

Research Paper

Reduced availability of habitat structures in urban landscapes: Implications for policy and practice



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HIGHLIGHTS

- We quantified the availability of key habitat structures across an urban landscape.
- Urban habitat structures were significantly reduced compared with semi-natural reserves.
- Reductions in habitat structures jeopardises urban ecological sustainability.
- Improvements to urban management policies and practices are urgently needed.
- We recommend conservation reserves, spatial zoning and community engagement.

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ABSTRACT

Over half the world's population resides in cities, with increasing trends towards urbanisation expected to continue globally over the next 50 years. Urban landscapes will be more ecologically sustainable where key habitat structures (e.g. trees, shrubs and woody debris) that support multiple taxa are maintained. Yet, there is little empirical data on the extent to which habitat structures have been modified in urban landscapes. Obtaining these data is a necessary first step towards reducing the ecological impacts of urbanisation. This is because urban practitioners can use this information to formulate more targeted management policies and conservation strategies that seek to better maintain and perpetuate habitat structures in urban landscapes. We compared the availability of multiple habitat structures in urban greenspace, agricultural land, and semi-natural reserves in Canberra, southeastern Australia. In urban greenspace, the density and/or probability of occurrence of trees, seedlings, dead trees, hollow-bearing trees, hollows, logs and native ground and mid-storey vegetation were significantly lower compared with reserves, but comparable with agricultural land. Our results highlight an urgent need for improved habitat protection policies, management strategies, and on-the-ground conservation actions that aim to retain and restore key habitat structures in urban landscapes. To achieve this requires innovative strategies that balance socio-economic priorities and biodiversity conservation. We propose three strategies that can be practically implemented in cities worldwide including: (1) establishing dedicated conservation areas; (2) spatially zoning habitat structures hazardous to humans within existing urban greenspaces, and (3) educating key stakeholders about the importance of habitat structures within urban environments.

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1. Introduction

Habitat loss through land-use change is the biggest driver of terrestrial biodiversity decline globally (Foley et al., 2005; Pimm

& Raven, 2000). Land conversion is driven by agricultural and urban expansion, the latter now occurring at unprecedented rates (United Nations, 2011). Urbanisation is a complex process of land conversion, densification and hard-scaping that has been identified as one of the most rapid and destructive forms of landscape alteration (e.g. Grimm et al., 2008). Over half the world's population now resides in cities, with the global shift to urban living expected to continue over the next half century (United Nations Development Program, 2011). A major concern is that many urban areas around the world are disproportionately located in biodiversity-rich regions (e.g. McDonald, Kareiva, & Forman, 2008). Therefore, it is increasingly important that biodiversity

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conservation be integrated into urban planning and development strategies to establish more ecologically sustainable urban landscapes (e.g. Rookwood, 1995). An important step towards achieving ecologically sustainable urban landscapes involves strategically managing and maintaining crucial habitat structures in urban contexts.

Trees, shrubs and associated structures, including hollows and woody debris, represent critical habitat for many species (e.g. Gibbons & Lindenmayer, 2002; Lindenmayer, Laurance, & Franklin, 2012). These structures provide important sources of food, shelter, nesting sites, and structural complexity that a diverse range of taxa depend on for survival worldwide, including microbes (Hendrickson, 1991), plants (e.g. Kruys & Jonsson, 1999), invertebrates (e.g. Kaila, Martikainen, & Punttila, 1997), and vertebrates (e.g. Webb & Shine, 1997). The loss of habitat structures from modified landscapes is of increasing concern because of the negative consequences for both biodiversity and underpinning ecological processes such as nutrient cycling and carbon sequestration (e.g. Fischer, Stott, & Law, 2010; Stagoll, Lindenmayer, Knight, Fischer, & Manning, 2012). Ultimately, this also may have implications for human well-being (e.g. Díaz, Fargione, Chapin, & Tilman, 2006).

Maintaining habitat structures for biodiversity in cities can conflict with underlying political and socio-economic drivers (e.g. population growth) of urban expansion, including policies that promote public safety and 'sustainable' urban growth (e.g. Grimm et al., 2008; Stagoll et al., 2012). For example, wood decay and canopy senescence in mature trees are key processes that form hollows and woody debris important for wildlife (Gibbons & Lindenmayer, 2002). However, these processes also may increase the risk of falling limbs in existing urban greenspace, which may harm people and property and result in managed tree removal (e.g. habitat tree removal in Rome, Italy; Carpaneto, Mazziotto, Coletti, Luiselli, & Audisio, 2010). Similarly, compact residential living is encouraged to reduce urban sprawl (Burgess, 2000), but this can lead to the in-fill of greenspace that might otherwise serve as wildlife corridors and refuges within built-up environments (e.g. parkland values to birds in Pachuca, Mexico; Carbo-Ramírez & Zuria, 2011). Given that these challenges occur in cities throughout the world, knowledge of current resource gaps in urban environments is urgently needed to better focus conservation efforts and improve methods of managing important habitat structures that cater to human interests while maintaining biodiversity values.

In this study we asked: What is the availability of habitat structures in urban landscapes and how does this compare with agricultural land and semi-natural reserves? A better understanding of current resource limitations in urban landscapes is a crucial first step in formulating more targeted land management policies, urban design strategies, and on-the-ground conservation actions (e.g. McDonnell & Hahs, 2013). This baseline information from primary data is typically unavailable to urban practitioners worldwide because few studies have empirically quantified the availability of habitat structures in urban environments at a landscape scale. We hypothesised that land management practices have led to significant reductions in the availability of habitat structures in urban landscapes compared with semi-natural reserves that are managed for conservation purposes. We also predicted that urban resource limitations would be comparable with agricultural land where the impacts of human-induced land modification on habitat resources has already been well demonstrated (e.g. Fischer et al., 2009; Gibbons, Lindenmayer, & Fischer, 2008). Our study has global policy relevance and practical conservation implications for the current management of habitat structures in urban landscapes and for biodiversity conservation.

2. Methods

2.1. Study area

We conducted our study in and around the city of Canberra, Australian Capital Territory (ACT), southeastern Australia. Canberra covers an area of 810 km² and supports a population of 375,000 people, which is projected to double by 2056 (ACT Government, 2011). The city is highly planned and described as the "Bush Capital" due to the extensive suburban tree cover and 34 nature reserves flanking the urban boundary. The Canberra region was once dominated by box-gum *Eucalyptus* woodlands. However, land clearance for farming and urban development has led to approximately 95% decline in intact box-gum woodland, resulting in the listing of this ecological community as critically endangered in State and Federal legislation (Department of Environment and Heritage, 2006).

2.2. Sampling design

We confined our sampling to a single vegetation type: the predicted pre-European (pre-1750) extent of box-gum woodland within our study landscape. Within this vegetation type, we stratified our sampling according to three dominant land-use types and five geographical zones (Fig. 1).

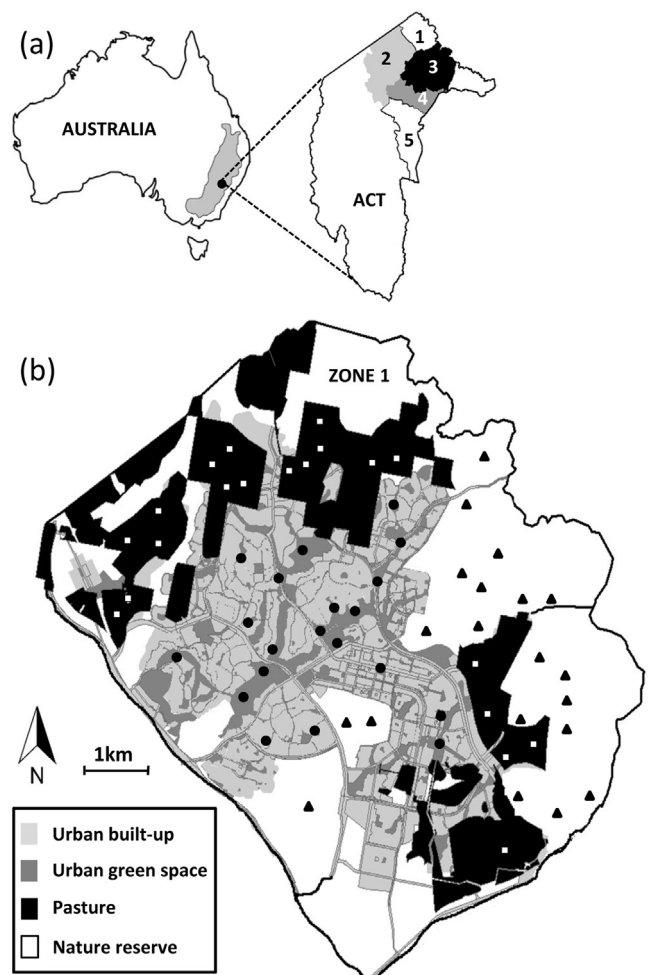


Fig. 1. Map of Australia with pre-1750 extent of box-gum grassy woodland (shaded area) and the Australian Capital Territory (ACT), highlighted to show Canberra broken into five geographical survey zones (a). Detailed perspective of zone 1 shows the stratification of the landscape into current dominant land-use types with random allocations of 20 plots to reserves, pasture and the urban greenspace (b).

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