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ECOSYSTEMS

SPATIAL VARIABILITY IN ECOSYSTEM FUNCTION

Introduction to Special Feature

Ecosystem processes vary spatially in response to many factors. For example, productivity, decomposition, and nutrient cycling vary spatially with temperature gradients, precipitation patterns, and topographic relief. In our opening editorial for the inaugural issue of *Ecosystems* (Turner and Carpenter 1998), we identified a number of frontiers in ecosystem science for which we hope to see both progress and synthesis unfold within the journal. One of these frontiers was the ongoing need to enhance our understanding of spatial heterogeneity in ecosystem function. We wrote,

> Just how spatially variable are ecosystem processes? How do the controls on processes and rates operate across space? Are there thresholds in rates beyond which qualitative shifts in processes occur? Despite tremendous advances in understanding ecosystem processes in relatively small study areas, little theory exists for predicting variability in ecosystem processes across broader spatial scales. This is a subject ripe for development.

To demonstrate and foster progress toward answering these challenging questions, we invited a set of articles that illustrate current understanding of spatial variability in ecosystem function. Recent research in ecosystem science has indeed expanded to consider spatial heterogeneity, with studies focusing on topographic or regional variation in nutrient cycling processes, spatial variation in evapotranspiration and leaf area, the transport of materials between terrestrial and aquatic ecosystems, and spatial interactions among the plants, animals, and nutrient cycling. Whereas the following articles by no means cover the full spectrum of ecosystem or landscape types, they do exemplify a range of approaches and syntheses by using oceanic, lake, riparian, grassland, and forest ecosystems.

Platt and Sathyendranath address the very broad spatial extent of the oceanic ecosystem. They suggest an operational definition of spatial structure within the ocean that recognizes that the boundaries between areas characterized by common physical forcing are not fixed. Soranno and others present a geographically extensive comparison of lake ecosystems to identify and explain natural variability among lakes as a function of their position in the terrestrial landscape. Walters and Korman focus on riparian ecosystems, which are conspicuous elements of many landscapes and important mediators of land–water interactions. They address the development of policy-relevant models that include dynamic effects that may cause broad-scale and long-term impacts. Burke and colleagues examine the relative importance of topography, grazing, plant species composition, and microsite characteristics in controlling the spatial variability of soil organic matter in shortgrass steppe ecosystems. Finally, Pastor and others use spatially explicit models that link seed dispersal, mammalian browsing, and nutrient cycling to address the causes of spatial pattern in the boreal forest.

Determining the spatial patterns of variation in ecosystem processes and the causes and effects of that heterogeneity are important current topics in ecosystem and landscape ecology. Our science lacks a well-developed theory of ecosystem function that is spatially explicit, nor do we have a wealth of empirical studies from which to infer general conclusions. The following articles nicely demonstrate the kinds of insights that will contribute to a more general understanding of spatial heterogeneity in ecosystem function. We hope that they also stimulate additional research and look forward to seeing further progress in this important area unfold within *Ecosystems*.

Monica G. Turner
Co-Editor in Chief
Ecosystems
Department of Zoology
University of Wisconsin
Madison, WI 53706
USA

Stephen R. Carpenter
Co-Editor in Chief
Ecosystems
Center for Limnology
University of Wisconsin
Madison, WI 53706
USA

REFERENCE

Carpenter SR, Turner MG. 1998. At last: a journal devoted to ecosystem science. Ecosystems 1:1–5.