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Memory carriers and stewardship of metropolitan landscapes

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ABSTRACT

History matters, and can be an active and dynamic component in the present. We explore social-ecological memory as way to diagnose and engage with urban green space performance and resilience. Rapidly changing cities pose a threat and a challenge to the continuity that has helped to support biodiversity and ecological functions by upholding similar or only slowly changing adaptive cycles over time. Continuity is perpetuated through memory carriers, slowly changing variables and features that retain or make available information on how different situations have been dealt with before. Ecological memory carriers comprise memory banks, spatial connections and mobile link species. These can be supported by social memory carriers, represented by collectively created social features like habits, oral tradition, rules-in-use and artifacts, as well as media and external sources. Loss or lack of memory can be diagnoses by the absence or disconnect between memory carriers, as will be illustrated by several typical situations. Drawing on a set of example situations, we present an outline for a look-up table approach that connects ecological memory carriers to the social memory carriers that support them and use these connections to set diagnoses and indicate potential remedies. The inclusion of memory carriers in planning and management considerations may facilitate preservation of feedbacks and disturbance regimes as well as species and habitats, and the cultural values and meanings that go with them.

1. Introduction

The Anthropocene era is characterized by, among other major changes, climate change, biodiversity loss and rapid changes in land use. Whilst halting global warming requires transitions in socio-technological systems, halting the loss of biodiversity also requires thinking about how to foster continuity. Metropolitan regions are loci of both drivers and impacts of such changes. These landscapes often include cities, peri-urban- and ex-urban landscapes, and impacts are partly due to cross-scale drivers of change related to rapid and dynamic demographic transitions, intense financial speculation, and changes in property right regimes (Antrop, 2005; Colding et al., 2013; Lee and Webster, 2006). This article will propose a social-ecological framework for assessing and informing stewardship of biodiversity in the metropolitan cultural landscape; a framework that links new ways of using land to deeper time and larger scales processes. Our framework explicitly addresses different types of continuity, their roots and importance.

Continuity in ecosystems has long been recognized as an important factor for maintaining biodiversity. Such continuity has to do with upholding similar or only slowly changing adaptive cycles over time (Carpenter and Turner, 2000; Gunderson and Holling, 2002) and connecting spatial nodes (Hanski, 2011, 1999). Looking to cities, their green areas usually have a long legacy of human management and use, either as old parks or as former agricultural or forestry land now appropriated by urban expansion. Either way, their present character and qualities have been created and maintained by complex interactions between humans and their environment (Redman, 2011) and exist as embedded in a larger landscape. In such cultural landscapes continuity must be broadened to include a wider range of social-ecological factors (Chappell and LaValle, 2011; Ferrier et al., 2004; Hanspach et al., 2014; Plieninger and Bieling, 2012). The continuation and development of this biocultural diversity (Maffi and Woodley, 2010) is in many cases the anchor that sustains current high levels of biodiversity (Foster et al., 2003; Perfecto and Vandermeer, 2010).

Continuity in turn is perpetuated through memory carriers, repositories and structures that carry processes forward – biota and physical landscape morphology as well as slowly changing and collectively created social and cultural features in groups and organizations (Misztal, 2003). Understanding how social and ecological memory carriers interact may help us maintain resilience

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Table 1
Ecological memory carriers and their roles and functions.

Ecological memory carriers	Role and function	Spatial or temporal dimensions
Memory banks	Maintaining baseline information and evolutionary path-ways in the landscape.	Temporal. Memory banks have been built up over time and serve as repositories of evolutionary history.
Local gene pool		
Refugia	Provide attractors for recolonization through mobile links	
Structural legacies like standing dead wood		
Spatial connections	Connecting memory banks both to each other and to the rest of the landscape, ensuring that ecological memory is available throughout.	Spatial. Spatial connections make sure that memory banks are accessible and that they interact actively with the larger landscape. Spatial connections provide the physical side of connectivity.
Corridors		
Redundant patches of land cover with similar species communities		
Permeable matrix		
Mobile link species	Functionally connecting spatial structure and thus facilitation recolonization through e.g. through seed dispersal and meta-population dynamics. Providing ecological processes outside source area, e.g. pollination and grazing.	Spatial. Mobile link species are directly involved in the process of connecting and integrating the memory banks in larger landscape dynamics. They provide the functional connectivity.
Migration		
Dispersal		
Home range		

and biocultural diversity even in a time of profound global changes (Bengtsson et al., 2003; Colding et al., 2003; Folke et al., 2003). This work explores in depth how a set of indicators based on memory carriers can help diagnose discontinuities and anchor rapidly changing urban landscapes in past experiences. We will address two overarching issues: How can we ensure continuity in new times and contexts, and how may memory carriers be used to diagnose continuity and biodiversity conservation in metropolitan regions? The exploration is guided by a resilience perspective (Berkes and Folke, 1998; Berkes et al., 2003), where social-ecological resilience is defined as the capacity to absorb shocks, utilize them, reorganize, and continue to develop without losing fundamental functions (Carpenter and Folke, 2006). Our analysis makes no claim to be valid for wider societal governance; we restrict it to stewardship with the goal to support biological diversity in cultural landscapes, particularly those set in an urban context.

The article is structured as follows: the next section describes memory in social-ecological systems, from the ecological foundation to the social memory carriers that interact with ecological memory. Then the different kinds of continuity – and what roles different memory carriers play – in cultural landscapes of metropolitan regions are discussed and illustrated by real world examples. The real world examples feed into a tentative framework for system diagnosis based on inventories of memory carriers. The paper ends with a discussion and a concluding section where we address applied ecology and ecosystem management and the need to broaden the understanding of "social nature" included in these, and what might be solutions to different breaks in continuity.

2. Linking memory carriers to social-ecological resilience

Memory carriers are the motors in long-term social-ecological dynamics and renewal (Barthel et al., 2013). The genetic variation of each individual organism represents *a memory* of past stresses and exposure to various conditions. Similar to the resilience function of the individual immune system of an organism, which reflects historical exposure to pathogens, the combined memories in a gene pool influence how a species respond to disturbances. Ecological memory carriers combine time depth and spatial structures for making these repositories available. Social groups and cultures may build up a collective social memory connected to the ecological memory carriers over time, a memory that enables accumulated past experiences to inform and permeate present practices (Barthel, 2014). Memory more broadly can hence be used as a fertile ground to develop indicators of social-ecological resilience. Memory enable transfer of skills, functions and tested responses that can inform future responses to disturbances simply by drawing on different forms of captured experiences from past disturbances (Bengtsson et al., 2003; Colding et al., 2003; Folke et al., 2003; McIntosh et al., 2000).

2.1. Carriers of ecological memory

The foundation of ecological memory is biodiversity, at all levels from genes to ecosystems, and its internal dynamics and interconnections with the geo-physical landscape. Following common usage in the ecological literature, we contextualize ecological memory in relation to disturbance (Bengtsson et al., 2003; Berkes et al., 2003; Nyström and Folke, 2001). At the local scale ecological *memory carriers are embedded in genes and adaptations to different site conditions, as well as in community compositions and species interactions* (see Table 1). After disturbance, such local, within patch memory banks are present in the form of *legacies*, i.e. surviving structures and organisms (Foster et al., 2003; Franklin, 1990). For example, structural legacies such as dead wood, or large dying trees can be seen as part of an ecological memory. Seed banks and microorganisms in soils can be major ecological banks of memory, setting the stage and defining the boundaries for future development.

In a comprehensive take on spatial and temporal dynamics, Gunderson and Holling (2002) suggested that the larger biophysical landscape may function as a memory bank which can be drawn on in times of disturbance, hence support ecological resilience. Ecological barriers and high levels of spatial heterogeneity often characterize urban landscapes (Andersson, 2006; Cadenasso et al., 2007; Elmqvist et al., 2013). Each landscape patch with its particular ecology and memory banks is embedded in a larger landscape mosaic, where distinctly different mixes of patches in each landscape shape both the present and future character and potential of the landscape in question. At higher spatio-temporal scale levels, memory banks can be seen as dynamic *refugia*, shrinking and expanding in relation to a changing environment. From these, recolonization can occur post disturbance (Forman, 1990; Gunderson and Holling, 2002; Hanski, 2011). For example, refugia played a crucial role for large scale recolonization after the glaciations determining both community compositions and the speed of recolonization (Haffer, 1982; Tallis, 1991). To have a reliable and functioning ecological memory *multiple patches with a certain ecological profile*, i.e. the same memory banks, are hence needed. Furthermore, these must be complemented by *spatial connections* that link the memory banks to each other and to the larger landscape.

Spatial connections are made functional when they allow organisms to move between nodes, as part of within territory movements, dispersal or seasonal migration (see Table 1). Some of these