PART I

Introduction

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Perspectives and prospects of landscape ecology

1.1 Introduction

Landscape ecology has rapidly established itself as an interdisciplinary research field worldwide in the past few decades. However, diversification in perspectives and approaches has apparently caused some concerns with the "identity" of the field in recent years. For example, Wiens (1999) stated that "landscape ecology continues to suffer from something of an identity crisis," while Moss (1999) warned that landscape ecology's "healthy, youthful development will be cut off before it matures if it does not recognize and develop its own distinctive core and focus." As landscape ecologists, we feel that we should not be particularly worried about the identity or the fate of the field. Its identity is to some extent self-defining through the activities that people calling themselves landscape ecologists undertake, and its fate will be determined by its utility and its ability to provide techniques, approaches, and applications which help tackle the complex environmental management challenges facing humanity. However, we do think that, after two decades of rapid developments in both theory and practice, landscape ecology can benefit from a forward-looking introspection.

For example, several questions may be asked to address some of the concerns and challenges this field now faces. What is the identity of landscape ecology that it is losing or that has never been established? Given the multidisciplinary origins and goals of the field, is it possible for landscape ecology to have "its own distinctive core and focus?" If so, what would it be? How should we solidify the interdisciplinarity or transdisciplinarity of landscape ecology? These are grand questions whose answers may be still quite elusive. Thus, this book is not intended to provide all the answers. Rather, it addresses a series of key issues

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and perspectives in contemporary landscape ecology identified by a group of leading scientists around the world. By closely examining these key topics, we hope that this book will contribute to the development of landscape ecology, and help resolve the grand questions posed above.

1.2 Key issues and research topics in landscape ecology

The chapters in this book were collected together to explore a set of key issues synthesized by Wu and Hobbs (2002) from a symposium which sought to draw out from leading landscape ecologists what these issues were. Many ideas from the group of 17 people was condensed to a long list of items (Table. 1.1), from which Wu and Hobbs (2002) further identified six key issues to be considered: (1) interdisciplinarity or transdisciplinarity, (2) integration between basic research and applications, (3) conceptual and theoretical development, (4) education and training, (5) international scholarly communication and collaborations, and (6) outreach and communication with the public and decision-makers.

Wu and Hobbs (2002) also identified ten key research areas dealing with these issues: (1) ecological flows in landscape mosaics, (2) causes, processes, and consequences of land use and land cover change, (3) nonlinear dynamics and landscape complexity, (4) scaling, (5) methodological development, (6) relating landscape metrics to ecological processes, (7) integrating humans and their activities into landscape ecology, (8) optimization of landscape pattern, (9) landscape conservation and sustainability, and (10) data acquisition and accuracy assessment.

The chapters in this book collectively cover most of these issues and research areas. The subject matter varies from questions regarding the collection and analysis of data for use in landscape ecological studies, through the intersection between landscape ecology, ecosystem ecology and conservation biology, to the broader application of landscape ecology in complex social–ecological systems in inter- and transdisciplinary settings. Hence this book provides a microcosm of the current state of play in landscape ecology: a lot of activity in the area of acquiring and interpreting spatial ecological data and an equivalent amount of effort in the broader aspects which interface ecology with management and planning.

There has been a lot of introspection in landscape ecology about what the subject is all about. It is apparent from the chapters in this book that this is still evident. In the subject as a whole, there seems to be something of a schism between the more biophysically oriented school and the arm that deals with the interface between science, planning and management. The first sees landscape ecology primarily as a means of dealing with spatial patterning and

TABLE 1.1. *A list of major research topics in landscape ecology based on suggestions by a group of leading landscape ecologists from around the world at the 16th Annual Symposium of the US Regional Association of the International Association for Landscape Ecology, held at Arizona State University, Tempe in April 2001*[a]

Development of theory and principles
- Landscape mosaics and ecological flows
- Land transformations
- Landscape sustainability
- Landscape complexity

Landscape metrics
- Norms or standards for metric selection, change detection, etc.
- Integration of metrics with holistic landscape properties
- Relating metrics to ecological processes
- Sensitivity to scale change

Ecological flows in landscape mosaics
- Flows of organisms, material, energy, and information
- Effects of connectivity, edges, and boundaries
- Spread of invading species
- Spatial heterogeneity and ecosystem processes
- Disturbances and patch dynamics

Optimization of landscape pattern
- Optimization of land-use pattern
- Optimal management
- Optimal design and planning
- New methods for spatial optimization

Metapopulation theory
- Integration of the view of landscape mosaics
- Integration of economic theory of land-use change and cellular automata

Scaling
- Extrapolating information across heterogeneous landscapes
- Development of scaling theory and methods
- Derivation of empirical scaling relations for landscape pattern and processes

Complexity and nonlinear dynamics of landscapes
- Landscapes as spatially extended complex systems
- Landscapes as complex adaptive systems
- Thresholds, criticality, and phase transitions
- Self-organization in landscape structure and dynamics

Land-use and land-cover change
- Biophysical and socioeconomic drivers and mechanisms
- Ecological consequences and feedbacks
- Long-term landscape changes driven by economies and climate changes

(*cont.*)

TABLE 1.1. (*cont.*)

Spatial heterogeneity in aquatic systems
- The relationship between spatial pattern and ecological processes in lakes, rivers, and oceans
- Terrestrial and aquatic comparisons

Landscape-scale experiments
- Experimental landscape systems
- Field manipulative studies
- Scale effects in experimental studies

New methodological developments
- Integration among observation, experimentation, and modeling
- New statistical and modeling methods for spatially explicit studies
- Interdisciplinary and transdisciplinary approaches

Data collection and accuracy assessment
- Multiple-scale landscape data
- More emphasis on collecting data on organisms and processes
- Data quality control
- Metadata and accuracy assessment

Fast changing and chaotic landscapes
- Rapidly urbanizing landscapes
- War zones
- Other highly dynamic landscapes

Landscape sustainability
- Developing operational definitions and measures that integrate ecological, social, cultural, economic, and aesthetic components
- Practical strategies for creating and maintaining landscape sustainability

Human activities in landscapes
- The role of humans in shaping landscape pattern and processes
- Effects of socioeconomic and cultural processes on landscape structure and functioning

Holistic landscape ecology
- Landscape ecology as an anticipative and prescriptive environmental science
- Development of holistic and systems approaches

[a] See Wu and Hobbs 2002 for more details.

heterogeneity and building this on the foundation of ecosystem and population ecology. The second sees landscape ecology primarily as the necessary scientific underpinning for spatial planning and management of landscapes, particularly in human-dominated settings. This dichotomy could simplistically be interpreted as a North American versus European divide, but that would be too simplistic since there are many European landscape ecologists working primarily on the biophysical aspects and equivalently, many North Americans dealing with the planning and management issues. In addition, there are others, such as the Australians, who perhaps take a pragmatic middle road which combines both aspects.

Is this dichotomy a problem? The obvious answer is that it should not be, since both approaches are necessary and can be highly complementary. It is only a problem if adherents of either approach fail to appreciate the value and context of the other. Clearly, landscape planning has to rely on the acquisition and analysis of complex spatial data. Similarly, to be useful, spatial data need to feed into the planning and management process. Landscape ecology's key role, therefore, is to provide an umbrella for all of these endeavors so that people with different objectives and backgrounds can interact and develop approaches which are more than the sum of the parts.

In recent years this umbrella function has succeeded in part, but has perhaps not yet achieved all it can. Landscape ecology could be accused of lacking the unifying direction of more mission-oriented sciences such as conservation biology or restoration ecology (Hobbs 1997). Landscape ecology conferences attract people who are interested in landscapes – any and all aspects of landscapes are covered, from the hard-core spatial ecology through to the more humanities-based landscape history, aesthetics, design, and so on. Often there is still a clash of cultures, with apparently little common ground between the numerical and the spiritual and aesthetic. This is perhaps inevitable, but is not necessarily a terminal problem. Its solution lies in the acceptance of the breadth of issues and approaches involved in understanding how landscapes work. It lies in greater communication among researchers and practitioners from different disciplines and backgrounds. It lies in fostering that communication through mechanisms such as workshops and meetings, joint supervision of Ph.D. students, and joint faculty appointments between ecology and landscape design departments. We have had an era of increased specialization and fragmentation of effort, which has led us to the current state of the world: the future has to be based more in integrative and transdisciplinary approaches if we wish to find effective ways of steering the world in a more sustainable direction. Landscape ecology provides much of value for those wishing to better conserve or manage the planet and its inhabitants.

1.3 Concluding remarks

Landscape ecology must, therefore, continue to develop along the lines identified in the chapters in this book. We need continued improvement in our ability to collect and interpret spatial data. We need to ensure that effective metrics are developed which aid in this interpretation. We need to develop streamlined ways of feeding complex spatial data into land-use planning and management decisions. And to do all this, we need to find ways of conducting our research in inter- and transdisciplinary settings which actually work. This set of requirements is surely enough to stimulate the field of landscape ecology to continue to develop its intellectual rigor and to mature as a science. The various chapters in this book explore the current status of endeavors in each of the areas outlined above, and we hope that they faithfully indicate the vigor and promise currently being shown within landscape ecology.

References

Hobbs, R.J. 1997. Future landscapes and the future of landscape ecology. *Landscape and Urban Planning* **37**, 1–9.

Moss, M. R. 1999. Fostering academic and institutional activities in landscape ecology. Pages 138–144 in J. A. Wiens and M. R. Moss (eds.) *Issues in Landscape Ecology*. Snowmass Village: International Association for Landscape Ecology.

Wiens, J. A. 1999. Toward a unified landscape ecology. Pages 148–51 in J. A. Wiens and M. R. Moss (eds.) *Issues in Landscape Ecology*. Snowmass Village: International Association for Landscape Ecology.

Wu, J. and R. Hobbs. 2002. Key issues and research priorities in landscape ecology: an idiosyncratic synthesis. *Landscape Ecology* **17**, 355–65.

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Excerpt
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PART II

Key topics and perspectives

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Adequate data of known accuracy are critical to advancing the field of landscape ecology

2.1 Introduction

The science of landscape ecology is especially dependent on high-quality data because often it focuses on broad-scale patterns and processes and deals in the long term. Likewise, high quality data are necessary as the basis for building policy. When issues, such as climate change, can induce international political and economic consequences, it becomes clear that providing high-quality, long-term data is paramount. It is not an accident that this chapter is positioned near the front of this book. Of the priority research topics presented in this book, this is the most pervasive across other topics because the availability of high-quality data limits progress in other realms. Be it historic land-use data needed to understand the dynamics of land-use change, the independent data of varying scales needed to assess scaling phenomena or test new metrics, the socioeconomic/cultural data needed to integrate humans into landscape ecology, or the biological and population data needed to evaluate ecological flows, the quality of raw data, metadata, and derived data products is critical to the core of landscape ecology. For each of these key topics and perspectives, the availability and quality of data will affect research results and practical recommendations.

2.2 Data advances in past two decades

It has been two decades since the 1983 workshop that many say established the landscape ecology field in North America (Risser *et al.* 1984). It was attended by many who have and still contribute to the field (e.g., Barrett, Botkin, Costanza, Forman, Godron, Golley, Hoekstra, Karr, Levin, Merriam,

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O'Neill, Parton, Risser, Sharpe, Shugart, Steinitz, Thomas, Wiens, and also a rookie named Iverson). From a scanty list of databases available, this group identified several databases with spatial components useful in landscape ecology: aerial photos; Landsat MSS; biological sampling schemes; and statistical measures of demography. They also identified several problems requiring attention: merging data from multiple sources with various levels of precision, resolution, and timing; choosing display formats appropriate for various uses and without distortions; the need for systematic or stratified field sampling in a heterogeneous universe; and decisions about the appropriate resolution for a particular problem. Researchers still struggle with these problems.

It may be useful to remind ourselves, especially our younger readers, where we were technologically with respect to data acquisition and manipulation two decades ago. I will relay what it was like for me. I was hired by Paul Risser in late 1982 to help develop the Illinois Lands Unsuitable for Mining Program to ensure lands of particular value were deemed "unsuitable" for surface mining. Risser had the foresight to identify that the new technology called "GIS" might be appropriate to do analysis of multiple mapped features. We hired Environmental Systems Research Institute (ESRI) to help us, and we became ESRI client number 12. Risser also believed it important that the GIS technology be made available to scientists, not just computer geeks. So I and my colleagues of various scientific bents spent three weeks in Redlands, CA training with the developers (ArcInfo 2.1 at the time), and the company president, Jack Dangermond, would take us during break to the orange orchard on the property to pick a few oranges. Subsequently, Illinois was the first state with full, integrated vector GIS at 1:500K. Prior to this time, most GIS work was performed with raster processing, using paper print-outs with different symbols for different classes within the matrix. Often entire walls were plastered with these print-outs to get the overall view of the study area. Several people from the Oak Ridge National Laboratory were creating and manipulating county-level data sets for the conterminous United States (Klopatek *et al.* 1979, Olson *et al.* 1980).

ArcInfo 2.1 was vector, but the hardware and software was limited. For data, we had a statewide digitized map of pre-European settlement vegetation (Anderson 1970) and the Land Use Data Acquisition (LUDA) data from the US Geological Survey (Anderson *et al.* 1976), vintage late 1970s. With these, we could assess long-term vegetation changes (Iverson and Risser 1987) and the attributes related to these landscapes (Iverson 1988). At that time, a simple overlay process would run all night; in fact, my colleagues forbade me to run those overlay batch jobs during the day because the shared computer system (which filled a room) would slow to a crawl or crash with more than a few jobs running simultaneously. I "divided" the state into many chunks because the software could not handle so many arcs.