Living in Interesting Times: Selected Implications of Landscape Ecology for Conservation Science

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Abstract—The phrase 'May you live in interesting times' links well with the sub-discipline of landscape ecology. Recent research in landscape ecology and associated disciplines (for example, conservation biology) provides significant challenges to the traditional conceptions of wilderness and conservation science, and may in part reflect upon our view of contemporary society as being characterized by complexity and uncertainty. Four selected implications of landscape ecology research for wilderness advocates and managers are identified and described. These issues relate to the importance of ecological processes in ecosystem functioning, the existence of multiple spatial and temporal scales in landscapes, the integration of the natural and social realms, and unpredictability and lack of understanding of ecological patterns and processes. While there are many ramifications of these four issues for wilderness conservation, there are also broader implications of landscape ecology's conceptualization of nature and conservation. A parallel movement in conceptualizing society and nature as self-organizing systems characterized by disturbance and complexity in the natural and social sciences is also discussed. Both these disciplinary and trans-disciplinary findings will significantly affect the social functions and management of wilderness in the future.

Introduction

When reviewing recent research in landscape ecology (LE) and associated disciplines, the popular phrase 'May you live in interesting times' comes to mind. While commonly thought to be an ancient Chinese curse, in fact, this saying was written by an American science fiction writer more than 50 years ago (DeLong 1996-98). However, the power of this saying in contemporary times shares at least one characteristic with LE research. In many ways, the history and author of this saying is irrelevant: there is no doubt that much of its power and usage comes from the perceived uncertainty and unpredictability of contemporary society, and the numerous social perturbations taking place in the early 21st century. We seem to be suffering the 'curse' promised by the saying.

Such rapid change is also evident in the sub-discipline of LE. Indeed, as will be demonstrated, change is at the very heart of LE, and landscape ecologists are learning to deal with 'interesting' findings and issues raised by their research. As a conservation scientist—not a practicing landscape ecologist—I believe that many important lessons for wilderness conservation, science and management can be gleaned from studying research in LE.

The first task in this paper will be to briefly review the history and central tenets of LE. Next, several of the most relevant findings in LE for wilderness and other conservation managers will be identified and reviewed. While these direct ramifications are important to wilderness and protected area managers, the broader implications of LE research will also be provided; linking the common findings and approaches of LE with other sub-disciplines suggests the emergence of a trans-disciplinary conception of landscapes, conservation, society and science. Finally, the paper concludes with a review of the major implications of LE research for wilderness and other protected area administrators and managers. Specific challenges to conservation scientists become evident when viewed through the lens of LE.

History and Central Tenets of Landscape Ecology

The sub-discipline of LE arose in the 1980s from the fields of ecology, conservation biology and wildlife biology/ecology (Bissonette and Storch 2003). Theoretical and methodological advances in these and other fields led to the creation of a sub-discipline focussed on the study of patterns and processes in landscapes. From a more practical perspective, the increased degradation of wild landscapes, loss of biodiversity, and increased frustration with the lack of targeting these social issues in ecology also led to the creation of LE. These latter factors are also shared with the closely related sub-discipline of conservation biology (CB), which also combines both a theoretical and applied focus on protecting species and biodiversity (Salafsky and others 2002).

LE and CB were also informed by and helped create a shift of how nature is conceptualized. The traditional view of nature was of a homeostatic, linear reality. More recently, the conception of landscapes has changed to being categorized by disturbance and complexity. This has led to a new conceptualization of nature as a complex, adaptive system. More specifically, instead of seeing nature as homeostatic, predictable, linear, and steady-state, it is now viewed as multi-causal, non-linear, non-deterministic, self-organizing and dynamic, an interacting maze of patterns and processes that exist simultaneously at numerous scales.

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Change and disturbance have moved from the background to the foreground of landscapes, and the scale of research has expanded to the landscape level. The new keywords that define natural processes are unpredictability and complexity in a self-organizing, non-equilibrium state (Berkes 2004; Bissonette and Storch 2003; Callicott 2003; Levin 1999).

The main conceptual framework of LE, as originally posed by Forman and Godron (1986), separates landscapes into: 1) structure, 2) function, and 3) change. Structure refers to spatial patterns of landscape components, their composition, configuration and connectivity. Landscape functions are ecological processes that take place in these spaces (for example, succession, nutrient recycling, species emmigration/immigration). Change is the constant dynamic that occurs at all scales.

Selected Implications of Landscape Ecology Research

1. Focus on Both Ecological Components and Processes

This new model has tremendous implications for the way we view wilderness and wilderness conservation. First, LE suggests that we need to focus as much on protecting landscape processes as on components, although landscape ecologists themselves have only begun to study the characteristics of these processes (Bürgi and others 2004; Hobbs 1997). Most conservation efforts still target species, or a larger species-based target, such as biodiversity or biodiversity hotspots (Lyons and others 2005). Other shortcuts to conserve ecosystems include the use of indicator, flagship, umbrella, endangered or focal species. While these shortcuts are absolutely essential to conservation managers - it is impossible to preserve all species—the long-term effectiveness of these shortcuts in preserving species or biodiversity is still uncertain, and each approach has limitations (see Bifolchi and Lodé 2005; Lyons and others 2005; Manley and others 2004).

For a variety of reasons, it has proven to be very difficult to shift managerial focus from species or biodiversity to ecological processes; the most obvious reason is that species are concrete, while processes are much more abstract. Public opinion can easily be swayed by endangered charismatic megafauna, but it is hard to generate public opinion or funds by highlighting dangers to ecological processes such as succession or nutrient recycling. Shifting focus to ecological processes in conservation science (rather than components such as species) will probably involve incorporating such approaches as ecological integrity and ecosystem health. While some conservation agencies, such as Parks Canada, have attempted to shift management directives to preserve ecological integrity, there is still difficulty is making such a significant shift in terms of organizational mindsets and capacity, funding, and research capabilities (Parks Canada Agency 2000). In addition, the definition of these two terms are still being debated in the scientific community and our knowledge of how these concepts (as social constructs) can be measured and managed in the landscape is still nascent (Pimentel and others 2000).

2. The Issue of Scale

The finding most emphasized in LE is that numerous, interacting scales exist in all landscapes. These scales exist in both spatial and temporal dimensions, and seem to drive much of the uncertainty and complexity in landscapes. Frustratingly, findings from one scale are often irrelevant at different scales, from the genetic to the global. Spatial scales are in turn affected by the history of the ecosystem, so that events occurring at one location will not necessarily occur in a similar ecosystem with a different ecological history (Landres and others 1999). Thus, findings in one location or scale can often not be extrapolated to other locations/scales; each landscape often has an idiosyncratic ecological history, which then leads to, for example, different responses to human-based disturbances such as fragmentation. These emergent, dynamic properties exist at all spatial and temporal scales, with each scale dynamically interacting with other scales.

These findings mean we cannot continue to view wilderness as static islands of conservation: ecological processes at smaller and larger than park scales are inevitably, though virtually invisibly, affecting protected areas. It seems likely that maintaining or restoring connectivity between and among scales will be the only way to conserve ecological components and processes in the medium term. For example, recent research suggests that while park size is important in maintaining biodiversity, maintaining the flow of processes between and among different scales, including the landscape level, will be even more critical. That is, de facto or designated buffer zones surrounding wilderness or other protected areas are essential, equal in importance to protected areas themselves. This is perhaps the greatest challenge facing wilderness, as neighboring landscapes are becoming increasingly fragmented and populated (DeFries and others 2005; Parks and Harcourt 2002; Wiersma and others 2004).

3. Acknowledge Limited Understanding of Ecological Structure, Function, and Change

Given the increased recognition of the sheer complexity of landscape structure, function and change, many landscape ecologists and conservation biologists accept that our knowledge of ecosystems and ecological processes is limited. In addition, huge gaps remain in our knowledge of even relatively basic ecological information. Acknowledging this lack of understanding and lack of data – not to mention the lack of funding to conduct research – requires different approaches to research in and management of ecosystems. For example, when knowledge is incomplete, an adaptive management approach may be optimal; the precautionary principle has also been suggested as a useful approach, although the political support for this approach has been inconsistent at best (Lyons and others 2005). In addition, multiple approaches to conservation (at multiple scales) may also be needed. As Kati and others (2004: 478) have noted, “conservation practices must be as dynamic as ecosystems.”

An important corollary of this implication is if one acknowledges uncertainty and imperfect knowledge of landscapes, the traditional techno-scientific model of decision-making becomes displaced. The role of science becomes focused on description of reality, but the evaluation of reality is open to all in society; science loses its hold upon decision-making in management (Beck 1992). This in part explains the recent movement towards, for example, ecosystem management, adaptive management, the precautionary approach, and community-based conservation. Each management approach recognizes this uncertainty, our limited knowledge base, and the limits of the traditional techno-scientific decision-making model.

4. Re-Integrating the Natural and Social Realms

Like many other relatively recent sub-disciplines, LE and CB acknowledge that the natural and social realms co-exist in landscapes (Berkes 2004; Bissonette and Storch 2003). Further, these two realms cannot be separated: humans impact all landscapes from the genetic to global scales. Of course, this is antithetical to the original wilderness ideal, and constructivists have also taken wilderness to task on the separation of landscapes and humans (see Callicott and Nelson 1998). LE and BC provide similar challenges to the wilderness concept.

However, recent research also makes it clear that wilderness and other protected areas are still necessary tools to protect landscapes. They are currently the best short-term approach to protecting landscape structure and function. But by themselves, species-based conservation approaches in protected areas will not preserve the ecological processes that provide the foundation of all landscapes at all scales over the long term; landscapes outside protected areas and the agencies that manage them must also conserve landscape structure, function and change (Marzluff 2004; McKinney 2002; Pierce and others 2005; Struhsaker and others 2005).

Broader Ramifications of Landscape Ecology

As noted, the four issues described above all have critical implications for wilderness and conservation science. Approaches to wilderness and conservation science and management will need to be refocused in order to reflect the importance of scale, acknowledging uncertainty and imperfect knowledge, the re-integration of natural and social forces and the necessity of managing ecological processes as well as components, especially species. To be sure, current management approaches such as ecosystem and adaptive management attempt to incorporate some—though not all—of these new realities. However, these management approaches are still being integrated into administrative structures, and conservation managers have been shown to continue to rely upon more traditional management actions (for example, species-based research and conservation at park scales) (Pullin and others 2004).

However, there are broader ramifications of the issues noted above. First, LE is not the only sub-discipline to emphasize non-linearity, scale uncertainty and complexity. Increasingly, newer sub-disciplines in the social sciences (for example, natural resource sociology) also characterize society as multi-scalar, showing non-linear processes and high levels of uncertainty and complexity. There is a movement towards an integrated socio-ecological systems model, one which suggests that similar processes and forces are at work in both the landscape and society (Scoones 1999; Warren 2005).

For example, the community concept in conservation science has tended to reflect a rather homeostatic, steady-state, linear view (much like the traditional view of nature). Communities are often seen as roughly equivalent, and similar approaches are attempted when introducing community-based conservation. However, the term 'community' hides a great deal of complexity. Communities are now seen, like landscapes, as dynamic, self-organizing entities influenced by spatial and temporal scales. Like landscapes, the history of communities affect their present structure and capabilities; they are dynamic and self-organizing. Perhaps the uneven success of community-based conservation in protecting biodiversity is based, at least in part, in viewing communities as steady-state, linear systems unaffected by social and cultural processes at other scales. For example, regional or national policies can have the effect of neutralizing or reversing local scale policies. Some researchers have suggested that the global focus on economic growth and increasing consumption of natural resources work against our efforts to preserve landscapes and ecological processes at the local level (Czech 2000; Naveh 2000). However, most community-based research tends to ignore the structural forces at larger scales, which may obstruct the ability of a community to protect biodiversity (Berkes 2004; Carlsson 2000).

The concept of communities is not the only concept to be critically questioned. Science itself is also being reconceptualized. From the Enlightenment era, science was focussed on the prediction and control of nature for utilitarian ends. Science traditionally uses deterministic, reductionist approaches to studying the natural (or social) world. But when nature and society are conceptualized as inherently complex and unpredictable, new approaches to science are required. So-called 'post-normal science' embraces the inclusion of non-linearity, complexity, multi-scaled reality, and self-organizing systems (Gallopi and others 2001).

A number of related approaches in many other disciplines and sub-disciplines have embraced this new model. For example, complexity theory, adaptive management, ecosystem management, and non-equilibrium thermodynamics all stress the dynamic, non-linear nature of reality and integrate humanity and the natural world (Shultis and Way 2006).

Conclusions

While I hesitate to use this oft-used phrase, I believe that wilderness and conservation science are facing a major paradigm shift. LE is both contributing and reacting to this shift, which relates to the 'interesting times' we are living in at the beginning of the 21st century. Several threads in this shift are emerging:

1. From viewing landscapes as homeostatic, ordered, and mechanistic to dynamic, complex systems;

2. Conceiving nature in multiple scales, with each spatial and temporal scale acting separately and in an integrated manner; and

3. Integrating nature and humans in science and conservation, acknowledging the impact social forces have upon ecological forces and human conceptions of nature, wilderness and conservation (and vice versa).

It is worthwhile to reiterate that the above changes are occurring in both the natural and social sciences; that is, landscapes and society are beginning to be viewed as having equivalent organizing processes and properties. This may serve to further hasten the consilience of natural and social science research (Warren 2005; Wilson 1998).

For wilderness advocates and managers, the issues identified in this paper provide a range of additional challenges to conservation science and management. For example, administrators and managers must begin to fund research into the patterns and changes in ecological processes; while species- and biodiversity-based approaches are very useful, it is dangerous to focus on ecosystem structure while ignoring ecosystem function and change. Research in wilderness and other protected areas should also occur at multiple scales. Too much park research examines only park level scales; however, ecological structures, functions and changes in other scales—both in the natural and social realm—also affect park ecosystems. While there are many structural barriers to manage for conservation purposes outside protected areas, conservation scientists must continue to push for conservation outside park boundaries. A multiple, adaptive approach to conservation is warranted, given the uncertainty and complexity of landscapes and our lack of understanding of all these complexities. In addition to using multiple scales, multiple approaches to research and management should also be attempted. While shortcuts to preserving ecosystem structure, function and change are inevitable (for example, using concepts such as biodiversity, indicator or endangered species), managers and scientists must be aware of their idiosyncratic limitations. Finally, wilderness and other protected area administrators and managers must communicate the new assumptions and conceptualizations to the public and decision-makers in order for necessary changes in approaches to science and management to germinate.

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