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Why history matters in ecology: an interdisciplinary perspective

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SUMMARY

In recent decades, the interconnectedness of history and ecology has received increasing attention. Although necessarily interdisciplinary, efforts to study this interconnectedness had their roots either in the humanities and social sciences or in the natural sciences: scholars have tried either to understand more about nature with the help of history, or, about human history with the help of natural phenomena. As a result, theoretical studies about the integration of ecology and history try to answer two relatively distinct questions: 'why ecology matters in history' and 'why history matters in ecology'. This paper sets out to systematize current knowledge on the latter question and to highlight those issues that have so far received less attention. The arguments can be grouped into three major themes. First, history matters in ecology because it aids understanding of current patterns and processes in nature. Second, because it fosters better informed management and policy decisions; and third, because it places ecology and conservation in a wider interdisciplinary context. Besides dealing with the perspectives of ecologists and conservationists, this paper also includes material from historians, anthropologists and archaeologists, that is, from scholars whose primary interest does not lie in ecological investigations, but who have, nonetheless, embraced the need for the integration of ecology and history.

Keywords: complex ecosystems, conservation, historical ecology, history, interdisciplinarity

INTRODUCTION

In recent decades, the interconnectedness of history and ecology has received increasing attention (for example see Peterken 1981; McDonnell & Pickett 1993*a*; Worster 1993; Russell 1997; Meine 1999; Bowman 2001; Egan & Howell 2001; Foster *et al.* 2003; Rackham 2003; Verheyen *et al.* 2004; Crumley 2007; Dietl & Flessa 2009). Although necessarily interdisciplinary, efforts to study this interconnectedness had their roots either in the humanities and social sciences (history, archaeology, anthropology, ethnography and human geography) or in the natural sciences (palaeoecology, vegetation ecology, landscape ecology, conservation biology and restoration ecology). This, in effect, means that, based on their initial training and inherent interests, scholars have tried either to understand more about nature with the help of (usually human) history, or about human history with the help of natural phenomena. The authors of such studies often felt it necessary to justify the inclusion of ecological or historical information into their work. As a result, there is a growing body of literature trying to answer two relatively distinct questions: 'why ecology matters in history' (for example Worster 1990, 1993; Hughes 1995) and 'why history matters in ecology' (for example Rackham 1998; Swetnam *et al.* 1999; Foster 2000; Egan & Howell 2001; Lunt & Spooner 2005; Bürgi & Gimmi 2007). In this paper, I deal with the second question. In my view, although the existing studies cover many aspects of this topic, they usually concentrate on a single discipline and one geographical region. This is partly justifiable: a scholar specializing in the management of current North American forests need not deal with medieval French forest management. However, given the interdisciplinary nature of the initial question, the combined knowledge of several disciplines and the particular experiences of many geographical regions have the potential to provide an overall picture that can in turn help the individual researchers to better contextualize their own work.

This paper sets out to review and systematize the existing knowledge on the question 'why history matters in ecology.' My main aims are to demonstrate the whole array of arguments and to highlight those issues that have so far received less attention but are equally valid and important. The arguments can be grouped into three major themes. First, history matters because it aids understanding of current patterns and processes in nature. Second, because it fosters better informed management and policy decisions; and third, because it places ecology and conservation in a wider, interdisciplinary context (for a broadly similar classification from a different viewpoint, see Bürgi & Gimmi 2007). I discuss these themes one by one, although some of the issues are overlapping, especially as regards ecosystems knowledge and its application in conservation and management. It is perhaps necessary to emphasize at this point that 'why history matters in ecology' is a different issue from 'which are the current trends in historical ecological research' and also from 'what should be done to

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foster the cooperation between history and ecology'. These topics certainly deserve attention, but will not be dealt with in this paper.

I use the terms 'history' and 'ecology' in a broad sense. The former refers to the study and interpretation of any information from the past; observational (including archival) and experimental (including long-term experiments and archives of past experiments) data are both historical sources (Newell & Wasson 2002). By 'history', I mean both human activities and natural processes in the past. Separating human and non-human history (at least in the Holocene) is impractical and often irrelevant or impossible. A Spanish forest fire in 1415, for example, may or may not have been started by people (Lloret & Marí 2001). To establish the effects of this fire in today's landscape, the source of fire is irrelevant. However, in the reconstruction of past fire regimes, how this particular fire started becomes more interesting. Knowing the proportion of human versus lightning-induced fires provides essential information for the management of this landscape. Given the nature of historical evidence, however, the source of the 1415 fire will most probably not be known. The key to fruitful interdisciplinary research is to understand the limitations of both historical and ecological sources and to find the kind of questions the available evidence may answer.

'Ecology' is also used in a broad sense, meaning 'the scientific study of the distribution and abundance of organisms and the interactions that determine distribution and abundance' (Begon *et al.* 2006), which, for the purposes of this paper, I understand as basic ecology, 'an extremely broad science that can encompass any system on Earth' (McDonnel & Pickett 1993*b*), including results from, for example, landscape ecology and restoration ecology. Although many aspects of nature conservation and restoration are not directly connected to ecological research (and therefore ecology and nature conservation and restoration are not the same thing), in this paper the practical application of ecological research in conservation and restoration is also included in the term 'ecology'.

The specific discipline that investigates past ecosystems is historical ecology. Although the term 'historical ecology' was not used until the twentieth century (the earliest publication to include it in its title known to me is Etter 1953), research in what is today called historical ecology has a long history. Probably the earliest such publications arose from the 18th-century controversy concerning whether the sweet chestnut was native to England (Rackham 2003). Research interest in the human impact on ecosystems was present in the 19th and early 20th centuries (see for example Marsh 1874; Schwappach 1886; Beevor 1924; Watt 1931). Historical ecology that defined itself as such was born approximately half a century ago simultaneously and independently in Europe and in the USA (Etter 1953; Lambert *et al.* 1960; Tubbs 1968; Peterken 1969; Rymer 1974, 1979; Crompton & Sheail 1975; Rackham 1975; Rice 1976; Bilsky 1980; Crumley & Marquardt 1987) as an interdisciplinary venture. Initially, its methodology and research topics were balanced between the natural sciences and the humanities. However, with the emergence of environmental history as a strong subdiscipline within history (see for example Worster 1988; Crosby 1995; Winiwarter & Knoll 2007), the focus of historical ecology has shifted towards ecology with a strong emphasis on nature conservation. Despite its long history, historical ecology still lacks unified methodology and specialized institutional background. The researchers who at least partly identify themselves as historical ecologists define historical ecology in a number of different ways (Rackham 1986, 1998, 2003; Crumley 1994, 2007; Russell 1997; Egan & Howell 2001; Balée 2006; Bürgi & Gimmi 2007). These definitions usually include the notion that the main focus of historical ecology is the study of human–nature interactions in the past. This, however, does not imply that the historical ecology of a place completely devoid of human impact (or at least human inhabitants) could not be written (Rackham 1998), but rather that most ecosystems have been influenced to some degree by humans and that it is an important goal of historical ecology to include this influence in the interpretation of past and present ecosystems.

CURRENT ECOSYSTEMS AND HISTORY

That current patterns and processes in nature have a historical trajectory was realized already in the theory of evolution. In palaeoecology, to take another example, pollen analysts have been working on the history of long-term changes in vegetation for almost a century (Boyd & Hall 1998). Such approaches, however, were somewhat ahistorical (as perceived by a historian) for two reasons. On the one hand, they regarded the past as essentially predictable (see for example how originally biostratigraphical zones [Boreal, Atlantic] became chronostratigraphical zones in common scientific language). On the other hand, they often disregarded human activity (with the exception of domestication, of course) (for a recent attempt at a more historical approach in evolutionary ecology, see Brooks 1985; Brooks & McLennan 1999). A significant change in this attitude happened about half a century ago, when a larger number of scientists started to appreciate the profound human impact on practically every landscape in the world (Birks *et al.* 1988). Initially this meant that patterns and processes that had been understood as natural were given a new, anthropogenic aspect: humans were accepted as an ecological factor. This, however, still often (although by no means always) implied that people were outside the system, that they disturbed processes that otherwise had a predictable trajectory (Cronon 1993; Russell 1997).

The next key argument in the process of integrating ecology and history was that human activity was not an outside factor that fitted awkwardly into natural processes, but rather an organic part of such processes, or, in other words, that nature and culture are impossible to tell apart (McDonnell & Pickett 1993*a*; Haila 1999, 2000). As a result, it is increasingly difficult to define what a 'natural' ecosystem might be. Woodland ecologists, for example, demonstrated that past land-use,

continuity and management history influence the vegetation of individual woods to the extent that anthropogenic impact becomes an integral part of vegetation development. This, apparently, has two main reasons. First, things that happened in what would be considered the distant (and therefore irrelevant) past by modern ecologists have a decisive effect on seemingly natural patterns. For example, past land-use influences soil conditions and vegetation composition through long time spans (Sandor *et al.* 1990; Verheyen *et al.* 1999; Hermy & Verheyen 2007), extending as far back as the Roman Period (1st–4th centuries AD) in several French woods (Dupouey *et al.* 2002; Dambrine *et al.* 2007; Plue *et al.* 2008). Similar studies also abound for other types of vegetation, such as grasslands (Pärtel *et al.* 1999; Eriksson *et al.* 2002; Herben *et al.* 2006). Second, as Rackham (2003, 2006) argued, certain conditions created by human impact have existed for such a long time that they are incorporated into the ecology of current woods. To take an example, fragmentation, which is usually viewed negatively by conservationists (for example Saunders *et al.* 1991), has in some protected woods existed for millennia and played an active part in shaping the current vegetation. Had these woods not stood in a fragmented landscape, they would have developed into different (and not necessarily richer) ecosystems from those valued so highly today (but see also Ewers & Didham 2006). A more comprehensive view on this issue is that ecosystems are highly complex (for example Bradbury *et al.* 2000; Newell & Wasson 2002). Their properties and dynamics are determined by mutual constraints among the individual elements over time. This 'refers simply to the fact that the local rules of interaction change as the system evolves and develops' (Levin 1998). Changes in one factor influence other factors, which, in turn, have their effect on the first factor and so on. The patterns of these feedback loops through time are difficult to map and, especially when humans are involved, are unpredictable.

Another major reason why historical information is essential in understanding present ecosystems was raised by the American ecologist D.R. Foster (2000). He argued that because 'time-lags develop in the response of all biological and physical systems to disturbance or environmental change', instantaneous measurements often collect data about events and processes that without a historical insight remain hidden from the investigators (see also Newell & Wasson 2002; Newell *et al.* 2005; Jackson *et al.* 2009). Repeated, longer-term observations may provide a solution, but only if they explicitly include historical events as explanatory data.

In addition, history also informs about the 'invisible' parts of ecosystems (Clark 1990; Foster *et al.* 1996; Foster 2000). There are some, typically catastrophic, disturbance events which are important elements of current ecosystems but will certainly not occur during a three-year grant project and may not occur for hundreds of years. The effects of extreme floods, fires or storms, if luck fails to bring them around, can only be approached through historical studies. A good example is the 'Great Storm' of 1987 in England, a powerful reminder of a forgotten ecological factor in that country (Kirby & Buckley 1994; Rackham 2003).

In connection with the previous issues, the general topic of change and dynamism in ecosystems has also been fostered by a historical approach. The lesson history teaches is that 'perhaps the most natural feature of the world in which we find ourselves is its continual flux' (Jackson & Hobbs 2009). Ecosystems change on many temporal scales from days to millennia, therefore current systems should be seen as necessarily temporal elements in a process that can have a multitude of realizations (Bowman 2001; Jackson 2006). Any given ecosystem can be part of a number of such processes: the mostly lodgepole pine (*Pinus contorta*) forests in Yellowstone National Park, for example, experience cycles of smaller fires and regrowth at relatively regular intervals. To this are added the effects of occasional huge fires and storms (Romme & Despain 1989). At the same time, these forests represent one phase in the general vegetation development since the latest Ice age (Whitlock & Bartlein 1993). Historical knowledge not only allows researchers to understand these processes, but also provides an opportunity to identify keystone processes, those that are apparently the most important in the given ecosystem (Marcucci 2000).

ECOLOGICAL CONSERVATION, MANAGEMENT AND HISTORY

Most theoretical research into the significance of history for ecosystems focused on conservation and restoration. This is by no means accidental. Restoration ecology, if it is to take itself seriously, must, by definition (the Latin prefix re- implies going back to or repeating a previous stage), be concerned with the past. Consequently, some scholars called restoration ecology 'applied historical ecology' (Swetnam *et al.* 1999; Rackham 2003; Balée 2006). Solid theoretical foundations are especially needed in this field, because management decisions will inevitably influence landscapes. These decisions cannot be avoided: doing nothing is also a form of management with its own distinct consequences.

On a basic level, historical ecology is thought to be able to identify baseline conditions (typically those before significant human impact) that can serve as restoration targets (Egan & Howell 2001; Swetnam *et al.* 1999; Balée 2006; Fule *et al.* 1997). This research direction has been particularly strong in North America and Australia, where pre-European settlement conditions were often interpreted as natural. However, many studies pointed out that this view could be misleading for two main reasons (see for example Pickett & Parker 1994; Landres *et al.* 1999; Lentz 2000; de Vries 2005). First, history did not start with European settlement. Native peoples had a large influence on many landscapes. This influence is now recognized to the extent that in recent years criticism was voiced (Vale 1998, 2002) that we should not swing to the other extreme and view all pre-European settlement North American landscapes as largely modified by humans. In Europe, however, this issue is less discussed.

Although early 20th-century historical geographers had a tendency to overemphasize the landscape impact of their own nation, environmental archaeology is a flourishing and well-recognized subject, and the American concept of 'wilderness' (Nash 1967; Oelschlaeger 1991) is very hard to interpret in a European context. It is for certain that practically all European landscapes have been heavily influenced by humans for thousands of years (Birks *et al.* 1988), and that 'natural' conditions, if they are to be found at all, have to be searched for somewhere in or before the Mesolithic (Szabó 2009). The second problem with defining baseline conditions stems from the realization, discussed above, that ecosystems are not static, but are in constant flux. Consequently, selecting a particular temporal phase as the most desirable target is often rather difficult to justify.

A much more useful concept than baseline conditions is that of the 'historical range of variability' (Morgan *et al.* 1994; Rackham 1998; Aplet & Keeton 1999; Hessburg *et al.* 1999; Landres *et al.* 1999; Keane *et al.* 2009; Mitchell & Duncan 2009; Thompson *et al.* 2009). Introduced in the 1990s, this concept, rather than focusing on a single state, includes the full variation of conditions that are known to have occurred in history. Current conditions and processes are evaluated against this background. This idea resolved the integration of dynamism into ecosystem management. Change is considered to be acceptable as long as it falls within the historical range. What is more, with a shift from patterns to processes, dynamic systems became conservation targets themselves (Foster *et al.* 1996; Jackson & Hobbs 2009). Rivers are good examples of such systems. It is understood that the quickly changing meanders of any larger river in some moment in history cannot be a restoration target. The whole system of the flood plain needs to be restored, where floods, geomorphology, climate, vegetation and traditional fishing, amongst others, together create a dynamic landscape. Another perspective on this issue is that the historical range of variability concept helps to 'isolate the unconservable': to identify things that are inherently ephemeral (Rackham 1994). These include not only passing phases in a dynamic system (such as the meanders above) but also phenomena that are not part of the long-term history of a site (such as a poplar plantation on the flood plain). A historic view on dynamic ecosystems also allows for a better understanding of change itself in all its temporal and spatial variation. An especially important issue here is that of driving forces, which often create considerable challenges (Brandt *et al.* 1999; Bürgi *et al.* 2004). A typical example is global climate change. From historical and palaeoecological records it is known that neither the current extent nor the current speed of change are necessarily unprecedented, and they therefore may fall within the historical range of variability. Such change, however, when caused by human activities, is (as far as can be told) exceptional and has no historical parallels (McNeill 2000). Historical ecology offers an integrated understanding of change that considers causalities as well as sequences of events (Christensen 1989; Bürgi & Schuler 2003; Bürgi *et al.* 2004; Szabó 2010).

In addition to enhancing knowledge about managed ecosystems, a historical perspective also sheds light on the process of management itself. Historical ecology studies not only past ecosystems but also past ecosystem management. The effects of past management systems can provide an indication of how current ecosystems may react to management efforts. By the same token, present management should be seen as part of an on-going 'experiment' with ecosystems, rather than a process with a confidently predictable outcome (Harper 1987; Newell & Wasson 2002; Thompson *et al.* 2009). History provides an opportunity to assess policy making and management as an adaptive process (Newell *et al.* 2005). Or, as historians would say it, only 'those who cannot remember the past are condemned to repeat it' (Santayana 1906), which in this case means repeating failures of past conservation efforts. It is especially important that natural resource management be aware of its own history with its changing fashions. The past provides a standard against which to check the current wave of fashion (be it zero management, species extirpation or species reintroduction; Chase 1986; Rackham 1998). The most important feature of this standard is that it is local: it warns not to accept conservation principles from other countries or continents uncritically (Marcucci 2000). As argued by Foster *et al.* (2003), perhaps the most critical contribution of historical knowledge to the process of ecological conservation is that it reinforces 'the conviction that, although science and history may inform management, the ultimate driver of policy is human values and perceptions', which is especially important to keep in mind when confirming or negating the rights of various groups of people to participate in management decisions (Hayashida 2005). This, however, does not mean that conservation and restoration have no claim on objectivity. By embracing a human perspective, historical knowledge simply helps us to realise our own limitations and motivations.

A significant and somewhat undervalued way historical ecology helps conservation and management is that it emphasizes the uniqueness of every site (Rackham 1998, 2003). History, as a science, inherently focuses on individual places and events. Generalizations are arrived at almost exclusively inductively. Historical studies explain why a given site is special, why it is different from any other site in the world. It should be a priority in every management plan to perpetuate this *genius loci*, rather than making the site conform to what is thought to be the right state of that ecosystem by the present level of knowledge. Quite often this may entail preserving features that seem anomalous; the knowledge of history can provide the courage to accept the fact that our understanding of how the ecosystem in question works may be inaccurate or inadequate.

AN INTERDISCIPLINARY VIEW

Scientists often emphasize the importance of interdisciplinary efforts in order to achieve a deeper understanding of

ecosystems. In fact, historical ecological research was originally initiated not with the aim of providing useful knowledge for nature conservation, but rather as an interdisciplinary venture in which natural scientists and humanists both tried to exceed the limitations of their respective disciplines (Bilsky 1980). Bridging the divide between the 'two cultures' (Snow 1959) in scientific research has become an explicit aim of historical ecology (Ingerson 1994). This has two distinct advantages. First, the higher variety of sources of information, the more secure knowledge about the past (and therefore about the present) is: 'independent data sets provide an important cross-check in building consensus among collaborators' (Crumley 2007). Second, interdisciplinary research produces synergetic results that, in optimal cases, are more than the simple sum of information gathered from individual disciplines.

By now some scholars take this standpoint for granted. Newell *et al.* (2005) argued that 'many researchers in the international community have taken up the integration challenge. For these workers the question is no longer why, but how and what, to integrate' (see also Crumley 1994, 1998, 2007; Bürgi & Russell 2001; Balée 2006; Balée & Erickson 2006). Egan and Howell (2001) added that it also helps historical ecologists to 'locate themselves within the 'complementary opposition' of culture and nature', providing them 'with a sense of personal, professional and bioregional identity'. An interdisciplinary view on ecosystems is also useful in understanding ecological processes on a landscape scale (Landres *et al.* 1999; de Blois *et al.* 2002; Lunt & Spooner 2005). Landscape, as emphasized mostly by anthropologists (Balée 2006; Crumley 2007), is one of the key concepts in historical ecology, because it provides a common platform for the investigation of the physical environment and human activity. This, however, poses its own interdisciplinary challenges. A common vocabulary is often not enough to create common understanding; in fact, the same words and expressions often have different meanings in various disciplines, which leads to confusion rather than cooperation (Wear 1999). Furthermore, as pointed out by Meine (1999), 'natural scientists and historians may gaze upon the same landscape, but they see different things and draw different lessons from what they see'. In order to succeed, scientists from various disciplines have to be able to ask common questions.

Lastly, historical ecological investigations are essential, because they link biological conservation to conservation in general (Rackham 1998). It becomes increasingly clear that the preservation of cultural heritage cannot be separated from the preservation of nature. Yet again, we are faced with the fact that nature and culture are indivisible, or, in David Lowenthal's words, 'if they are twins, they are Siamese twins, separated only at high risk of the demise of both' (Lowenthal 2005). Most of the world's landscapes are cultural landscapes, where ecologists, conservationists, historians, geographers, archaeologists and anthropologists must work together in order to understand at least some of the complexities of these landscapes. It must be realized that changing one part of a system (such as species composition, management system, settlement pattern or built heritage) inevitably influences all other parts.

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