to develop large conservation areas, such as the Royal Society for the Protection of Birds' "Futurescapes" (RSPB, 2001) and the Wildlife Trusts' "Living Landscapes" (Wildlife Trusts, 2007). There is also an increasing appetite for greater collaboration among and between conservation NGOs and local and national governmental agencies to support existing and new initiatives (Macgregor et al., 2012).

It was in this context that a recent project explored large-scale conservation initiatives (LSCIs) in England, Scotland and Wales, where LSCIs were defined as any area larger than an arbitrary threshold of 10 km^2 that is actively managed for biodiversity conservation goals (Eigenbrod et al., 2017). This research looked at the different categories and locations of LSCIs, the factors involved in their planning and management, and their environmental benefits (Adams et al., 2016; Eigenbrod et al., 2017; Macgregor et al., 2012). This analysis identified over 800 LSCIs in England, Scotland and Wales, which were subsequently categorised based on land tenure and management strategy (Macgregor et al., 2012). This large number of LSCIs highlights the growing interest in the approach in the UK. However, despite their number and appeal, there is little evidence on whether these new initiatives have resulted in a more representative PA network. The aim of this paper is thus to explore the extent to which LSCIs and agri-environment schemes have complemented the current network of PAs to reduce spatial biases.

The best way to explore this question is to undertake a gap analysis, a spatially resolved quantitative approach for measuring how well PA networks represent biodiversity and protect different biogeographic zones, land-cover types and species (e.g. Jenkins et al., 2015; Scott et al., 1993). Here we conduct the first ever gap analysis of the relative contribution of PA, LSCIs and agri-environment schemes, focusing on these different conservation area types in England. We begin by measuring how England's PA network has changed since a 2001 gap analysis in terms of extent and protecting different ecoregions and elevation zones (Oldfield et al., 2004). We then assess the contribution of two other major categories of conservation management initiatives: large-scale conservation initiatives (LSCIs), using the recently created LSCI database (Eigenbrod et al., 2017), and; incentive payment areas (IPAs) based on agri-environment and woodland improvement schemes. This involves measuring the overlap in the PA, LSCI and IPA networks, and the extent to which land under these management types cover the different ecoregions, land-cover types and elevation zones. In doing so, we test the hypothesis that Other Effective Area-Based Conservation Measures (OECMs), as highlighted in the Convention for Biological Diversity's Aichi target 11 (CBD, 2011), reduce some of the limitations of the original PA network by better representing England's ecoregions and land with higher socio-economic value.

2. Methods

2.1. Types of conservation areas

We distinguished four categories of conservation areas in our analysis:

1. Protected areas (PAs). We focused on National Nature Reserves (NNRs) and Sites of Special Scientific Interest (SSSIs), the core statutory designations for biodiversity protection in England. We did not include European and internationally designated PAs in this analysis, because they are already included as NNRs or SSSIs, and we excluded National Parks and Areas of Outstanding National Beauty because non-PA land within such areas is normally not managed with conservation as a primary objective (Oldfield et al., 2004).
2. Type 1 Large Scale Conservation Initiatives (LSCIs). These consist of large, privately-owned land parcels that are managed by one or a few organisations or individuals, typically for long periods of time. Examples include the Great Fen Project, Wild Ennerdale and Wicken Fen Vision (Table S1). Type 1 LSCIs are currently managed primarily for conservation.
3. Incentive Payment Areas (IPAs). These are agricultural land parcels receiving HLS or woodland grant scheme payments (Natural England, 2012; Raum and Potter, 2015) under renewable ten year contracts. We excluded land under Entry-Level Stewardship schemes, as they cover only a small proportion of any land holding and support broader environmental improvement actions rather than conservation management (Davey et al., 2010).
4. Type 2 Large Scale Conservation Initiatives (LSCIs) represent large areas that are typically proposed to be managed for biodiversity conservation. They consist of many land parcels managed by different organisations or individuals, but guided through a single