

# A Decade of Ecosystems

Stephen R Carpenter,<sup>1,\*</sup> and Monica G. Turner<sup>2</sup>

<sup>1</sup>Center for Limnology, University of Wisconsin, Madison, Wisconsin 53706, USA; <sup>2</sup>Department of Zoology, University of Wisconsin, Madison, Wisconsin 53706, USA

Ten years ago, *Ecosystems* was introduced as a “substrate for primary succession of the discipline” (Carpenter and Turner 1998). We envisioned *Ecosystems* as an arena for new ways of thinking and new kinds of progress in ecosystem science. We suggested four frontiers that seemed particularly important at that time. “People and ecosystems” addressed the study of social-ecological systems, including pressing issues of sustainability. “Spatial dynamics and scale shifts” was concerned with expanding the range of spatial scales considered by ecosystem scientists and improving conceptual and empirical tools for understanding spatially structured processes. “Cross-disciplinary linkages” have frequently stimulated progress in ecosystem science, and we encouraged contributors to *Ecosystems* to embrace linkages among the subdisciplines of ecology, among natural sciences, and across social and natural sciences. “Temporal scale interactions” involved feedbacks of slow and fast variables, disturbance regimes, thresholds and ecosystem surprises.

The first year of *Ecosystems* showed reasonable balance among the four frontiers (Turner and Carpenter 1999a, b, c). Spatial dynamics and scale shifts were best represented of the four frontiers. Vigorous hybrids of landscape and traditional ecosystem ecology continue to be a major growth area for science that is strongly represented in the pages of *Ecosystems*. The journal’s first year coincided with publication of an important assessment of ecosystem science from the seventh Cary Conference (Pace and Groffman 1998a, b). That volume (Pace

and Groffman 1998a) stressed the need for greater integration among the subdisciplines of ecology, and of ecology with other disciplines, to invigorate the science and address the “rising tide of human-accelerated ecological change” (Pace and Groffman 1998b). We were pleased by the high frequency of synthetic papers in the first volume of *Ecosystems* (Turner and Carpenter 1999a, b, c).

Now, with 9 full volumes in print and volume 10 well underway, we re-visit the frontiers we identified in our inaugural editorial. Has *Ecosystems* fulfilled its mission to address those frontiers? How is the field progressing? Have the frontiers been assimilated in the routine practice of ecosystem science? Are new frontiers discernible? Here we take a quick look at these questions using the 20 most-cited papers from *Ecosystems*, based on Web of Science data from December 2006. A future Special Feature will examine these questions in greater depth through a series of invited commentaries.

Spatial dynamics and scale shifts are a strong component of the contents of the journal, with three of the four most-cited papers reflecting this line of inquiry. The most highly cited article (Gustafson 1998) evaluated approaches used for landscape pattern analyses, providing readers with an entrée to this field and arguing effectively for appropriate use and greater integration of methods based on categorical maps and point data. Spatial dynamics related to disturbance and land use are in the second and fourth most-cited papers (Foster and others 1998a, b; Peterson and others 1998) and among the top 20 papers (Foster and others 1998, b; Paine and others 1998; Turner and others 1998; Wear and Bolstad 1998). Scale questions are addressed in many of these. For their novel spatially explicit forecasts of changes in land use and building density in the Southern Appalachians,

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\*Corresponding author; e-mail: srcarpen@wisc.edu

Wear and Bolstad (1998) also received the best publication award from the US chapter of the International Association for Landscape Ecology. Clearly, the merger of landscape and ecosystem ecology is of great interest to our authors, people who cite our papers, and presumably our readers. This merger is becoming more common, but it is not yet routine. In particular, the functional implications of spatial heterogeneity for many ecosystem processes are still poorly understood. A Special Feature in *Ecosystems* focused on this topic (Turner and Carpenter 1999a, b, c), as did a recent Cary Conference (Lovett and others 2005), but much remains to be uncovered by future research. Similarly, despite widespread recognition in ecology of the importance of scaling, understanding scale shifts still poses a formidable challenge to ecosystem and landscape scientists. A forthcoming special feature addresses cross-scale interactions and ongoing progress in this area (Peters and others 2007). On the whole, we see sustained interest in and opportunities for spatial dynamics and scale shifts to remain prominent in the pages of *Ecosystems* in the coming decade.

Temporal scale interactions are also represented in the most cited papers. For example, decadal changes in biogeochemistry of the North Pacific Ocean (Karl 1999) and temperate forest (Goodale and others 2000; Magill and others 2000) were subjects of well-cited papers. Paine and others (1998) addressed the multiple causes of massive temporal change. Many papers about temporal change are also about spatial dynamics (for example, Peterson and others 1998; Foster and others 1998a). Evidently ecologists frequently consider spatial heterogeneity, disturbance regimes, and other aspects of spatial ecology to be key factors in long-term change. We look forward to seeing more studies that deal explicitly with the integration of spatial and temporal dynamics in ecosystem ecology in *Ecosystems*.

Some highly cited papers are principally about mechanisms of ecosystem or landscape processes. Walker and others (1999) investigate the role of rare species in resilience of ecosystem processes. Carpenter and others (2001) point out that conclusions about resilience of social-ecological systems follow from definitions of key components, scales and processes, so changing perceptions of resilience are often a result of changing the question rather than changing the data. Inferences from whole-ecosystem experiments were addressed by Schindler (1998). Insights about ecosystem function from whole-lake biomanipulation programs were evaluated by Hansson and others (1998). Canadell and

others (2000) used multiple methods to assess carbon metabolism of earth's terrestrial ecosystems. The role of life histories in marine pelagic food web dynamics were studied by Walters and others (2000). Ehrenfeld (2003) analyzed the effects of exotic plant invasions on soil nutrient cycles.

While the roles of humans in ecosystems are implicit in many of the most-cited papers, some of these papers focus explicitly on functioning of social-ecological systems. Levin (1998), Carpenter and others (2001), and Holling (2001) address conceptual frameworks for understanding social-ecological systems. Wear and Bolstad (1998) use individual human decisions as a basis for understanding and forecasting land-use change in the southern Appalachians. In the future we would like to see more papers about social-ecological systems on the pages of *Ecosystems*.

Integration and synthesis and conceptual development are well represented in the papers mentioned above and many other papers in *Ecosystems*. We mention only a few well-cited examples. Levin (1998) wrote a concise explanation of complex adaptive systems theory and its relevance for understanding the biosphere. A novel model for understanding water and biogeochemical flows in stream corridors was introduced by Fisher and others (1998). Holling (2001) provided a summary of panarchy theory.

So where have we been, and where are we going? Clearly, the first decade of *Ecosystems* has established some dominant themes, although not all papers fit easily within our four frontiers. Spatial dynamics is in vigorous flower as a branch of ecosystem science, and there are myriad opportunities for novel insights to be gained as studies continue and mature (Turner and Carpenter 1999a, b, c; Peters and others 2007). Temporal scaling is an important theoretical issue that is increasingly integrated with spatial thinking; perhaps new theory that better integrates space and time will emerge and help shape future studies (Carpenter and Turner 2000a, b). Studies of social-ecological systems are beginning to blossom. Several Special Features in *Ecosystems* have attempted to bridge social and ecological science, addressing topics such as interdisciplinarity (Turner and Carpenter 1999a, b, c), economic valuation of ecosystem services (Carpenter and Turner 2000a, b), critical intellectual challenges for addressing environmental problems (Kinzig 2001), scenarios for future ecosystem services (Bennett and others 2005), and resilience of social-ecological systems (Carpenter and others 2005). Yet papers that integrate social and ecological science are not yet common on the

pages of *Ecosystems*. We hope that future papers will build on the foundation that is developing for interdisciplinary science. Across all branches of ecosystem science, integrative, conceptual thinking is well developed, and we are proud of the conceptual papers published in *Ecosystems*. Creation of productive concepts seems to require special encouragement and nurturing. We hope to continue providing in *Ecosystems* a seedbed in which new ideas can germinate and grow.

There have been bumps along the way. Perhaps our greatest challenge was to re-establish the rapid time to publication that characterized our first several years, and in which we took pride, that eroded as submissions climbed. The bottleneck that we experienced was successfully alleviated by tightening up the acceptances and receiving an increased page budget from the publisher. We are pleased to have returned to a reasonable time to publication (currently 4–5 months after acceptance) and will strive to maintain this. The challenge faced by all journals, including *Ecosystems*, is to remain open to the truly novel while maintaining high selectivity. Papers that challenge existing conventions and may potentially change the direction of a field may be reviewed more critically than papers that are technically excellent but not particularly novel.

In terms of geographic and international representation, the editorial board members and authors represent a diverse group. Nonetheless, we still receive more submissions from scientists in North America, Australia and Europe than from other locations worldwide, and the 20 most highly cited papers reflect this trend (13 USA, 4 Canada, 2 Australia, 1 Sweden, based on first authors). We have encouraged and will continue to seek increased international representation of research within *Ecosystems*, and we hope that ecosystem scientists worldwide will consider submitting their most important papers to the journal.

Ecosystem science is inherently interdisciplinary and collaborative, so it is not surprising that most papers in *Ecosystems* are multi-authored. The topic of author accountability and communication among collaborators who contribute to a scientific publication is being discussed in many disciplines, including ecology (Weltzin and others 2006). In the near future, we will alter *Ecosystems'* Instructions to Authors to ask for a brief description of the contributions of each author. Other journals that publish many multi-author papers, such as *BioScience* and *PNAS*, now request such information. Authors will be asked to indicate how they contributed to the study being presented in a brief note

that will appear at the bottom of the title page with the contact information for authors. For example, the footnote for this editorial might read “SRC and MGT jointly outlined the contents, SRC compiled citation statistics and wrote the first draft, MGT edited the draft and wrote additional material.”

The success of *Ecosystems* in its first decade rests on the shoulders of many people, and perhaps foremost among them is Suzann McClenahan, Managing Editor. Board members and authors alike routinely acknowledge her effectiveness, professionalism and consideration—and we would not be where we are today without her invaluable contributions. We also have had the benefit of truly outstanding scientists who have been willing to serve on our Advisory and Editorial Boards during the past 10 years. They have been consistently conscientious, exercising good judgment and providing thoughtful and well-considered guidance to us and to our authors. Their job is not always easy, and again, we thank each and every one. We simply could not do it without you. The editors and production staff at Springer have been supportive throughout, and we also thank the numerous scientists who have submitted their work and reviewed submissions for *Ecosystems*. We look forward to working with all of you in the future.

Ecologists seem to be using *Ecosystems* more than ever. Submissions and citations are growing. We hope that the topics covered in the journal will continue to diversify, reflecting the vigor, expansion and aspirations of our discipline.

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