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PERSPECTIVE

Research in the journal *Landscape Ecology*, 1987–2005

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Abstract This paper examined the types of research papers published in the journal *Landscape Ecology*. Based on the original six criteria developed by John Wiens in his 1992 study of the first five volumes, changes over time through Volume 20 were investigated. From this brief study, there was found some progress in diversifying landscape ecology. There was a modest increase in papers addressing sociological subjects, a more spread out distribution of study scales, more use of descriptive, methodological and GIS approaches, and more employment of mathematical and statistical approaches. The lack of experimental studies continued through Volume 20. A suggestion for further work is advanced.

Keywords Research · Methodology · Landscape ecology · Theory

Introduction

The journal, *Landscape Ecology*, has become a forum for communication about landscape-level ecological research, particularly about spatial analysis of human scale landscapes. One of the key features of *Landscape Ecology* papers has been their emphasis on space as "the arrangement of ecological systems, communities, habitats and organisms on the land surface" (Golley 1996). The disciplines which carry out landscape ecological research form an interdisciplinary group—ecologists, geographers, landscape architects, land planners and managers, urban planners, landscape historians, botanists, wildlife biologists and others.

Since the journal began 20 years ago, the number of pages published and its impact factor have dramatically increased. For example, the number of pages per volume have increased from about 250 pages in the late 1980s to approximately 1,300 pages per volume in 2006. The number of issues per volume, i.e., per year, has also increased, from four in 1987 to ten in 2007. The impact factor has increased progressively, from 0.746 in 1998 to 2.558 in 2006 (Wu 2007).

The state of landscape ecology in the early to late-1990s

In a survey of the first five volumes of *Landscape Ecology*, John Wiens (1992) assessed the state of landscape ecology as a science and concluded that, rather than abandoning its focus on qualitative, descriptive research, the discipline needed to expand to include more quantitative rigor and predictive theory. Wiens' study analyzed the 99 papers

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published in the journal to that point, using six criteria (level of organization, subject focus, scale of study, methodology and approach, mathematical approach, and four 'hot' topics: scaling issues, spatial pattern description, boundary flows, and disturbance). He found that the studies focused on human scale (several hectares to many km^2) landscapes, landscape structure, and either human land use issues or spatial pattern analysis. Wiens also found landscape ecology research was not very quantitative or theoretical, had little use of hypothesis testing, and was mostly concerned with broad-scale land use features and human landscape structure.

Frank Golley also wrote of the need for more theoretical research in landscape ecology and the necessity for the field to "move beyond the case study approach, where system structure and dynamics are described, to a more process focused approach which will result in the prediction of the consequences of decisions, actions, and events" (Golley 1996, p. 323).

Hobbs (1997) surveyed the second five volumes of *Landscape Ecology*. Using Wiens' criteria, he found more quantification and statistical analysis, more emphasis on modeling and methods development. However, as Wiens found in the first five volumes, Hobbs found few studies included experimentation.

Andersen carried out a study (1998) of the first 11 years (1987–1997) of papers published in *Landscape Ecology*. A random sample of 60 papers was chosen from Volumes 1–12. That assessment found that the papers in the first 5 years (Volumes 1–6) seem to have reflected the young state of the discipline, with slightly more than a third (34.3%) using no explicit theory. No use of theory diminished to 1.4% for Volumes 7 through 12. Correspondingly, use of more quantitative scientific methods in Volumes 7–12 increased to 75.0% over the 56.3% in Volumes 1–6. This greater reliance on more quantitative scientific methods and data driven research was considered to be a sign of progression in the discipline. Papers using a more qualitative, humanistic approach remained a small proportion: 6.0% in Volumes 1–6 and 3.6% in Volumes 7–12. From 1987 through 1997, there was found to be increasing use of multiple scale studies, modelling as a methodology, statistical testing, community/ecosystem studies and plant/invertebrate/vertebrate studies.

Study objectives

The overall aim of this paper is to evaluate the types of research that have been published in *Landscape Ecology* from its first issue in 1987 through 2005 (Volume 20, Number 8) and to describe how the research has changed over time. Specifically, the current paper extends the earlier studies by Wiens (1992), Hobbs (1997), and Andersen (1998) to encompass all volumes of the journal through 2005. The three study objectives were to describe a representative sample ($N = 50$) of papers published from 1998 through 2005, to categorize these papers according to Wiens' six criteria, and to look for differences in research trends over time, 1987–2005.

Methods

A random sample of 50 research papers from *Landscape Ecology* was selected from Volumes 13 through 20 which cover the years 1998 through 2005. To do this selection, all research articles in Volumes 13 through 20 were numbered sequentially from 1 to 425. Then fifty random numbers were obtained from the online random number generator at http://www.random.org. These fifty papers were then classified according to six criteria containing 26 subcategories (Fig. 1). Wiens' criteria (1992) were used with the exception of six additional sub-criteria which were added to three of the criteria to establish finer distinctions. These additional criteria consisted of the sub-criterion of "other" added to the Level of Organization criteria; "vertebrates (except humans)," "land cover," and "landscapes" added to the Subject Focus criteria; and "multiple scales" and "no scale" added to the Scale of Study criteria.

Next, the classification of the sample of research papers according to these criteria was compared to the results of Wiens' 1992 survey and Andersen's 1998 study to determine if there were changes over time in the six criteria: level of organization, subject focus, scale of study, methodology or approach, mathematical approach, and topics. To supplement knowledge of current trends, all 10 editorial comments and 4 perspective articles published in Volumes 13 through 20 were also read but were not included in the analysis.

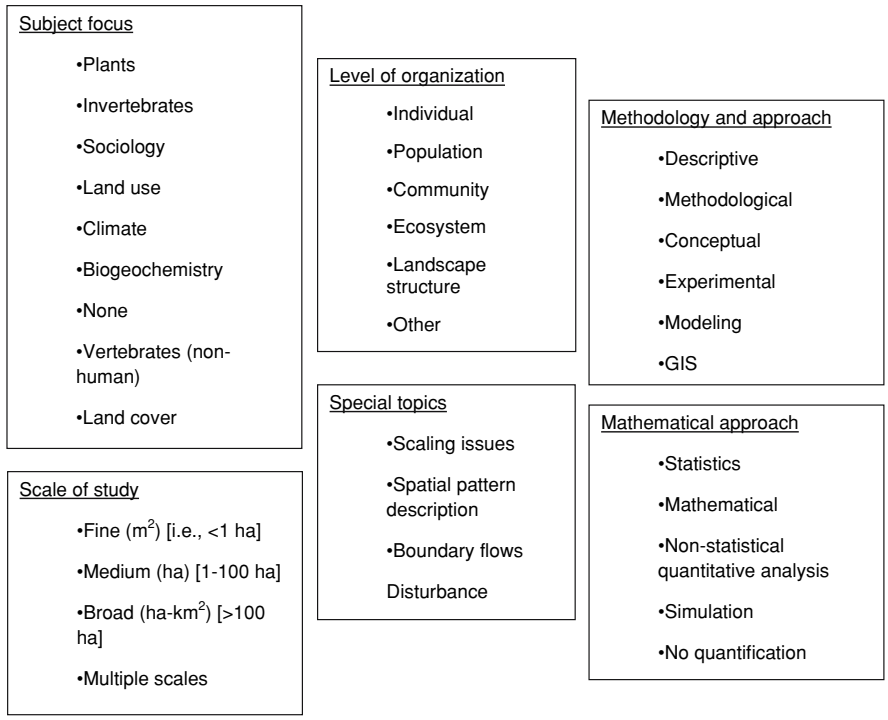

Fig. 1 Classification system, adapted from Wiens 1992

Results

There have been changes over time in the types of research being published in *Landscape Ecology*. The largest changes have been more papers at the landscape structure level, more papers with a sociological subject focus, more use of descriptive, geographical information systems (GIS) and methodological approaches, more use of mathematical and statistical approaches, and more papers involving spatial pattern description.

For the level of organization criteria, there was an 18% increase in papers at the landscape structure level, while papers in the ecosystem, community and individual levels decreased by 11.4%, 14.2%, and 5.2%, respectively (Fig. 2).

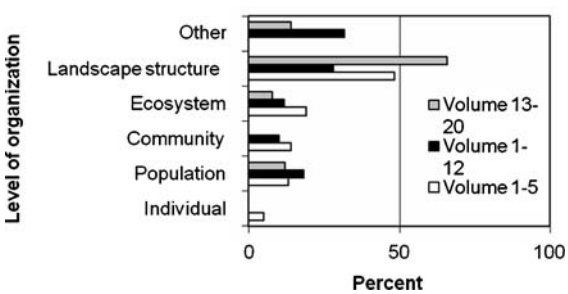

Fig. 2 Changes over time in level of organization

In subject focus, the largest changes seemed to be a large (22.4%) decline in the papers that examined land use (Fig. 3). However, because this study divided Weins' land use category into land use and land cover, when those two categories are combined, Weins' original category decreased only 2.4%. Therefore, the largest change in subject focus was the 14.9% increase in papers centering on some aspect of sociology. There were small increases of 5%, 3%, and 1.9%, in papers on biogeochemistry, climate, and invertebrates, respectively.

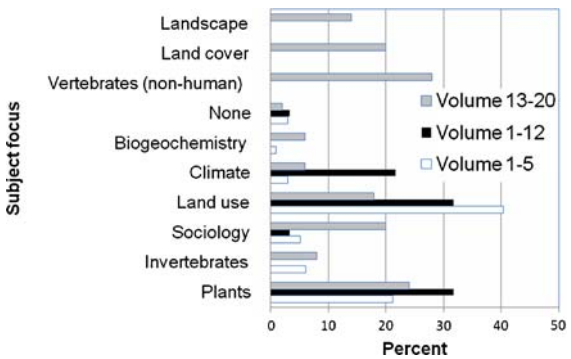

Fig. 3 Changes over time in subject focus. *Note*: The percents in Volumes 13–20 exceed 100% because some papers were classified into multiple subjects

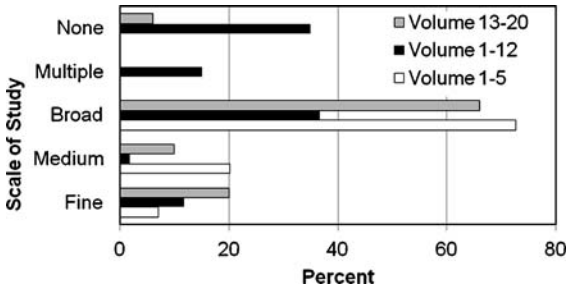

Fig. 4 Changes over time in scale of study. *Note*: The percents in Volumes 13–20 exceed 100% because a few papers involved more than one scale

A comparison of study scales over time found weak evidence of more of a distribution of scales in Volumes 13–20 (Fig. 4). In Volumes 1–5, 72.7% of papers were broad-scale studies. In Volumes 13–20, broad-scale studies were 66% of papers. In Volumes 13–20, there was a 12.9% increase in fine scale research and 10.2% and 6.75% decreases, respectively, in medium and broad scale studies over Volumes 1–5.

Examining methodology or approach, there were found to be large increases (29.4%, 26.2%, and 23%, respectively) in descriptive, GIS, and methodological papers (Fig. 5). There was slightly more use of modeling (8.1% increase) and experimental (4% increase) approaches. Conceptual approaches declined by 22.7%.

Mathematical approach changed dramatically, with a 51.9% increase in mathematical approaches and a 50.8% increase in statistical approaches (Fig. 6). Studies with no quantification declined 14.2% and simulation studies decreased by 9.2%.

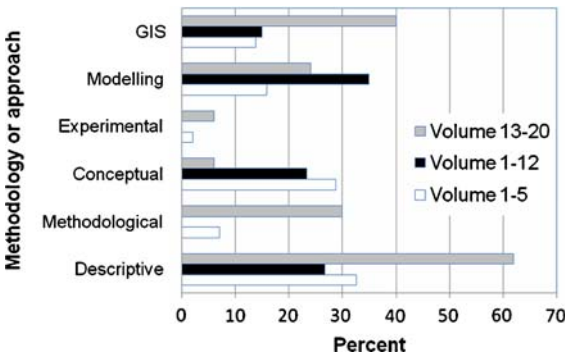

Fig. 5 Changes over time in methodology of approach. *Note*: The percents for Volumes 13–20 exceed 100% because some papers were classified into multiple methodologies or approaches

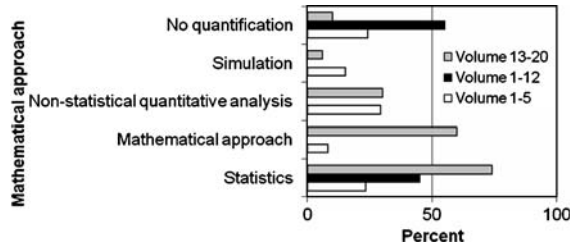

Fig. 6 Changes over time in mathematical approach. *Note*: The percents for Volumes 13–20 exceed 100% because some papers were classified into multiple mathematical approaches

Finally, the largest change in the four "hot" topics of Wiens' study (1992) was a 24.8% increase in spatial pattern descriptions (Fig. 7). There was also slightly less emphasis on scaling, disturbance and boundary flow issues.

Discussion

Landscape ecology as a discipline, as evidenced by this analysis of papers in *Landscape Ecology*, has in some aspects become more unified as the two contrasting and complementary perspectives have become more integrated. The perspective of European landscape ecologists has been characterized as more humanistic and holistic and the perspective of North American landscape ecologists has been described as more bio-ecological and analytical (Bastian 2001; Wu and Hobbs 2002). Drdoš (1996) has written of two landscape ecology methodologies—one being reductionist, deriving from ecology, and the other being comprehensive and synthetic and deriving from geography, which goes back to Carl Troll's depiction of landscape ecology as the meeting

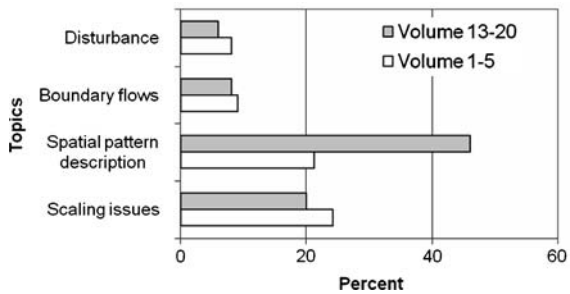

Fig. 7 Changes over time in topics. *Note*: Percents do not equal 100% because not all papers addressed any of these four topics

of two disciplines, ecology and geography (Wu 2006). Drdoš declared that landscape ecology's ultimate goal is environmental protection and using different investigational methods to advance this goal is part of its interdisciplinary nature. Wiens argued a similar point with his idea that landscape ecology includes a diversity of perspectives ranging from spatial statistics to cultural perceptions to watershed hydrology and many more. Wiens (1999) wrote that the interdisciplinarity of landscape ecology can be a divisive quality but has the potential to be a strength if the different disciplines learn from each other. Wu (2006, p. 1) advanced the associated perspective of commonalities among the two approaches, the "society-centered, holistic view" and the "bioecology-centered spatial view." Noting the essential interdisciplinary nature of landscape ecology, Wu and Hobbs stated that these approaches, rather than just being different, are, more importantly, complementary (2002, 2006). With further integration of ecological research with social sciences (Gragson and Grove 2006), landscape ecology is in a position for advancing science that not only studies landscapes with interdisciplinary and integrative methods but also proposes solutions to landscape scale dilemmas. This has been *Landscape Ecology*'s goal from its beginning (Wu 2007).

Based on this brief study, there has been some progress in diversifying landscape ecology. However, if progress is defined as a sharpening of focus, this may not equate with an advancing of the discipline. A modest increase in papers addressing sociological subjects, a more spread out distribution of study scales, more use of descriptive, methodological and GIS approaches, and more use of mathematical and statistical approaches have occurred. However, the lack of experimental studies continued through Volume 20. Since landscape ecology topics since 1992 have changed, a more detailed and comprehensive analysis of research topics may be warranted. A beginning place could be the list of major landscape ecology research topics compiled at the 2001 US-IALE meeting (Hobbs and Wu 2007). The topics from this list could be placed into a "hierarchical, pluralistic framework for landscape ecology" in order to fully integrate the various approaches (Wu 2006, p. 2). To address the exponential rise in published papers in *Landscape Ecology* over the last 20 years, either a proportionate stratified sample of papers or a census in correspondence with Wiens' (1992) and Hobbs' (1997) studies would be selected. With a proportionate stratified sample, strata could be time-oriented, with early, middle and later volumes being proportionately sampled. Or strata could be each year, with 10% of the papers being chosen from each year to address the issue of needing to sample more papers from later years when there have been more papers. The papers would be categorized according to the framework. Such an analysis would more closely examine the changes over time in topics, approaches and methodologies in the journal and, to a certain extent, within the discipline.

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Appendix 1

Papers in random sample of Volumes 13–20

Year	Volume	Issue	Author(s)
1998	13	2	Lobo et al.
1998	13	5	Larsen and Bliss
1998	14	1	Kitzberger and Veblen
1998	14	1	Nikora et al.
1999	14	2	Hunziker and Kienast
1999	14	5	Bastin and Thomas
1999	14	6	Nagasaka and Nakamura
2000	15	1	Theobald et al.
2000	15	1	Boone and Krohn
2000	15	3	Mander et al.
2000	15	3	Wagner et al.
2000	15	3	O'Neill and Walsh
2000	15	4	Reid et al.
2000	15	5	Haydon et al.
2000	15	6	Hansen et al.
2000	15	6	Oba et al.
2000	15	6	Palmer et al.
2000	16	1	Sweeney and Cook
2001	16	2	Wellnitz et al.
2001	16	3	Coppolillo
2001	16	6	Roshier et al.
2001	16	6	Moreira et al.
2002	17	Supplement	Pieterse et al.
2002	17	5	Turner and Hiernaux

Appendix continued

Year	Volume	Issue	Author(s)
2002	17	7	Moser et al.
2003	18	1	Rustigan et al.
2003	18	2	Riffell et al.
2003	18	2	Opdam et al.
2003	18	2	Walker et al.
2003	18	3	Poudevigne and Baudry
2003	18	3	de la Pena et al.
2003	18	3	Arnaud
2003	18	4	Brotons et al.
2003	18	5	Desroches et al.
2003	18	7	Snyder et al.
2003	18	8	Verbeylen et al.
2004	19	2	Duncan and Schmalzer
2004	19	6	Genxu et al.
2004	19	6	Wimberly and Ohmann
2004	19	7	Prasifka et al.
2004	19	8	Bain and Brush
2004	19	8	Burgi et al.
2005	20	1	Heinz et al.
2005	20	1	Mouillet et al.
2005	20	3	Frair et al.
2005	20	5	Mazerolle
2005	20	6	Nunes et al.
2005	20	6	Taverna et al.
2005	20	6	Jordon et al.
2005	20	8	Storch et al.

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Gragson TL, Grove M (2006) Social science in the context of the long term ecological research program. Soc Nat Resour 19:93–100

Hobbs R (1997) Future landscapes and the future of landscape ecology. Landsc Urban Plan 37:1–9

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Wiens JA (1999) Toward a unified landscape ecology. In Wiens JA, Moss MR (eds) Issues in landscape ecology. International Association for Landscape Ecology 5th World Congress, Snowmass, Colorado, USA, pp 148–151

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