PREFACE

Ecosystem Services: From Biodiversity to Society, Part 2

Ecosystem services (ES) are the natural functions and processes of ecosystems that are of value to humans. By definition, therefore, ES are an anthropocentric concept: humans are the focus of ES (Fig. 1). This means that it is essential to acknowledge the social, economic and ecological systems within which individuals and human societies are embedded, in order to fully apply the concept of ES. Given the ubiquity these socioeconomic–ecological interrelationships across the globe, the ES framework has almost universal potential and its importance in policymaking is growing. Nonetheless, ES and the way the concept is sometimes applied (e.g. the commodification or monetarisation of nature) are still viewed with caution by many, especially those who see it as a threat to the traditional conservation goals of maximising biodiversity. Even now, a full decade after the publication of the Millennium Ecosystem Assessment (MEA 2005), which catalysed the field, there is surprisingly little empirical data that bring together social, economic and ecological thinking about ecosystems, and much of the theory is similarly embryonic.

This two-part volume of *Advances in Ecological Research* opened with an overview of the major trends in the field and the remaining challenges that need to be addressed since the publication of the MEA in 2005. Although ES had been studied before the MEA, under a variety of different names or from somewhat different perspectives, it was with the MEA that the field really took off. The number of papers on ES has been growing since then, with ES accounting for an ever-larger slice of the total number of papers published in ecology journals (Fig. 2). As attested by the papers published, including those assembled here, the term ES is often used loosely, rather than being strictly limited to studies that explicitly consider humans. This might partly explain why the growth of ES has outstripped the related and more established fields related to ecosystem processes (EP) or functioning (EF), through a rebadging of more traditional EP and EF research under the ES moniker, as well as "genuine" new ES research. The idea that ecosystems provide things of value to humans is hardly new, but the formalisation of these concepts into a (more) unified framework (QUINTESSENCE Consortium, http://dx.doi.org/10.1016/j.tree.2015.12.003) and the strong links to emerging environmental legislation represent a fundamental shift in

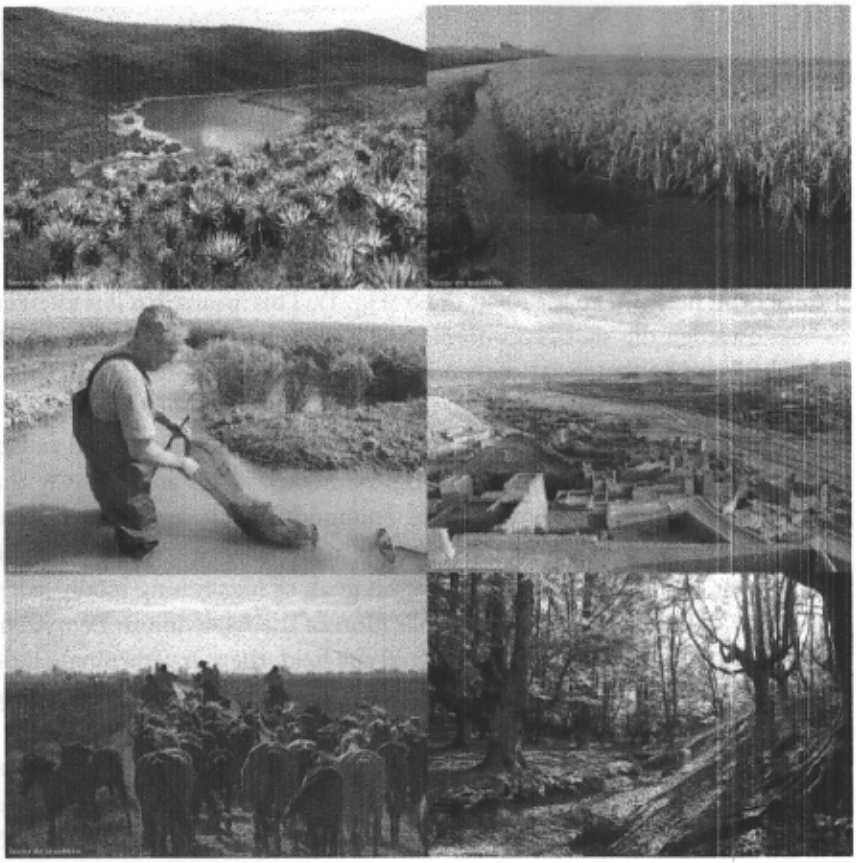

Figure 1 Examples of human-modified ecosystems and the services they provide. *Images courtesy of I. Palomo.*

how humans are now recognised as being integral to nature, rather than somehow set apart.

The papers in the volume are arranged in a sequence of increasingly broader scope and scale, from those focused on understanding how human activities can alter local biodiversity and ecosystem processes that ultimately support, deliver and modulate services, through to those that move deeper into the more complex territory where the natural and social sciences overlap. Our aim was to show how these studies lie on a continuum and that ES can permeate all levels of biological organisation, influencing socioeconomic–ecological systems both directly and indirectly.

One theme that emerges throughout the volume is the need to move towards a more unified framework, to develop a clear, unambiguous shared

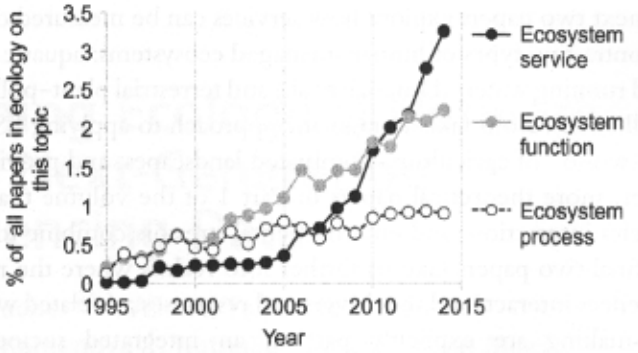

Figure 2 Trends in ES publishing in peer-reviewed journals over the past two decades spanning the publication of the MEA in 2005. Searches were undertaken using Web of Science for the topics "ecosystem service", "ecosystem function" and "ecosystem process" within the category "ecology" and the results were compared to the number of papers in that category published between 1995 and 2014 inclusive.

lexicon and also, where possible, analytical approaches. This may be done by applying network-based approaches, which are powerful tools for coping with complex systems having multiple drivers, responses and entities that interact with one another—whether these are species in a food web, humans in a farming cooperative or banks within an economic system. This is of course just one of many potential ways of studying ES, but given the multivariate and multidisciplinary nature of the field—and the fact that network theory has already developed in parallel, but largely independently, within each of these disciplines—it represents a promising extension and integration of existing tools that could help provide the more coherent approach we need.

The second part of this volume opens with a paper by Vacher et al. examining the whether next generation sequencing, molecular approaches and synthetic learning methods might, in combination, be used to reconstruct networks of interaction, ultimately for rapid and robust biomonitoring and evaluation of ES. Empirical and analytical methods, built on theory, that can feed into ES studies are increasingly necessary in this field that continues to be hampered by a shortage of good quality data and transferable methods with which to test and validate hypotheses objectively. This methodological line continues with Pocock et al., who review how network-based data and the developing field of ecological visualisation of complex systems can be brought together to facilitate communication and to act as tools to improve engagement, advocacy and ES management.

The next two papers explore how services can be measured on the ground in contrasting types of human-managed ecosystems: aquatic food webs in upland running waters (Durance et al.) and terrestrial plant–pollinator systems (Gill et al.). Both take a pragmatic approach to applying ES theory in the "real world" of agriculture-dominated landscapes, and provide links to the earlier, more theoretical papers in Part 1 of the volume that explored how species interactions and environmental stressors combine to affect ES.

The final two papers take us further into realms where the natural and social sciences interact, and the drivers and responses associated with human decision-making are explicitly part of an integrated socioeconomic–ecological system. Butterfield et al. consider the role of trade-offs among different ecosystem services, and how these are modulated by biological, physical and economic drivers. Palomo et al. focus on the role of human social behaviour both in shaping and being shaped by ecosystem services, stressing the importance of co-production in the development of decisions. This represents an important and fundamental shift in how we view the place of our own species within natural systems, with far-reaching implications for how we need to approach sustainable management of natural systems in the future.

The 12 chapters in this two-part volume provide a snapshot of ES research: illustrating the current state of the art and spanning a full spectrum from developing a mechanistic understanding of the biological processes that ultimately deliver services, through to the implementation of policies designed to optimise service delivery. There is clearly much work to be done, but this volume offers an important step towards developing the next generation of approaches that we will need to ensure humanity remains within a "safe operating space" in a more sustainable future.

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