Biodivers Conserv (2010) 19:2767–2772
DOI 10.1007/s10531-010-9905-y

ORIGINAL PAPER

Ecosystem services and biodiversity conservation: an introduction to the RUBICODE project

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Received: 19 July 2010 / Accepted: 21 July 2010 / Published online: 1 August 2010

Introduction

The well-being of humans is integrally linked to the well-being of the other species with which we share the planet. There is now wide acceptance that if the current rate of loss of biological resources is continued, the result will be catastrophic for humankind within a few generations. This loss of species and genetic diversity decreases the resilience of ecosystems, but at the same time ecosystems are experiencing growing pressures from drivers such as climate change, land use change, pollution and invasive species. The challenge is to translate these threats to biodiversity into tangible and quantifiable factors which can be used by policy-makers to promote the development of flexible and effective conservation strategies. Increasing knowledge and awareness of the services provided by ecosystems, and the importance of conserving them for maintaining our own quality of life, can help to address this challenge.

Ecosystem services are the benefits that people recognise as obtained from ecosystems. They support, directly or indirectly, their survival and quality of life (modified from the Millennium Ecosystem Assessment 2005). They include provisioning services (e.g. food, fibre and water), regulating services (e.g. climate regulation and water purification), cultural services (e.g. recreation and aesthetic experiences), and supporting services which are needed for the production of all other ecosystem services (e.g. soil formation and nutrient cycling). Research on ecosystem services has grown dramatically since the review of the state of the world's ecosystems and their ability to deliver services that benefit human well-being by the Millennium Ecosystem Assessment (MA) (2005). The RUBICODE project (www.rubicode.net) built on the work reported by the MA to review and advance methodologies for assessing the state of Europe's ecosystem services.

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What is RUBICODE?

RUBICODE (Rationalising Biodiversity Conservation in Dynamic Ecosystems) was a Coordination Action project funded by the European Commission. The main aim of RUBICODE was to provide frameworks for aiding decision-making for biodiversity conservation, taking account of the dynamic nature of ecosystems and constraints due to limited land and other resources. By identifying the importance of biodiversity to the provision of ecosystem services, the project sought to increase understanding of the value of such services and, consequently, the cost of losing them. This will give a more rational base for decision-making and will help the understanding of the need for adequate conservation policies to halt biodiversity loss.

Coordination Action projects aim to achieve improved integration of existing research. Hence, the project consisted of three main activities. The first was to review relevant concepts, methods and results from previous and ongoing projects, the literature, databases, experts and policy documents. The second was to organize workshops to evaluate the concepts and methods, raise awareness and identify gaps in knowledge. Five workshops and one electronic conference were held during the lifetime of the project ranging from an international conference involving around 100 scientists on ecosystem services and drivers of change to smaller workshops involving around 20 stakeholders such as one on integrating the concept with conservation strategies (Table 1). Stakeholders and/or scientific experts from a wide range of backgrounds and disciplines were invited to attend each workshop to promote discussion and consensus. The final activity was to synthesize knowledge from the reviews and workshops, and further develop various concepts, frameworks or strategies to address gaps in knowledge and inform future research needs.

Table 1 The scientific and stakeholder workshops held during the RUBICODE project

Workshop/e-conference	Participants	Date	Location	Workshop outcomes
Workshop on "Assessing and monitoring ecosystems—concepts, policies and indicators"	18 scientists	27 February–1 March 2007	Essen, Germany	RUBICODE (2007)
Workshop on "Linking threats to biodiversity with action in the policy-making process"	18 stakeholders, 11 scientists	15–16 May 2007	Brussels, Belgium	Tinch et al (2007)
Workshop on "Ecosystem services and drivers of biodiversity change"	2 stakeholders 94 scientists	25–28 February 2008	Helsingborg, Sweden	RUBICODE (2008a)
E-Conference on "Ecosystem services and drivers of biodiversity change"	154 contributors	31 March–11 April 2008	–	Grant et al (2008)
Workshop on "Habitat management and conservation policy—strategies for a new dynamic approach focused on ecosystem service provision"	17 stakeholders, 20 scientists	29–30 April 2008	Kranjska Gora, Slovenia	RUBICODE (2008b)
Workshop on "Ecosystem services and biodiversity conservation: knowledge gaps and roadmap for future research"	22 stakeholders, 39 scientists	12–14 January 2009	Leipzig, Germany	RUBICODE (2009)

The RUBICODE approach

The different methodological components of RUBICODE are shown in Fig. 1 together with references to publications in this special issue and elsewhere. The most important and threatened ecosystem services were defined for the main European terrestrial and freshwater ecosystems (agro-ecosystems, forests, semi-natural grasslands, heathlands and shrublands, mountains, soils, rivers, lakes and wetlands). This included a review of relevant terminology (Harrington et al. 2010) and a systematic assessment of the relative importance of different services as well as past trends in their status and human use (Harrison et al. 2010). The delivery of ecosystem services depends in many cases on the maintenance of biodiversity, but specific information on the biological units that provide services is limited. Thus, identifying the organisms and their characteristics that provide services is crucial to developing policies which will protect them, especially as it is likely that key species or groups of species that perform particular ecological functions play a major role in delivering ecosystem services. The concept of "service providing units" (SPU) was explored as a tool to link these species populations, functional groups and ecological communities to the quantification of the services provided to humanity. An SPU is defined as "the collection of individuals from a given species and their trait attributes necessary to deliver an ecosystem service at the desired level" (adapted from Luck et al. 2003, 2009). Data from 64 case studies were gathered to test the concept covering a range of scales from local to regional to global, though local examples were more common as it is easier to recognize service provision and usage at this scale (Vandewalle et al. 2008).

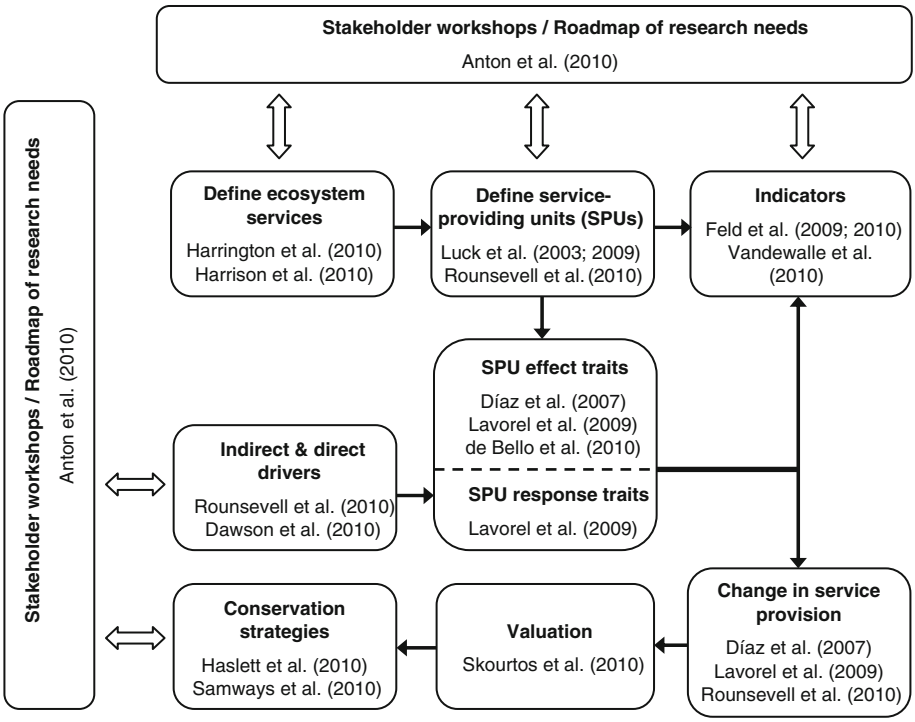

Fig. 1 The methodological components of the RUBICODE project and references to publications

Most ecosystem services are usually provided by more than one type of organism and the identity of suitable organisms varies in time and space. Therefore, it is useful to consider ecosystem service providers in terms of their traits, rather than taxonomy per se. For example, in the case of biocontrol of aphids, insects such as hoverflies, ladybirds and lacewings can be useful. Quantification of the traits present, such as voracity, prey handling time and intrinsic rate of population increase is consequently more informative than quantification of the species themselves. Certain traits will determine the ability of organisms to provide a given ecosystem service (effect traits) and quantitative evidence of links between these traits and service provision was reviewed resulting in more than 500 examples (de Bello et al. 2010). Certain traits will determine the response of organisms to environmental change (response traits). It is likely that, if effect and response traits are the same or are linked in some way, then environmental change will have an impact on the provision of the service (Lavorel et al. 2009).

The provision of ecosystem services in the future will be influenced by multiple and interacting environmental change drivers (Dawson et al. 2010). A new conceptual framework was developed to assess the impacts of indirect and direct drivers on ecosystem services and identify the mechanisms of either mitigation or adaptation that would derive from policy and management responses (Rounsevell et al. 2010). The Framework for Ecosystem Service Provision (FESP) allows comparison across competing services, highlighting the conflicts and trade-offs between not only multiple ecosystem services, but also multiple service beneficiaries. Rounsevell et al. (2010) discuss three examples of how FESP might be applied in practice, whilst Samways et al. (2010) test it against data on the provision of ecosystem services by ecological networks.

Indicators represent a fundamental requirement for monitoring ecosystems and for measuring the success of conservation actions. They also represent an essential tool for communicating complex patterns and processes to decision-makers. Over 500 existing indicators were examined to evaluate their ability to monitor adequately trends in ecosystem services (Feld et al. 2009). Most of the indicators studied assessed trends in biodiversity and habitat quality for monitoring local or sectoral conservation strategies and did not address ecosystem services directly. However, several indicators were identified which are of potential use for monitoring ecosystem services. Particularly promising are biological traits as indicators of regulating and supporting services (Vandewalle et al. 2010). It is critical that indicators that are suitable for their intended purpose are used in monitoring programmes. A framework was designed to assess adequacy of indicator selection against well established criteria and tested with 24 widely used indicators within and across terrestrial and freshwater ecosystems (Feld et al. 2010).

The valuation of ecosystem services is also essential in terms of communicating the importance of ecosystem services and developing effective policy tools. Although methodologies for the valuation of ecosystem services exist, few studies have explored the dynamics of economic values and preferences for services. Information was gathered on how human preferences and values for ecosystem services change through time to address this knowledge gap, and the methods and data necessary to assess these changes accurately were reviewed (Skourtos et al. 2010).

Management and protection of ecosystem services can provide a "value added" strategy to complement and support existing biodiversity conservation efforts. RUBICODE research and discussion with policy-related stakeholders has shown that many present European strategies and policies for biodiversity conservation need changing and adapting to include the elements of ecosystem dynamics and service provision. A framework was developed to highlight relationships between present conservation approaches and the

provision of services in dynamic ecosystems (Haslett et al. 2010). Improving the evidence base will be essential to integrate ecosystem services effectively into sectoral policies and conservation planning. Increased research is needed not only on ecosystem service provision and the factors influencing it, but also on the valuation of ecosystem services and the governance context in which it is embedded (Anton et al. 2010).

Conclusions

The RUBICODE project has collated and reviewed information on ecosystem services for the main terrestrial and freshwater ecosystems in Europe in order to provide frameworks to rationalise biodiversity conservation strategies. This has included information on the current status and trends in ecosystem services and how these may be monitored over time, how biodiversity contributes to service provision, what might happen to services in the future under various drivers of change, how services can be valued in decision-making, and policy and research needs for conserving and managing ecosystem services. The results of the reviews and the frameworks were discussed with the wider scientific and stakeholder communities in five workshops and an e-conference. The results obtained from all these sources are summarised in the papers presented in this special issue.

RUBICODE has highlighted the need to identify the biological units that provide services, how quantitative changes in these service providers impact on service provision and human well-being, and how these changes may interact with ecosystem dynamics, resilience and the functional diversity of service-providing communities. The challenges facing biodiversity conservation management strategies and policy remain considerable. There is an urgent need to incorporate an ecosystem services approach into conservation policy which requires the adaptation of present strategies and policies, a focus on governance and institutions and increased communication and integration across the different policy sectors.

Acknowledgments This work was supported by the RUBICODE Coordination Action Project (Rationalising Biodiversity Conservation in Dynamic Ecosystems) funded under the Sixth Framework Programme of the European Commission (Contract No. 036890). RUBICODE is an endorsed project of the Global Land Project of the IGBP. I would like to thank Pam Berry and Richard Harrington for insightful comments on the manuscript. I am also grateful for the valuable input provided by all RUBICODE partners and associates as well as all stakeholders who participated in the workshops and e-conference.

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