

# Foreword

Among the most difficult problems in the life sciences is the challenge to understand the details of how ecosystems/watersheds/landscapes function. Yet, the welfare of all life, not just the human species, depends upon the successful functioning of diverse and complicated ecosystems, each with various dimensions and compositions. Central to this “working” is the dominance, and to a major extent control, of ecosystems by organisms, which means that these systems are constantly changing as the component organisms change and evolve. Such changes increase the challenge to understand the functioning of ecosystems and landscapes. Moreover, understanding the interactions among the myriad components of these systems is mind-boggling as there are scores of biotic (probably many thousands of species when the microbial components are fully enumerated through genomics) and countless abiotic (ions, molecules, and compounds) entities, all simultaneously interacting and responding to diverse external factors to produce functional or dysfunctional environments for life.

This book focuses on the problems of connectedness and ecosystem functioning. It is difficult enough to understand how an ecosystem functions when it is considered in isolation, but all ecosystems are open and connected to everything else. Clearly, the inputs to any ecosystem are the outputs from others and vice versa, and as such the fluxes represent major, if not critical, points for managing or changing the overall functioning of an ecosystem or landscape. A major challenge is to find appropriate conceptual frameworks to address these complicated problems. Understanding spatial heterogeneity is now recognized as one of the most significant aspects of this challenge. However, because ecologists have ignored spatial heterogeneity for so long, there is a pressing need to integrate it into their studies, theories, and models. With new frameworks and tools, ecology is now poised to make important strides forward in the focused study of heterogeneity from an ecosystem and landscape perspective. Ecology has accepted the

challenge of understanding these complicated systems overall, and is making good progress toward doing so. Such knowledge is vital to guide conservation initiatives, sustainable management, mitigation of environmental impacts, and future breakthroughs in understanding.

With funding from The Andrew W. Mellon Foundation, the Institute of Ecosystem Studies (IES) launched a study of "*Ecosystem Function in Mosaic Landscapes: Boundaries, Fluxes, and Transformations*" in 1999. We proposed that our research would advance the understanding of how heterogeneity influences ecosystem function by:

- "1) rigorously assess[ing] the degree of ecosystem heterogeneity at different scales . . . ;
- 2) determin[ing] how ecosystem heterogeneity affects long-term change in the mosaics of which they are a part;
- 3) focus[ing] on the role of boundaries between and within ecosystems in governing ecosystem function; and
- 4) discover[ing] how fluxes across mosaics affect the organismal, material, and energetic transformations [within and among] ecosystems."

The 2003 Cary Conference, "Ecosystem Function in Heterogeneous Landscapes," addressed many of these challenges and the results are brought together in this book. Cary Conferences, started at IES in 1985, have identified and addressed such major "cutting edge" questions and challenges in an effort to provide leadership in the field. This Conference was no exception.

With the leadership of Drs. Lovett, Jones, Turner, and Weathers, the authors of this volume have brought their diverse talents and experiences to bear on the topic of how interactions among ecosystems affect not only their own functioning, but the function of the larger landscape or region in which they are embedded, and have done so in new and enlightened ways. By evaluating the linkages at different scales, the authors of this volume have progressed toward building the "suspension bridge" between ecosystem and landscape ecology, a major goal of the editors of this volume.

There is an important need for revised models, conceptual as well as mechanistic, that will allow ecologists to bring the many aspects of heterogeneity together under one framework. As ecologists continue to develop these new frameworks for understanding how ecological systems function, the ideas put forward in this book hopefully will catalyze new studies that will lead to a more synthetic and unified understanding of heterogeneity, and in the process, a greater understanding of how ecosystems and landscapes "work."

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