Ecological Indicators 24 (2013) 193–200

Contents lists available at SciVerse ScienceDirect

Ecological Indicators

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

Evaluation of biotope's importance for biotic resource protection by the Bonner Approach

Markus Gastauer[a,*], Linda Trein[b], João Augusto Alves Meira-Neto[a], Wolfgang Schumacher[b]

[a] Laboratório de Ecologia Vegetal, Departamento de Biologia Vegetal, Universidade Federal de Viçosa, Campus Universitário s/n, Viçosa 36570-000, Minas Gerais, Brazil
[b] Fachbereich Ökologie der Kulturlandschaft–Geobotanik und Naturschutz, Landwirtschaftliche Fakultät, Rheinische Friedrich-Wilhelms Universität Bonn, Nußallee 9, 53115 Bonn, Germany

ARTICLE INFO

Article history:
Received 20 June 2011
Received in revised form 9 June 2012
Accepted 17 June 2012

Keywords:
Importance for biotic resource protection
Biotic value
Compensatory measures
Naturalness
Conservation activities
Landscaping
Planning

ABSTRACT

In this article we present the Bonner Approach to evaluate a biotope's importance for biotic resource protection from the criteria naturalness, rarity and endangerment, substitutability, intactness and importance for the ecosystem structure. Each criterion is evaluated separately from 0 to 5 points which are summed up to the biotic value. According to this biotic value the biotope is classified in six categories from very low or no to international importance for the biotic resource protection. Furthermore, the Bonner Approach is applied in two case studies evaluating different biotopes from a Central European landscape, Nettersheim, North Rhine-Westphalia, Germany, and from a Neotropical region within the Atlantic Rain Forest, Viçosa, Minas Gerais, Brazil. These outcomes are compared to evaluations from the IUCN schemata to identify Key Biodiversity Areas (KBA) and the index of naturalness. Case studies show that biotope's ranking differs between frameworks because each approach is based on different evaluation criteria. Compared to the other frameworks, the Bonner Approach outmatches because this framework considers the influence of evaluated biotopes for biotic resources of surrounding biotopes or landscapes. Furthermore, classification in six categories is wide enough to identify areas of low importance where inevitable impacts might be carried out as well as areas of medium, high, very high or even international importance to elaborate their conservation activities. As the biotic value is of numeric character, the findings can be used to outline compensatory measures. The necessity to consider zoological data given by the Bonner Approach is lacking in other frameworks. The Bonner Approach is transferable to other biogeographical regions due to abstract formulation of criteria. High reproducibility and easy and fast application underline the universal character of the Bonner Approach encouraging its adoption in landscaping and planning conservation activities.

1. Introduction

The unambiguous identification of areas with low, medium, high, and very high importance for the protection of biotic resources (i.e. species richness and diversity) is a relevant issue for nature conservation and landscape planning (Arponen et al., 2009), because rationality demands to reduce necessary and unavoidable impacts to areas of low importance (Cuperus et al., 1999; Biedermann et al., 2010), while areas of higher values should be protected (Williams et al., 2004).

But assessing the value of a defined area for the biotic resource protection is not an easy task: while the benefits of all ecosystem services worldwide might be calculated in monetary terms (Costanza et al., 1997; Toman, 1998), the economic evaluations of single species or single stands, so-called biotopes,[1] bear many difficulties (Edwards and Abivardi, 1998; Wallace, 2007). This demands evaluation frameworks assessing a biotic value as a reference corresponding to the biotope's importance for the conservation and protection of the biotic resources.

* Corresponding author. Present address: Centro de Ciências Ambientais Floresta-Escola, Cidade das Águas s/n, Frutal 38200-000, Minas Gerais, Brazil.
Tel.: +55 34 3429 9533.
E-mail addresses: markus.gastauer@ufv.br, mgasti@hotmail.com (M. Gastauer), l.trein@me.com (L. Trein), j.meira@ufv.br (J.A.A. Meira-Neto), dr.wolfgang.schumacher@web.de (W. Schumacher).

[1] Against the international diction (see, for example, EEC, 1992) we differ between habitat and biotope. The habitat is an area of uniform environmental conditions. The German loanword "biotope" comprises the habitat and its specific assemblage of plant and animals as the smallest uniform unity within a landscape. A biotope type is the abstract from all uniform or similar biotopes characterized by specific plant communities reflecting more or less homogenous geographical conditions (Pott, 1996).

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http://dx.doi.org/10.1016/j.ecolind.2012.06.014

Scientific frameworks based on criteria like naturalness, anthropogenic influences, typicalness, rarity, endangerment, and many others (Usher and Erz, 1994; Bastian and Schreiber, 1999), deal with the identification of highly valuable areas to establish conservation units (Usher, 1980; Kaule, 1986). Some classify evaluated sites qualitatively (Ratcliff, 1977) while others use numerical characters allowing biotope ranking (Bastian, 1991; Biewald et al., 1991).

"No-net-loss" policies introduced in some states like Germany, the Netherlands and others based on the three principles avoidance, mitigation and compensation (Cuperus et al., 1999; Jessel, 2003) resulted in evaluation schemata regulating the outline of such compensation measures (i.e. Biedermann et al., 2010).

Mostly, these schemata provide standardized lists of biotic value of different biotope types. As nature conservation tasks are national business, each German state provides its own evaluation framework resulting in a variety of methods (i.e. LANUV, 2008; Netz, 2006). Between single states, these standardized biotope lists differ in criteria used for evaluation, but–due to biogeographic conditions–also in biotope types listed.

The application of most evaluation frameworks is restricted to defined biogeographical regions or landscapes (i.e. Kirsch-Stracke, 1990; Schick and Schumacher, 1994), only few can be used worldwide (i.e. Bastian and Schreiber, 1999). Then, they produce results of low geographic resolution, i.e. evaluate complete ecosystems (Myers et al., 2000), request high taxonomic knowledge (IUCN, 2007) or extremely high sampling effort (Rodríguez et al., 2009).

A universal evaluation framework which is adequate to

- select areas of low value from a nature conservation point of view where inevitable impacts might be carried out,
- outline compensatory measures by passing losses of biotic value from impacted area to account,
- identify smaller or greater areas of high to very high biotic value to develop their protection strategies and,
- furthermore, control the efficiency of nature protection measures in a competitive and reproducible way

in different biogeographic regions with maintainable effort is widely lacking in international literature.

In the following, we will present such a universal evaluation framework, the Bonner Approach. In two case studies, its feasibility is demonstrated applying the framework on different biotopes. To underline its advantages, the outcomes of these applications are compared to that from other frameworks.

2. Material and methods

2.1. Study sites

2.1.1. Case study I: biotopes from temperate Nettersheim, North Rhine-Westphalia, Germany

13 biotopes from the Nettersheim municipality in the Limestone Eifel were selected for evaluation (Table 1). They belong to the Special Area of Conservation (SAC) "Hänge an Urft und Gillesbach" (Hills in the Urft or Gillesbach Valley) or "Unteres Genfbachtal" (Lower Genfbach Valley) and its surroundings (Table 1).

Due to geological heterogeneity, profound to shallow soils range from lime-rich to lime-deficient. The temperate climate, classified as Cfb by the Köppen system (Peel et al., 2007), shows average annual temperature between 7.5 and 8.5 °C; the precipitation ranges from 700 to 800 mm (Außen, 1992). Potential natural vegetation (Tüxen, 1956) on all stands are either beech or alluvial forests in their different specifications.

2.1.2. ***Case study II:*** *biotopes from tropical Atlantic Rain Forest, Viçosa, Minas Gerais, Brazil*

Within the municipality of Viçosa, Minas Gerais, Brazil, seven different biotopes were selected to test the Bonner Approach (Table 2).

The climate of Viçosa municipality is characterized as Cwb (Peel et al., 2007), a mesothermic climate with mild, rainy summers and dry winters. The annual precipitation amounts 1220 mm, average temperature is 19.4 °C (DNMET, 1992). Profound yellow or red oxisols dominate in the landscape, substituted by cambisols on hill tops. In the valleys, sandy sediments form neosols enriched in nutrients and organic matter. Natural vegetation in the highly fragmentated landscape are Seasonal Semideciduous Forests (IBGE, 2004), above 750 m called Submontane Seasonal Semideciduous Forests (Veloso et al., 1991).

2.2. The Bonner approach: a universal framework for biotope's evaluation

As in Schick (1997) and other frameworks (Bastian and Schreiber, 1999) the five criteria naturalness, rarity and endangerment, substitutability, integrity and importance to the biotope structure are selected to assess the biotic value of each biotope. Each criterion is independently evaluated by its degrees of performance from 0 to 5 points which are summed up to the biotic value ranging from 0 to 25 points. This biotic value is used to classify the biotope in six categories from very low (or no) to national or international importance for the protection and conservation of biotic resources (Table 3).

The criteria "naturalness" describes all actually on-site extractions or inputs of matter or energy and residues remaining in the ecosystem like elevated nitrogen levels after intensive agricultural management (Table 4). The "substitutability" of a biotope consists of two elements: a temporal element (How long does it take to establish the biocenosis completely on a comparable habitat) and a spatial element (How frequent are habitats with the same abiotic conditions in the surroundings, Table 5). "Rarity and endangerment" evaluates the occurrence of rare or endangered biotope types or species and their population sizes (Table 6). To assess this criterion, red data books may be consulted. The criterion "intactness" evaluates the actual situation of the biotope from the four subcriteria relative size, relative species assemblage, relative structural diversity and presence of invasive species, disturbances or other irregularities (Table 7). "Importance to the ecosystem structure" assesses the biotope's importance for populations in surrounding biotope types: evaluated are (1) cross-linking between surrounding biotopes for migrating species or gene drift between separated populations, (2) buffer functions for biotope types sensitive for nutrient input like dystrophic raised bogs, (3) possibilities to hideaway for (nocturnal) fauna and (4) importance for animals using different biotope types for breeding, alimentation or hibernation (Table 8).

2.3. Further evaluation frameworks

The outcomes from the Bonner Approach are compared to biotope's evaluation by three other frameworks.

The IUCN (International Union of Conservation of Nature) uses vulnerability and irreplaceability of populations of rare and endangered species listed by the IUCN Red List to define key biodiversity areas (KBA, IUCN, 2007). The index of naturalness (Machado, 2004) subdivides the criteria naturalness in different sub-criteria (see Tables A.2 and A.4 from the supplement material).