Taking a Functional View of Ecosystems

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be used to allow conservation biologists to better design parks and nature preserves in order to protect endangered species?

Transferring theory to applied science is often difficult to do, as is illustrated by the recent SLOSS controversy. SLOSS is an acronym for "single large or several small," and refers to the rather hotly contested debate between ecologists Jared Diamond and Daniel Simberloff as to whether conservation districts should be designed as single, large areas or as several smaller units. Diamond, and other ecologists who draw from MacArthur and Wilson's predictions on the relationship between species diversity and the size of islands, argue for preserves to be as large and as contiguous as possible, for only in large areas could at risk species find enough habitat to survive. In an ironic twist, Daniel Simberloff, who as a graduate student helped to validate the species-area relationship predicted by the MacArthur-Wilson model, argues just as forcefully that other factors besides just sheer area can be, and often are, more important in sustaining specific species. Relying on accumulating only large packets of land for preservation, he argues, might be a politically difficult thing to do, and as a result, species which might otherwise be saved might be lost forever.

By the late 1970s ecologists began to ask not only what the "minimal viable population" of a species might be, but also, did it differ from one species to another. Taking into consideration not only demographic, but the genetic aspects of uncertainty, workers such as Ian Franklin and Michael Soulé quantitatively showed how genetic variation is lost in small populations to the detriment of both their short-term and long-term survival. Known as "the 50/500 rule," they predict the minimal population size for short-term avoidance of inbreeding depression to be 50 individuals, while a population of 500 individuals is needed to maintain long-term adaptability in the species. While criticized by some as overly simplistic, the thought of determining species' minimal population sizes created new interest in the emerging field of conservation biology. Indeed, it was Soulé, along with graduate student Bruce Wilcox, who organized the First International Conference on Conservation Biology in 1978. It is clear from the papers that the participants presented at this conference that *The theory of island biogeography* had played a major role in providing the theoretical basis for this new science.

Interspersed in this 700-page-plus volume are personal accounts of adventures to far-flung places around the globe. One is treated to first-hand accounts of Komodo dragons and Madagascan indris, both small populations endemic to their namesake islands, and both in danger of extinction. One also travels with the author in an unsuccessful search of thylacines, better known as Tasmanian tigers. Last seen in 1936, these creatures still evoke an almost mythic hold on the imaginations of many on that island. Accounts of how chuckwallas, honeycreepers, giant tortoises, and, of course, dodos, have all been pushed to and beyond the edge of extinction provide evidence for the interplay among habitat size, rarity, and extinction. The most compelling story that Quammen tells, however, is that of the Tasmanian aborigines, who in an eerily similar fashion to the dodo, were hunted, herded, and eventually forced into extinction.

Some weaknesses do present themselves. Fewer examples would have made the point just as well and some sections could have been shortened or omitted. A few examples of needless coarse language stand out. Nevertheless, this is a book which once begun is hard to put down. The movement from historical perspective to personal narrative to scientific explanation works well, and the author clearly demonstrates his mastery of the subject. Indeed, the book's strongest asset is the integration of science, personality, and history that it provides to the reader. This book should be read by all students and professionals interested in the preservation of biodiversity, for it provides an historical perspective for much of the current thinking in this field. *The song of the dodo* is not just about extinction. Rather, it is about how the science of island biogeography and its successor, conservation biology, will allow us to hopefully solve one of the most serious ecological problems of our day.

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TAKING A FUNCTIONAL VIEW OF ECOSYSTEMS

Smith, Thomas Michael, H. H. Shugart, and F. I. Woodward, editors. 1997. **Plant functional types: their relevance to ecosystem properties and global change.** International Geosphere-Biosphere Programme Book Series. Volume 1. Cambridge University Press, New York. xiv + 369 p. $80.00 (cloth), ISBN: 0-521-48231-3; $44.95 (paper), ISBN: 0-521-56643-6.

The complexity of natural ecological systems presents challenges for predicting the impact of global environmental changes on ecosystem structure and function. In recent years, there has been a move to develop functional, rather than phylogenetic, classifications of organisms to simplify systems and better understand their present and future dynamics. The demand for functional groupings of organisms has further increased since the emergence of global ecology. We are often required to reduce biological diversity in order to extrapolate from the mostly local scale of ecological investigation to regional and global scales. There has, however, been a noticeable lack of consistency in the application of functional groupings to current ecological studies. For this reason, *Plant functional types* comes at a welcome time, and I began to read it with considerable interest. The editors have gathered together an impressive and diverse array of authors and subjects, and the book certainly considers many of the current

issues surrounding plant functional types. Ultimately, though, the cohesive framework that I was seeking was not fully addressed, and I was left feeling unsatisfied.

Plant functional types is the product of a workshop held in 1993 as part of the Global Change and Terrestrial Ecosystems (GCTE) project, and the book focuses on one of the GCTE core objectives dealing with "change in ecosystem structure." A primary goal of the book is to develop and evaluate ways of grouping organisms into functional types so that we can predict vegetation responses to novel environmental perturbations. The book is structured around five sections that clearly outline many of the key issues relating to plant functional classifications.

The first part of the book focuses on definitions and provides a historical background to the concept of functional groupings in ecology. The second section contains a series of chapters addressing approaches and limitations to developing functional classifications. The contrasts between different approaches are effectively highlighted. Some authors (e.g., Woodward and Kelly, Hobbs) advocate a deductive approach, where functional types are derived from an a priori statement of which species' characteristics or ecosystem properties are most important. Others (e.g., Westoby and Leishman, Grime et al.) take a data-dependent view, using multivariate techniques as an objective way to derive groupings. In the third section, chapters evaluate the usefulness of plant functional groupings for particular world ecosystems (e.g., arctic tundra, fynbos, and semi-arid grasslands). Many of these chapters are among the best in the book, with authors often using their own knowledge and research on a specific system to address more general issues about the value of functional groupings. Chapters by Shaver et al., Reynolds et al., and Sala et al. use functional groups effectively in mechanistic models of ecosystem dynamics. The penultimate section of the book looks at the application of functional classifications to global vegetation models, and the final part of the book critically considers the use of plant functional types in ecological research. I thought that Smith's chapter in this last section was particularly insightful, as he tests the sensitivity of the forest dynamics model, ZELIG, to different groupings of the component species. This kind of analysis could be extended further in the future as an objective method of evaluating a particular functional classification.

Given the increased use of functional groupings in ecosystem dynamics, it is important to clearly define the terms adopted and provide a coherent setting for future work. In this case, clarifying our vocabulary may be the key to developing a conceptual framework. Unfortunately, the book does not achieve this goal. It assumes that the terminology surrounding functional types is now well-established in the ecological literature, when in reality we have little idea what functional type means. This disparity is noticeable from the lack of cohesiveness in authors' use of terms (e.g., plant vs. vegetation vs. ecosystem functional types). In the final chapter, this ambiguity in usage is acknowledged, but little is done to remedy the situation. Gitay and Noble's introductory chapter makes the best attempt at clarification by surveying the vast array of terms that have historically been used in functional classifications, but still does not go far enough. They demonstrate that there is an incredible lack of consistency in terminology and provide their own hierarchical arrangement of terms. It seems, however, the main cause of ambiguity is the context in which terms are used—an issue brought up repeatedly in many of the chapters.

The need to clarify context is highlighted by the fact that the term functional type is currently being used in two very different ways in the literature (Catovsky, S. 1998. Functional groups: clarifying our use of the term. *Bulletin of the Ecological Society of America* 79:126–127). One meaning focuses on species that respond in a similar way to environmental perturbations, while the second usage groups together species that have similar effects on ecosystem-level processes. Most chapters in the book only refer to one of these uses, with only a few authors (Walker, Shaver et al., Sala et al.) acknowledging both meanings. Many of the differences in usage are related to geography, with U.S. researchers often grouping species with regard to their ecosystem-level effects and others (mostly European) primarily addressing response groups. My unease is not merely a semantic one—the basic framework for utilizing plant functional types requires a clear assessment of terminology and meaning.

These inconsistencies, however, should not mask the value and timely nature of *Plant functional types.* The book outlines the current state of our knowledge about the use of functional classifications in global change research, and represents a useful reference point upon which future work can build. Researchers and students of global change biology should delve into the book to discover more about the way the field is developing. We can then all contribute to improving the rigor of the discipline in an informed and educated manner.

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WARMING UP TO ARCTIC ECOLOGY

Woodin, Sarah J., and Mick Marquiss, editors. 1997. **Ecology of Arctic environments.** Special Publication Number 13 of the British Ecological Society. Blackwell Science, Malden, Massachusetts. vi + 286 p. $75.00, ISBN: 0-632-04218-4.

This multi-authored volume grew out of a symposium in 1995 to pull together knowledge of the Arctic as the pace of scientific research quickens in the face of possible high-latitude climate change. With 25–33% of the planet's soil carbon locked up in northern ecosystems which cover 14% of Earth's land surface (Oechel et al.'s chapter), such research may help