Biodiversity and Conservation
September 2010, Volume 19, Issue 10, pp 2873-2893

Towards an assessment of multiple ecosystem processes and services via functional traits

Abstract

Managing ecosystems to ensure the provision of multiple ecosystem services is a key challenge for applied ecology. Functional traits are receiving increasing attention as the main ecological attributes by which different organisms and biological communities influence ecosystem services through their effects on underlying ecosystem processes. Here we synthesize concepts and empirical evidence on linkages between functional traits and ecosystem services across different trophic levels. Most of the 247 studies reviewed considered plants and soil invertebrates, but quantitative trait–service associations have been documented for a range of organisms and ecosystems, illustrating the wide applicability of the trait approach. Within each trophic level, specific processes are affected by a combination of traits while particular key traits are simultaneously involved in the control of multiple processes. These multiple associations between traits and ecosystem processes can help to identify predictable trait–service clusters that depend on several trophic levels, such as clusters of traits of plants and soil organisms that underlie nutrient cycling, herbivory, and fodder and fibre production. We propose that the assessment of trait–service clusters will represent a crucial step in ecosystem service monitoring and in balancing the delivery of multiple, and sometimes conflicting, services in ecosystem management.

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Biodivers Conserv (2010) 19:2873–2893
DOI 10.1007/s10531-010-9850-9

ORIGINAL PAPER

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Received: 18 November 2009 / Accepted: 31 March 2010 / Published online: 10 April 2010

Abstract Managing ecosystems to ensure the provision of multiple ecosystem services is a key challenge for applied ecology. Functional traits are receiving increasing attention as the main ecological attributes by which different organisms and biological communities influence ecosystem services through their effects on underlying ecosystem processes. Here we synthesize concepts and empirical evidence on linkages between functional traits and ecosystem services across different trophic levels. Most of the 247 studies reviewed

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Keywords Ecosystem functioning · Functional diversity · Indicators · Multitrophic communities · Plant, animal and microbial biodiversity

Introduction

The recent emphasis on ecosystem services as a currency to value ecosystems and promote their sustainable use (Millennium Ecosystem Assessment 2005) has drawn attention to the ways in which different organisms contribute to the delivery of ecosystem services (Kremen 2005; Díaz et al. 2007; Suding et al. 2008; Luck et al. 2009). While the current demand for ecosystem services is growing rapidly (Beier et al. 2008; Loring et al. 2008; Carpenter et al. 2009), uncertainty remains as to how to manage the provision of multiple, and sometimes conflicting, ecosystem services. How these challenges are met will play a major role in determining the ecological, economic, and cultural future of the planet (Bennett and Balvanera 2007).

The ability of an ecosystem to provide multiple services, first, consists in allocating relevant ecosystem properties to each service and identifying which organisms, or groups of organisms, control these properties (Bengtsson 1998; Kremen 2005). Next, it is necessary to identify the key characteristics and mechanisms by which these organisms affect ecosystem properties (Grime 2001; Eviner and Chapin 2003; Hooper et al. 2005; Luck et al. 2009). This task is being undertaken in an increasing number of studies, such as those identifying the functional roles of pollinators (Kremen et al. 2007), particular plant groups as nitrogen fixers (Spehn et al. 2002), soil or sediment engineers (Wardle et al. 2004; Boyero et al. 2007) and different soil microbial and faunal groups (Bailey et al. 2002; Heemsbergen et al. 2004; Wall 2004). Furthermore, empirical studies and syntheses have

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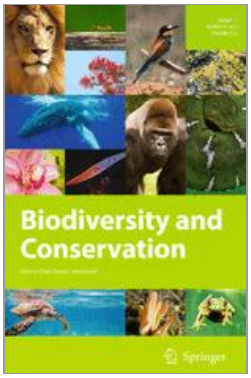

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Biodiversity and Conservation
Volume 19, Issue 10 , pp 2873-2893
Cover Date
2010-09-01
DOI
10.1007/s10531-010-9850-9
Print ISSN
0960-3115
Online ISSN
1572-9710
Publisher
Springer Netherlands
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