



Manor gardens: Harbors of local natural habitats?

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ABSTRACT

Recent studies have revealed that manor gardens may serve as local hotspots of biodiversity and provide cultural ecosystem services. As a consequence of dramatic land-use changes in recent centuries, followed by significant loss and degradation of natural habitats, manor gardens often serve as harbors for organisms within the cultural landscape. We randomly selected 98 manor gardens, followed by a grid overlay of data from the national natural habitats mapping system. Proportions of natural habitats were calculated for each garden in relation to the surrounding landscape. The results provide information about importance of manor gardens for biodiversity conservation through findings that especially large manor gardens, compared with the surrounding landscape, contain an important proportion of natural habitats, particularly in areas with a high level of human impact. For the gardens, occurrence of the following formation groups of the natural habitats was recorded: forests (total proportion of all kinds of forests habitats is 25.4% of the gardens area), secondary semi-natural grasslands (4.4%), streams and water bodies (1.6%) and wetlands and riverine vegetation (0.5%). The significantly high proportion of natural habitats in manor gardens was found mainly for beech forests and for secondary semi-natural grasslands, especially mesic and montane meadows. No significant importance was proven for wetland habitats. We conclude that nature friendly managed manor gardens can provide a conservation function of local natural habitats and their biodiversity especially in intensively managed landscapes.

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1. Introduction

In connection with land-use changes in the cultural landscape, a significant loss and degradation of natural habitats has occurred in Europe especially during the second half of the 20th century, primarily due to intensified agricultural land management practices and increased urbanization (e.g., Krebs et al., 1999; Sklenička et al., 2009; Vos and Meeke, 1999; Benton et al., 2003; Donald et al., 2006; Henle et al., 2008; Van Calster et al., 2008). The fragmentation and loss of natural habitats is one of the main challenges to plant biodiversity conservation. Thus, natural habitat conservation within intensively managed cultural landscapes is a constant concern.

Historical gardens established around manors and castles in the 16th–19th centuries form an integral part of the European cultural landscape. Attention is particularly focused on the cultural heritage and aesthetic-recreational value of these gardens (Cranz and Boland, 2004). A recent study revealed that manor gardens may also serve as local hotspots of biodiversity and provide cultural ecosystem services within

urban areas (e.g., Andersson et al., 2015; Chiesura, 2004; Cornelis and Hermly, 2004; Hermly and Cornelis, 2000; Kowarik, 1998; Kümmerling and Müller, 2012; Langemeyer et al., 2015) as well as in rural landscapes (Liira et al., 2012; Löhmus and Liira, 2013; Walerzak et al., 2015). In many cases, during the creation of these manor gardens, the local natural habitats (e.g., species-rich meadows and natural forests) were incorporated to increase the overall value of the garden. Additionally, due to long-term, nature-friendly management techniques, the newly established meadows and tree plantations began functioning as natural meadow and forest habitats within the less intensely managed sections of the gardens (Glendell and Vaughan, 2002; Jonsell, 2012; Liira et al., 2012). In particular, the landscape gardens are an example of how appropriate, initial sustainable design can provide important areas for biological conservation (Kümmerling and Müller, 2012). Despite a rising number of research studies concerning gardens and biodiversity, there remains a lack of general knowledge about the position of historical gardens compared to the surrounding landscape.

Therefore, based on an assessment of our data, we sought to answer the following questions:

1. What is the proportion of natural habitats in manor gardens compared to the surrounding landscape?
2. What is the role of manor gardens as natural habitat harbors in relation to human impact within the surrounding landscape?

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2. Study region

2.1. Brief characteristics of the Czech Republic

The Czech Republic is a land-locked country in Central Europe. It is predominantly characterized by a hilly landscape with lowlands in the central and southeastern parts. The highlands are situated mainly in the border region with the highest peak having an altitude of 1602 m above sea level. The territory of the Czech Republic is drained by a dense river network, lying on the main European watershed between the Black, Baltic and North Seas. Due to its geographical position, the country has a moderate climate with an average annual temperature of 7.5 °C and average annual precipitation of 674 mm. Furthermore, it is situated within a zone of temperate, broad-leaved deciduous forest and borders the forest-steppe zone in the southeast. Currently, its vegetation is affected by abiotic conditions, historical biogeographical processes and human activity (for details see Chytrý, 2012). Forest covers 33.8% of the territory, agricultural land 53.5%, built-up areas 1.7% and water 2.1% (CUZK, 2014).

2.2. Manor gardens

Manor gardens are horticultural garden areas around manor houses. They can be ornamental and/or natural in character, and they were formerly managed to achieve aesthetic effects. They consist of multiple sub-compartments, and typical design elements are the vistas that connect features of special interest (sculptures and pavilions) (Turner, 2005; Navrátil et al., 2015; Liira et al., 2012; Kümmerling and Müller, 2012; Jonsell, 2012). Manor gardens are dispersed throughout the entire territory of the Czech Republic. The gardens were planted mainly between the 16th and 19th centuries. Landscape gardens are the most common type because they are the last universal garden design. In terms of land area, the gardens differ markedly (Navrátil et al., 2015; Šantrůčková, 2012).

3. Data and methods

3.1. Data sources

Coordinated Information on the Environment (CORINE) land cover data 2006 (European Environmental Agency) is a vector map with a scale of 1:100,000. The CORINE land cover nomenclature is a 3-level hierarchical classification system and has 44 classes at the third and most detailed level. In the Czech Republic, 28 classes were identified at the third level. The data were used to identify the level of human impact on landscapes of the Czech Republic.

Natural habitats mapping data of the Nature Conservation Agency of the Czech Republic (© AOPK) was used to assess proportions of natural habitat. The data consisted of a digitized vector output for the Czech Republic at a scale of 1:10,000. It was developed during the establishment of Natura 2000 (according to the Habitat Directive). The May 2014 database version was used for analysis.

In total, 23 different types of natural habitats were found in gardens included in the study. For better clarity, habitats were grouped in the following higher units and used for analysis: alder carrs and alluvial forests, oak-hornbeam and oak forests, beech forests, ravine forests (forests); mesic and montane meadows, alluvial *Alopecurus* meadows, wet meadows, grasslands and tall-forb vegetation (secondary semi-natural grasslands); wetlands and riverine vegetation; streams and water bodies. The names of these habitat units correspond with those presented in the national interpretation manual for Natura 2000 biotopes for the Czech Republic (Chytrý et al., 2010).

A database of historic garden art monuments of the Czech Republic contains a point dataset of the historic gardens and parks in geographic information systems (GIS) as well as text sheets. The database was created by the Research Institute of Landscape and Ornamental Gardening

during the 2000s according to old and new encyclopedias of garden art monuments in the Czech Republic, in addition to other literature (Hieke, 1984; Hieke, 1985; Vlček, 2001; Pacáková-Hošťálková et al., 2004). For this research, manor gardens were selected from the database according to the item “type of the garden art monument” (total 700 items).

The demographic database of the Czech Statistical Agency provides data about population development for municipalities in the Czech Republic. We used the total population numbers of the municipalities in which the gardens are situated as of 31st December 2014. The correlation between the population size of the settlement and the presence of natural habitats in the manor gardens was investigated.

3.2. Data processing

First, the territory of the Czech Republic was overlaid with a square grid, which divided the country into squares of ten longitudinal and six latitudinal minutes (approximately 133.5 km²) to create a spatial dimension. To distinguish intensively used landscapes from semi-natural and “natural” landscapes, CORINE land cover data were used. Classes at the third level were applied to calculate the ratio K_{aiv} (suggested by Löw et al., 1995 as index of anthropogenic impact on vegetation) for each square:

$$K_{aiv} = N \cdot A^{-1}$$

where N represents natural or semi-natural areas (forest, shrubs, grasslands, wetlands and water bodies),

A represents anthropic surfaces (urban spaces, mine sites, sport and leisure facilities, etc.) and intensive agricultural areas and crop lands (arable land, gardens, orchards, vineyards, etc.) (Löw et al., 1995).

K_{aiv} was transformed to K' :

$$K' = \text{LOG}(K_{aiv}^{-1})$$

K' was used as a measure of human impact on ecosystems.

Second, 98 gardens throughout the Czech Republic (Fig. 1) were randomly selected from the point database of manor gardens using Hawth's Analysis Tools for ArcGIS (Beyer, 2007). The sample covers the diversity and typical features of manor gardens in the Czech Republic. Afterwards, selected gardens were digitized using a basic map of the Czech Republic at a scale of 1:10,000 (Czech Environmental Information Agency) as the background and old maps of the Stable cadaster from the first half of the 19th century at a scale of 1:2880 (State Administration of Land Surveying and Cadastre) for controlling the historical state of the gardens. After digitization, only squares intersected by digitized gardens were used for analysis. The selected manor gardens in the sample range from 0.0006 km² to 2.88 km², where the average size is 0.155 km². The manor gardens occupy only a negligible part of every square. The most numerous are small manor gardens (median of the model sample is 0.061 km²) within villages and small towns. In ten cases, gardens crossed into two squares, therefore the weighted average of K' was calculated.

Subsequently, the selected squares were intersected by natural habitat mapping data, and proportions of natural habitats were calculated for each garden and surrounding landscape in the squares.

3.3. Statistical analysis

First, the manor gardens and surrounding landscapes were compared. Proportions of natural habitat types in gardens and landscape in squares were tested by linear regression on K' . For the calculation of the significance of the difference between regression coefficients of gardens and landscape in squares, formulas in Diem (1960) were used. Second, the difference between the proportion of habitat in a garden and the surrounding landscape was calculated. The importance of

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