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Review Article

How can wastelands promote biodiversity in cities? A review

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HIGHLIGHTS

- We carried out a review of factors influencing the biodiversity of urban wastelands.
- Wastelands have a rich biodiversity which is often greater than that of other urban habitats.
- The diversity of local features of wastelands encourages the diversity of communities.
- Landscape factors are less important than local features in explaining wasteland biodiversity.
- Wastelands should be included in dynamic urban planning.

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ABSTRACT

Urbanisation leads to natural habitats being fragmented with various effects according to the species and their ecological characteristics. Paradoxically, the urbanisation process creates relatively unused environments, wastelands, habitats which could contribute to biodiversity conservation in urban regions. In this review we examined the role of wastelands in maintaining biodiversity in the city and assessed the different factors responsible for wasteland biodiversity. 37 articles were suitable for our aim. Most of the studies have been conducted in large cities in Western and Central Europe. A wasteland is defined as an abandoned site with spontaneous vegetation (i.e. wild grown vegetation). In most cases, wastelands harbour more species than other urban green spaces. The processes which affect the biodiversity of wastelands operate on two different levels. Locally, the area size, age, soil, microclimate and the vegetation structure are the dominant factors. As in other environments, the species richness increases with the size of the wasteland. Wastelands of different ages include different stages of vegetation, ranging from pioneer to pre-forest stages, and consequently harbour different communities of plants and animals. The diversity of anthropogenic soil substrates leads to different plant communities. At the landscape scale, matrix composition and geographic connectivity between wastelands influence the biodiversity of wastelands, although to a lesser extent than the local features. We show that wastelands have a real potential to contribute to biodiversity conservation in urban regions. At the city scale, they represent habitats which urban planners need to take into account and include in dynamic urban planning.

Contents

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1. Introduction

Urbanisation leads to natural habitats being fragmented and strongly impacts communities, with different effects according to the taxonomic groups (Gagné & Fahrig, 2011; McKinney, 2008) and the considered scale (Sax & Gaines, 2003). Urbanisation can also lead to a stepwise habitat transformation with the emergence of novel urban habitats which may harbour rare and endangered species (Kowarik, 2011).

From a taxonomic perspective, the plant species richness is often greater in the city than outside due to the presence of exotic plants which have been introduced accidentally or deliberately for ornamental purposes (Gavier-Pizarro, Radeloff, Stewart, Huebner, & Keuler, 2010; Kowarik & Pyšek, 2012; Walker, Grimm, Briggs, Gries, & Dugan, 2009), but cities can be also richer in native plant species than their surroundings (Kühn, Brandl, & Klotz, 2004). On the other hand, the richness of animals is often higher in rural and suburban areas compared to central core urban areas, with various effects among groups (Dallimer et al., 2012; McKinney, 2008; Reis, López-Iborra, & Pinheiro, 2012). The urban environment filters species according to their traits and their ability to colonise and settle in the city, to such an extent that the urban communities have developed different characteristics to those of farming and natural environments (Croci, Butet, & Clergeau, 2008; Knapp et al., 2008; Williams et al., 2009). Urbanisation often leads to a biotic homogenisation of communities which results in the loss of specialist species in favour of generalists which tolerate a greater range of environmental conditions (Lizée, Mauffrey, Tatoni, & Deschamps-Cottin, 2011; McKinney, 2006). However, exotic plant communities can show differentiation in the most urbanised areas (Kühn & Klotz, 2006).

With the debate on the contribution of cities to biodiversity conservation (Kowarik, 2011; Miller & Hobbs, 2002), many studies have sought to identify the urban environments and management methods that enable urban biodiversity to be conserved. Some work has focused on developed and managed spaces such as public parks and gardens (Bryant, 2006; Stagoll, Lindenmayer, Knight, Fischer, & Manning, 2012; Zerbe, Maurer, Schmitz, & Sukopp, 2003) or domestic gardens (Goddard, Dougill, & Benton, 2010; Marco, Lavergne, Dutoit, & Bertaudiere-Montes, 2009; Smith, Thompson, Hodgson, Warren, & Gaston, 2006). Other studies have investigated semi-natural spaces such as urban woods (Hedblom & Söderström, 2010; Vallet, Daniel, Beaujouan, & Rozé, 2008). In this review, we have focused on urban wastelands which are vacant spaces whose management is random (Sukopp, 2002).

Wastelands are urban habitats which are potentially of great importance for biodiversity. These sites often accommodate a rich flora and fauna including rare species (Eyre, Luff, & Woodward, 2003; Maurer, Peschel, & Schmitz, 2000; Small, Sadler, & Telfer, 2003). They constitute habitats which are highly dynamic in space (i.e. the location of patches of wasteland changes according to construction and demolition) and time (i.e. individual patches of wasteland are constantly changing with the stages of succession).

In several urban regions of Europe and the United States, de-industrialisation and demographic decline have led to an increase in urban wastelands (Martinez-Fernandez et al., 2012; Rieniets, 2009). In contrast, in some cities urban densification policies, drawn up to limit urban sprawl, tend to decrease the area size of green spaces and wastelands (Dallimer et al., 2011). Thought should be given to these densification policies to avoid negative consequences on urban biodiversity (Davies et al., 2009).

In this review, we have assessed the role of wastelands in harbouring biodiversity in the city. Specifically, we have determined the different factors responsible for the biodiversity of wastelands linked to the local features of the wasteland and the surrounding landscape context. Finally, we have proposed some ways of integrating wastelands in urban planning.

2. Method

Our aim was to address papers on factors and mechanisms that drive biodiversity patterns in urban wastelands. We selected articles using the Web of Knowledge database (*www.webofknowledge.com*) by entering the following key words: (*urb**) and (*wasteland* or *waste land* or *brownfield* or *abandoned area* or *abandoned land* or *vacant area* or *vacant land* or *derelict area* or *derelict land* or *semi natural area* or *semi natural land* or *neglected area* or *neglected land* or *ruderal area* or *ruderal land* or *spontaneous urban vegetation* or *urban wild**) and (*biodiv** or *ecol** or *species richness* or *species abundance*). The term 'urb' was used to select articles carried out in a urban context. The word 'wasteland' and the following were used to take into account the diversity of terms meaning a wasteland. The prefixes 'biodiv' and 'ecol' and the words 'species richness' and 'species abundance' were used to represent the aspects regarding ecological processes. We included records that were published up until March 2014.

393 references were identified. By examining the abstracts, we excluded two thirds of articles. These studies were clearly out of the scope of this study (e.g. extra urban studies, social studies, vacant land conversion to forestry and crop cultivation, urban wasteland redevelopment). We then read the complete text of the remaining articles. In the end, 37 articles fulfilled our criteria. These articles (i) compared wasteland biodiversity with that of other urban habitats (9 articles), (ii) tested local and/or landscape factors responsible for the biodiversity found in wastelands (24 articles) and (iii) investigated the biodiversity of wastelands in another way (6 articles). The selected studies are summarised in Table 1.