Ecological Indicators 70 (2016) 232–248

Contents lists available at ScienceDirect

Ecological Indicators

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

Exploring spatial indicators for biodiversity accounting

Roy P. Remme[a,b,*], Lars Hein[a], Chris A.M. van Swaay[c]

[a] Environmental Systems Analysis Group, Wageningen University, PO Box 47, 6700 AA, Wageningen, The Netherlands
[b] National Institute for Public Health and the Environment, PO Box 1, 3720 BA, Bilthoven, The Netherlands
[c] De Vlinderstichting, Mennonietenweg 10, Postbus 506, 6700 AM, Wageningen, The Netherlands

ARTICLE INFO

Article history:
Received 23 May 2015
Received in revised form 14 June 2016
Accepted 15 June 2016

Keywords:
Biodiversity indicators
Spatial analysis
Ecosystem accounting
Criteria
Monitoring
SEEA-EEA

ABSTRACT

In the context of the System for Environmental-Economic Accounting, biodiversity accounting is being developed as a tool to monitor and increase the understanding of human impacts on biodiversity. Biodiversity accounting aims to structurally measure, monitor and map changes in multiple biodiversity components, as an integral part of a larger system of ecosystem accounts. Both indicators relevant for ecosystem functioning and indicators that reflect the non-use values of biodiversity can be included in biodiversity accounting. In this paper we focus on the latter, and we test the potential applicability of a set of species indicators for developing a biodiversity account in Limburg province, the Netherlands. In particular, we map and analyse a range of indicators reflecting species richness, the presence of rare and threatened species and species diversity. We test spatial correlation to identify the minimum set of indicators that would need to be included in the account. We also evaluate individual indicators using eight different criteria. We show that, in Limburg province, a set of indicators covering at least five species groups is required, and that it would be most meaningful to have indicators reflecting the occurrence of threatened species. However, data availability as well as the most suitable set of indicators are likely to differ between areas, and case studies in other countries are required to support the selection of indicators for biodiversity accounting in an international framework.

© 2016 Elsevier Ltd. All rights reserved.

1. Introduction

Biodiversity and ecosystems are under increasing threat (Díaz et al., 2006; Hooper et al., 2005; MA, 2003; Vitousek et al., 1997). Formulating and implementing strategies for conserving biodiversity in changing landscapes requires a comprehensive and structured information system. The UN System of Environmental Economic Accounts-Experimental Ecosystem Accounting (SEEA-EEA) is being developed and tested as a broadly applicable system to measure ecosystems and ecosystem use (Hein et al., 2015; UN et al., 2014). The SEEA-EEA has been tested in a range of studies by statistical agencies and in research papers (Australian Bureau of Statistics, 2015; Duku et al., 2015; Remme et al., 2015; Schröter et al., 2014a; Sumarga et al., 2015; World Bank, 2013). The SEEA-EEA consists of a set of integrated accounts including ecosystem extent, ecosystem assets, and ecosystem services supply and use (UN et al., 2014). One of the accounts deals with biodiversity, focussing on aspects such as species richness, abundance and threat (UN et al., 2015). Whereas the other accounts of the SEEA-EEA framework have been developed in detail in the last years, there is as yet no consensus on how the biodiversity account should be structured, even though a set of initial recommendations has been developed (UNEP-WCMC, 2015).

The biodiversity accounts, in the conceptualisation of the SEEA EEA, should reflect (1) biodiversity as an important element of ecosystem condition and therefore, for the provision of ecosystem services, as well as (2) biodiversity as a consideration for ecosystem management in itself (cf. Mace et al., 2012; Reyers et al., 2012). For the first aspect there is increasing evidence for the link between ecosystem services and biodiversity, however capturing this link in a set of indicators is not straightforward (e.g. Harrison et al., 2014; MA, 2005; Mace et al., 2012; Reyers et al., 2012; Schröter et al., 2014b). The second aspect reflects that people appreciate certain aspects of biodiversity, such as the presence and conservation of (specific) species. Consequently, species diversity is often an important consideration in ecosystem management (Mace et al., 2012; UN et al., 2014). Given the challenges of linking biodiversity to ecosystem functioning, in this paper we focus on indicators for species distribution and diversity, as species are a fundamental aspect of biodiversity (Mace et al., 2012).

* Corresponding author at: Environmental Systems Analysis Group, Wageningen University, PO Box 47, 6700 AA, Wageningen, The Netherlands.
E-mail addresses: roy.remme@rivm.nl, royremme@gmail.com (R.P. Remme), lars.hein@wur.nl (L. Hein), chris.vanswaay@vlinderstichting.nl (C.A.M. van Swaay).

http://dx.doi.org/10.1016/j.ecolind.2016.06.024
1470-160X/© 2016 Elsevier Ltd. All rights reserved.

Note that there are important differences between biodiversity accounts and biodiversity monitoring systems. Biodiversity accounts need to capture information at an aggregated level in a limited set of indicators that are relatively easy to understand for policy makers, using information from one or more biodiversity monitoring systems, and using the general approach and definitions of the SEEA framework (e.g. for spatial units, accounting periods, etc.). These indicators need to express, among others, the relative importance of areas for biodiversity conservation, and trends in biodiversity. The challenge is to find a small set of indicators that jointly are able to inform the users of the accounts on such aspects (UNEP-WCMC, 2015). It is crucial that a framework for biodiversity accounting is set up to avoid a lack of consideration of biodiversity in the SEEA accounting systems that are being tested in a growing number of countries and that otherwise focus on the economic benefits provided by ecosystems through the use of ecosystem services and not on the non-use value aspects of biodiversity (Obst and Vardon, 2014; Polasky et al., 2015; UNEP-WCMC, 2015). If biodiversity is not included in these accounts, there is a risk that biodiversity is not sufficiently considered when the accounts are used to support policy making (UN et al., 2015).

There have been several studies testing different approaches to biodiversity accounting. Jones (1996) already initiated a pilot study to outline a general model for biodiversity accounting. Nearly a decade later this pilot study was followed up by a case study at a company scale (Jones, 2003). Since then a number of case studies have been published, focussing mostly on biodiversity accounting for corporations and projects (Gardner et al., 2013; Rimmel and Jonäll, 2013; van Liempd and Busch, 2013; Virah-Sawmy et al., 2014). Most of these studies focussed on the combination of species richness and abundance (Jones and Solomon, 2013). The only case where a large scale account was developed was by Bond et al. (2013) for Victoria, Australia. That study is one of the first biodiversity accounting studies to apply a spatial approach. For accounting according to the SEEA-EEA framework, a spatial approach is required to capture the spatial heterogeneity of ecosystem services and biodiversity and to align the information in the biodiversity account with the information in the other accounts, for example on ecosystem use (UN et al., 2014). Developing a framework for biodiversity accounting requires consideration of the SEEA framework (UN et al., 2014) as well as of the wide range of studies on biodiversity indicators (e.g. Butchart et al., 2010; EEA, 2012; Feest, 2013; Gregory et al., 2005; Mace et al., 2010; Noss, 1990) and biodiversity monitoring systems, such as GEO BON (Pereira et al., 2013) or WWF's Living Planet Index (WWF, 2014).

The objective of this paper is to test a number of indicators for biodiversity accounting in Limburg province, the Netherlands, drawing upon extensive biodiversity data available for the area, as well as the broader literature on biodiversity indices and monitoring. Specifically, we assess which spatially explicit state indicators for biodiversity would potentially be suitable to include in biodiversity accounts. We identify criteria for selecting indicators that are relevant for biodiversity accounting, and test and map a set of biodiversity indicators. Given that countries will generally face data shortages and limited resources for collecting additional data to prepare biodiversity accounts, we examine how indicator sets can be simplified while still capturing essential information required to support policy-making. We provide a first assessment of biodiversity accounting indicators, which is an important step in the development of spatial biodiversity accounts, embedded in a larger ecosystem accounting system (as described by SEEA-EEA UN et al., 2014). We build on the suggestions for biodiversity accounting of the SEEA-EEA, and focus on the need for governments to account for changes in large administrative areas. We therefore focus on the spatial component of biodiversity accounting, temporal accounting was outside the scope of the research. Based on recent discussions (e.g. UNEP-WCMC, 2015), we have focussed our paper on species indicators – even though we recognise that ecosystem indicators may also be relevant for measuring biodiversity (e.g. EEA, 2012; Ferrier, 2002; Pereira et al., 2013), and hence in biodiversity accounting. Monetary valuation of biodiversity falls outside the scope of our research (cf. the SEEA EEA framework (UN et al., 2014), which provides guidance on valuing ecosystem services and assets, but does not propose valuing biodiversity as such).

2. Methods

2.1. Study area

Limburg province is located in the south-east of the Netherlands and covers approximately 2200 km^2. Limburg is densely populated (522 inhabitants per km^2 in 2010), with a total population of 1.1 million people (Statistics Netherlands, 2013). The province has a varied cultural landscape, which has been intensively managed for many centuries (Berendsen, 2005; Jongmans et al., 2013). Most natural ecosystems have been converted, and those that remain are highly fragmented (Jongman, 2002). Nevertheless, Limburg harbours numerous species of national and even international importance, and provides habitats that are unique in the Netherlands (Statistics Netherlands et al., 2008; Willems, 2001).

2.2. Criteria for assessing biodiversity accounting indicators

The technical guidelines on biodiversity accounting have distinguished several criteria for assessing the potential suitability of biodiversity indicators for biodiversity accounting (UNEP-WCMC, 2015). The guidelines state that biodiversity indicators should be spatially explicit, show trends in biodiversity, be comparable to a common reference condition, and that it should be possible to aggregate indicators. Although these criteria provide guidance for assessing the suitability of indicators for accounts, the suitability of the indicator to convey ecologically meaningful information should also be considered. In the scientific literature, there is extensive information on criteria for selecting and assessing biodiversity indicators (e.g.; Noss, 1990; Gregory et al., 2005; Niemeijer and de Groot, 2008; van Strien et al., 2009; Heink and Kowarik, 2010; Chiarucci et al., 2011; EEA, 2012; Vačkář et al., 2012; Pereira et al., 2013). Based on the biodiversity accounting and monitoring literature we identified eight key criteria to select and assess indicators for biodiversity accounting, and we apply these in our case study.

In order to develop biodiversity accounts, indicators need to be selected that fit the purpose of accounting, i.e. indicators need to be relevant to inform policy makers on major trends and issues related to biodiversity conservation (UNEP-WCMC, 2015). In particular, this means that the indicators should differentiate between areas of more and of less importance for biodiversity, and show trends in biodiversity over time. In this paper, we only consider the first part, i.e. we analyse the capacity of indicators to capture spatial not temporal patterns. Of course, whether a biodiversity indicator is relevant for policy making and evaluation also depends on the type of policy questions that need to be assessed (Heink and Kowarik, 2010) and we come back to this in the Discussion section. Our second criterion is validity; indicators should be able to convey correct and meaningful information on biodiversity in order to complement information included in the other SEEA accounts. See e.g. Heink and Kowarik (2010) for more information on assessing the validity of biodiversity indicators. Third, indicators for biodiversity accounting should be quantitative, with quantification possible both in space and over time (Heink and Kowarik, 2010; Vačkář et al., 2012; UN et al., 2014). Fourth, it needs to be feasible to collect data on biodiversity indicators. Feasibility means that the analysis is

Download English Version:

https://daneshyari.com/en/article/6293086

Download Persian Version:

https://daneshyari.com/article/6293086

Daneshyari.com