Landscape and Urban Planning 145 (2016) 1–11

Contents lists available at ScienceDirect

Landscape and Urban Planning

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

Research Paper

Testing the effectiveness of surrogate species for conservation planning in the Greater Virunga Landscape, Africa

Kendall R. Jones[a,d,*], Andrew J. Plumptre[b,e], James E.M. Watson[c,d], Hugh P. Possingham[a], Sam Ayebare[b,e], A. Rwetsiba[c,e], F. Wanyama[c,e], D. kujirakwinja[f,e], Carissa J. Klein[a,d]

[a] Australian Research Council Centre of Excellence for Environmental Decisions, School of Biological Sciences, University of Queensland, St Lucia, Queensland 4072, Australia
[b] Albertine Rift Program, Wildlife Conservation Society, PO Box 7487, Kampala, Uganda
[c] Global Conservation Program, Wildlife Conservation Society, Bronx, NY 10460, USA
[d] School of Geography, Planning and Environmental Management, University of Queensland, St Lucia, QLD 4072, Australia
[e] Uganda Wildlife Authority, PO Box 3250, Kampala, Uganda
[f] WCS Eastern Democratic Republic of Congo Program, Goma, DR, Congo

HIGHLIGHTS

- We present the first test of the landscape species approach.
- We test whether landscape species are effective surrogates for biodiversity.
- Landscape species are the worst surrogates of all species groups tested.
- Prioritising for randomly selected species gives better surrogacy performance.
- Landscape species approach should be used with more robust planning approaches.

ARTICLE INFO

Article history:
Received 15 September 2014
Received in revised form 31 July 2015
Accepted 19 September 2015
Available online 24 October 2015

Keywords:
Surrogates
Spatial prioritisation
Landscape species approach
Protected area planning
Threat management
Marxan

ABSTRACT

Given the limited funds available, spatial prioritisation is necessary to help decide when and where to undertake conservation. One method for setting local scale priorities for conservation action is the landscape species approach which aims to identify priorities based on the needs of a small number of wide ranging species with large environmental impacts. Despite being used for the past decade by conservation organisations such as Wildlife Conservation Society, the effectiveness of the approach for representing a more comprehensive range of biodiversity has never been evaluated. Here we compare conservation priorities identified using a suite of landscape species ($n = 13$) against those using many alternative sets of threatened or endemic species ($n = 7–88$) to assess the applicability and suitability of the landscape species approach in a biologically diverse landscape (Greater Virunga Landscape, Uganda, Rwanda, and Democratic Republic of Congo, Africa). We defined the minimum area needed to conserve each species on the basis of the species' range size. We found that prioritising for landscape species adequately conserves only 31 (35%) species, whereas prioritising for an equal number of endemic species, threatened species, or randomly sampled species adequately conserves 74%, 69% and 42% of species, respectively. We also found that prioritising for one taxonomic group (birds or plants) alone resulted in better surrogacy performance than the Landscape Species. These results question the underlying assumption of the landscape species approach, that managing threats to Landscape Species will also manage threats to all other species, as it is applied in the Greater Virunga Landscape.

* Corresponding author. Permanent address: 3 Enfield Crescent, Battery Hill, QLD 4551, Australia.
E-mail addresses: kendall.jones@uqconnect.edu.au (K.R. Jones), aplumptre@wcs.org (A.J. Plumptre), jwatson@wcs.org (J.E.M. Watson), h.possingham@uq.edu.au (H.P. Possingham), sayebare@wcs.org (S. Ayebare), aggrey.rwetsiba@ugandawildlife.org (A. Rwetsiba), fred.wanyama@ugandawildlife.org (F. Wanyama), dkujirakwinja@wcs.org (D. kujirakwinja), c.klein@uq.edu.au (C.J. Klein).

http://dx.doi.org/10.1016/j.landurbplan.2015.09.006
0169-2046/

1. Introduction

Biodiversity is currently in rapid decline, with extinction rates 100–1000 times background levels (Butchart et al., 2010; Pimm, Russell, Gittleman, & Brooks, 1995; Vié, Hilton-Taylor, & Stuart, 2009). The impacts of losing biodiversity are widespread, as biodiversity influences ecosystem processes upon which humanity is dependent for goods and services (Cardinale, 2012; Cardinale et al., 2012; Stachowicz, Bruno, & Duffy, 2007). For example, increasing biodiversity generally leads to increased productivity of ecosystems, a fundamental supporting ecosystem service that underpins the provision of services such as food or wood (Balvanera et al., 2006). Conservation action is vital if we are to preserve ecosystem function, and associated ecosystem services (Balmford et al., 2002; Nelson et al., 2009). Conservation practitioners have a range of potential conservation actions available for use (Driscoll et al., 2010; Hobbs & Humphries, 1995; Hobbs & Norton, 1996; Richards, Possingham, & Tizard, 1999), and different combinations of actions must be planned for in each specific conservation landscape (Levin et al., 2013).

Conservation planning, the organised process of identifying conservation priorities and developing a group of actions to meet conservation goals (Groves et al., 2002; Knight, Cowling, & Campbell, 2006), is considered vital for conservation actions to be effectively implemented (Sarkar et al., 2006; Sewall et al., 2011). Numerous approaches for conservation planning have been developed by various governmental and non-governmental organisations (NGO's) (Early & Thomas, 2007; Manne & Williams, 2003; Moilanen & Cabeza, 2002; Moilanen, Wilson, & Possingham, 2009; Watts et al., 2009). The landscapes species approach (LSA) (Didier, Glennon, et al., 2009; Sanderson, Redford, Vedder, Coppolillo, & Ward, 2002) was developed to plan conservation actions at the landscape scale and is currently used by the Wildlife Conservation Society (WCS) and other international bodies such as the U.S. Fish and Wildlife Service, Melbourne Water, and the Kenya Wildlife Authority (Didier, Wilkie, et al., 2009; Hamer, Ainley, & Hipler, 2010; U.S. Fish and Wildlife Service, 2012). For the purposes of the LSA, a landscape is defined by the sum of all areas required to support a population of landscape species (LS) (Sanderson et al., 2002). Within the LSA, and indeed within most conservation planning approaches, spatial priorities for conservation must be identified (Moilanen et al., 2009).

Spatial prioritisation requires spatial information about the distribution of species and ecosystems, but our knowledge of the earth's biodiversity is remarkably limited, and much of the diversity we do know about is yet to be catalogued and described (Bini, Diniz-Filho, Rangel, Bastos, & Pinto, 2006; Whittaker et al., 2005). Thus, conservation planning is often based upon surrogates for biodiversity. Surrogacy, in a conservation planning context, is defined as the extent to which conservation planning based on a particular set of biodiversity features (surrogates) effectively represents another set of species (Caro & O'Doherty, 1999; Rodrigues & Brooks, 2007). Surrogates usually fall into two categories: coarse-filter surrogates, which represent broad features (e.g., habitat types, well known taxa), and fine-filter surrogates, which represent more specific features (e.g., threatened species) (Larsen, Bladt, & Rahbek, 2007; Rodrigues & Brooks, 2007). The use of certain groups of species as surrogates for the total biodiversity of an area has garnered significant attention in recent times, mostly due to its potential for greatly simplifying data requirements for conservation planning (Gladstone, 2002; Larsen, Bladt, & Rahbek, 2009; Leal, Bieber, Tabarelli, & Andersen, 2010; Moritz et al., 2001). Numerous conservation approaches are based around suites of surrogate species, such as focal species, umbrella species and flagship species, as well as landscape species (Andelman & Fagan, 2000; Didier, Glennon, et al., 2009; Lamberck, 1997) Although the use of surrogates presents many advantages for conservation practitioners, there is considerable debate around the effectiveness of surrogates at representing biodiversity; that is how well conservation planning based around surrogate species also acts to conserve other species (Grantham, Pressey, Wells, & Beattie, 2010; Larsen et al., 2009).

The LSA focuses on identifying areas of conservation intervention using a suite of LS at a landscape scale to ensure that their long-term conservation requirements are met. While not described as a conservation prioritisation process for species per se, there is an assumption that the approach will 'capture' or act as a surrogate for other biodiversity (Didier, Glennon, et al., 2009). The assumption behind the approach is that if threats facing the LS are effectively managed, threats to all other species will also be effectively managed (Didier, Glennon, et al., 2009). To choose a suite of LS, candidate species are scored based on five categories: (1) area: whether the size of the home range of the species, where large home ranges score higher, (2) heterogeneity: whether species need more than one habitat type in their life cycle, and the proportion of each habitat type needed, (3) vulnerability: whether species to threats from human activities, (4) functionality: whether the effect of a species on the structure and function of natural ecosystems, and (5) socioeconomic significance: whether a species has positive or negative cultural value, whether it is a flagship species (Coppolillo, Gomez, Maisels, & Wallace, 2004). Usually a group of experts score a suite of candidate species and from these a suite of LS is selected, where the highest scoring species is selected first, and then the most complementary species is chosen from the next 5 highest scored species. Complementarity is defined as minimum overlap in habitat requirements, distributions, and distinctiveness of threats encountered. This process is continued until the needs of the next species to be added are already met by the current suite of species (Coppolillo et al., 2004). Because each LS is chosen to form part of a suite of species, each species is not required to have all of these characteristics, but the suite as a whole should.

Despite the use of the LSA by WCS and other organisations, the underlying assumption that LS are suitable surrogates to identify conservation priorities has never been tested, although other surrogacy approaches have been frequently tested (Andelman & Fagan, 2000; Che-Castaldo & Neel, 2012; Grantham et al., 2010; Larsen, Bladt, Balmford, & Rahbek, 2012; Leal et al., 2010; Nicholson, Lindenmayer, Frank, & Possingham, 2013). Therefore, it is unknown how well spatial conservation prioritisation using LS works to comprehensively represent other aspects of biodiversity across a landscape (Margules & Pressey, 2000). The assumptions underlying the LSA may have never been tested because it has been mostly used in areas where there are few data on other biodiversity. This makes it difficult to determine whether LS are suitable surrogates for identifying conservation priorities. The Greater Virunga Landscape in Africa presents the first opportunity to test the assumptions of the LSA, as a suite of LS have been identified, widely studied, and existent extensive data are available. Here, we identified priorities for conservation management in the Greater Virunga Landscape by targeting only LS, and evaluated how well other aspects of biodiversity were represented. Further, we investigated the effectiveness of various combinations of species, other than LS, at representing other biodiversity to further inform surrogacy selection.

2. Methods

2.1. Study area

The Greater Virunga Landscape (GVL), in Africa, straddles the borders of 3 countries: Uganda, Rwanda, and the Democratic Republic of the Congo in Africa (Appendix A). The GVL is one of the most biodiverse regions in the world, containing three world heritage sites, one Ramsar site, and one UNESCO biosphere reserve