Available online at www.sciencedirect.com
SCIENCE DIRECT®
Landscape and Urban Planning 77 (2006) 39–53
LANDSCAPE AND URBAN PLANNING
This article is also available online at:
www.elsevier.com/locate/landurbplan

Ecological diversity of birds in relation to the structure of urban green space

U.G. Sandström [a,*], P. Angelstam [a,b], G. Mikusiński [a,c]

[a] *Department of Natural Sciences, Centre for Landscape Ecology, Örebro University, SE-701 82 Örebro, Sweden*
[b] *Schools for Forest Engineers, Faculty of Forest Sciences, Swedish University of Agricultural Sciences, SE-739 21 Skinnskatteberg, Sweden*
[c] *Swedish University of Agricultural Sciences, Department of Conservation Biology, Grimsö Wildlife Research Station, SE-730 91 Riddarhyttan, Sweden*

Received 26 January 2004; received in revised form 6 January 2005; accepted 16 January 2005
Available online 16 March 2005

Abstract

A functional network of green space is important for the maintenance of the ecological dimension of a sustainable urban landscape. We used avian ecological diversity as a proxy for evaluating the functionality of different types of urban green space. The urban landscape of the municipality of Örebro in Sweden was stratified into four strata (City centre, Residential, Greenway and Periphery). Bird species found in these strata were classified into four ecological groups with decreasing degree of specialisation (woodpeckers, hole-nesters, forest birds and urban birds). Overall there was lower bird species richness in the City centre and Residential areas compared to the Greenway and Periphery. Woodpeckers, hole-nesters and forest birds showed an increasing trend in the number of species as well as individuals from the City centre to the Periphery while urban birds showed the opposite trend. The amount and quality of green space as well as natural vegetation increased from the City centre to the Periphery. Species richness of woodpeckers, forest birds and hole-nesters were positively correlated with tree density while urban birds showed an inverse correlation. There was no dead wood in City centre, Residential and Greenway in contrast to the Periphery, which held some dying trees, stumps and old windthrows. Our findings emphasise the importance of urban green space with natural structures to maintain high ecological diversity. Finally, we discuss how conflicts between habitat for biodiversity maintenance and other functions of green space could be handled by zoning.

Keywords: Urban planning; Birds in cities; Urban vegetation; Urban biodiversity; Sweden; Greenway

1. Introduction

The concept of sustainable development was developed to mitigate negative effects of the heavy human footprint on nature (WCED, 1987). One of the

* Corresponding author. Present address: The City Planning Department, Box 334 00, SE-701 35 Örebro, Sweden.
Tel.: +46 19 211477; fax: +46 19 211563.
E-mail address: ulf.sandstrom@orebro.se (U.G. Sandström).

0169-2046/$ – see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.landurbplan.2005.01.004

clearest examples of how human impact may change natural ecosystems is a large city. Urbanisation and sub-urbanisation are major global trends, currently undergoing rapid acceleration and have direct as well as indirect effects on the environment, and hence negatively affecting the ecological dimensions of sustainable development (Rees, 1997). Using compositional, structural and functional elements of biodiversity (Larsson et al., 2001) as proxies for ecological sustainability, urban areas have been shown to have fewer native species (Emlen, 1974; Rebele, 1994), have a higher amount of disturbed habitats in early successional stages (Trepl, 1995; Niemelä, 1999), and altered ecosystem functionality (Hough, 1995) compared with natural ecosystems.

Nevertheless, parks, avenues, greenways and other semi-natural habitats for a range of species are found in cities and suburbs (e.g. Tomiałojć, 1998; Savard et al., 2000). Such green spaces may also function as dispersal corridors for various organisms (Bolger et al., 2001). In fact, sufficient amounts of green space of relevant quality in cities may actually permit the presence of specialised forest species in urban landscapes (Park and Lee, 2000; Mörtberg and Wallentinus, 2000). However, by and large most large urban areas can be considered biological deserts. The ongoing trend in the development of urban areas is in general not positive for biodiversity maintenance, mainly due to continued growth of roads and buildings to meet the demands from an increasing number of citizens (e.g. Niemelä, 1999; Yokohari et al., 2000). During recent decades there has also been an urban sprawl in the sense that large parts of the landscape surrounding cities has become increasingly urbanised (Thomas, 1999).

To mitigate problems of urban sprawl and satisfy the social and economic components of sustainable development in urban areas the Commission of the European Community (1990) has recommended "compaction" as a strategy, implying that new residential development should take place on already existing land within the city limits. Compaction is advocated to reduce the amount of transportation, technical infrastructure, and energy consumption, and at the same time provide space for more inhabitants (Breheny, 1997). Obviously, green spaces constitute attractive land for compaction of existing urban areas rather than expanding in suburban areas (Nyhuus and Thorén, 1996; Yokohari et al., 2000).

Several Swedish cities have adopted the idea of compaction (e.g. Sandström et al., 2006). As this trend tends to reduce the amount of green space within cities, there may even be a conflict between ecological and other components of sustainable development (Reneland, 1999). For example, urban green spaces can be regarded as a multi-functional system being important for urban biodiversity as well as recreation, coping with storm water and improving the local climate (Mazza and Rydin, 1997), and providing better public health (Grahn, 1994). In other words, even if in a narrow sense humans compete with biodiversity for space in urban environments, the presence of green spaces in cities is a prerequisite for human well being in a broader perspective (e.g. Ulrich, 1993; Frumkin, 2001). Balancing urban compaction and maintaining green space is therefore a major challenge for urban planners (COM, 2001). Addressing the issue of functionality of habitat networks will help resolve this (Angelstam et al., 2003).

This study focuses on the idea that functional networks of urban green space contributes to ecological sustainability defined as the conservation of biodiversity and sustainable use of biological resources (UN, 1992). Biodiversity is referred to as genetic, species and ecological diversity (Harper and Hawksworth, 1995). Biological processes and ecosystem functions are often also considered as a part of this concept (see Larsson et al., 2001). Of these elements, species diversity is particularly useful, as it is dependent on a representative and sufficiently well connected network of habitats (Breininger et al., 2002). As a surrogate model for evaluating the level of maintenance of biodiversity in urban environments we chose ecological groups of birds requiring natural forest structures such as large old trees and dead wood. Birds are especially useful because they are mobile organisms, which depending on the species, require the existence of a wide variety of habitat at different spatial scales (Angelstam et al., 2004). Birds are also relatively conspicuous and fairly easy to survey. Consequently, several studies on urban landscapes have been carried out using bird species as indicators of habitat quality (e.g. Hostetler and Holling, 2000; Mörtberg and Wallentinus, 2000; Bolger et al., 2001; Fernández-Juricic, 2004).

Specifically, we evaluate the extent to which bird species classified into different ecological groups occur in a gradient from the inner city to surrounding