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Coppice abandonment and its implications for species diversity in forest vegetation

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ABSTRACT

Coppicing, once a common type of management in European broadleaved forests, was abandoned in many places after WWII. This form of management provided a variety of structural and microclimatic conditions for tree and understorey vegetation. After the abandonment of this intensive management, succession towards mature close forests ensued, and suitable habitats for species ecologically connected to coppicing were reduced. In our study, we chose a region in central Europe where coppicing was the dominant type of forest management until the first half of the 20th century but was abandoned after WWII. We investigated long-term changes in both woody and herbaceous species composition in the Lower Morava UNESCO Biosphere Reserve using historical sources and vegetation plot resurveys from the 17th to the 21st century. The impact of coppice abandonment on vegetation composition and on the conservation value of forests was evaluated. Dominant tree species appeared to be very stable throughout the past four centuries, but changes occurred in their proportions. A shift from species rich oak–hornbeam woodland towards species poorer communities with increasing proportions of lime, ash and maple was observed after the abandonment of coppicing. The observed tendencies partly differed according to site and data source. The conservation value of forests was measured as the occurrence of red-list species, which were considerably reduced after coppice abandonment. To stop the process of biodiversity loss and support the goals of nature conservation, the re-establishment of coppice management is proposed.

1. Introduction

Although forest vegetation patterns generally depend on the demands and interactions of species along environmental gradients, in Europe they were co-shaped by human activities at various spatio-temporal scales (Buckley, 1992; Peterken, 1993; Sanderson et al., 2002; Rackham, 2003). Centuries of human management in European forests have modified species composition both by introducing certain species and genotypes, and by favouring certain species in selective cutting (e.g. Gil et al., 2004; Urbieta et al., 2008). Long-term anthropogenic impacts of various intensities are considered to be key factors in forest structure and species composition in regions with long human history in Europe (e.g. Decocq et al., 2004; Dambrine et al., 2007; De Frenne et al., 2011) and elsewhere (e.g. Ross and Rangel, 2011).

In central Europe, broadleaved forests were coppiced for centuries. After fossil fuels became widely available, coppicing lost its importance. By the end of WWII, this form of management was almost completely abandoned. In a few decades, whole landscapes once covered with open woodlands were transformed into closed forest areas, which caused massive losses for biodiversity conservation (Miklín and Čížek, 2014). Most coppice woods have been transformed into high-forests either by replanting or by reducing the underwood to one or two large trunks ('singling out') (Peterken, 1996; Van Calster et al., 2008; Rackham, 2008). In coppice woods, a fine mosaic of differently-aged forest patches and the presence of scattered old trees provided favourable conditions for a variety of invertebrates (e.g. saproxylic beetles, Vodka and Čížek, 2013), macrofungi (Diamandis and Perlerou, 2001) or herbaceous plants (Bartha et al., 2008). While coppicing forms a dynamic mosaic supporting high species diversity, after the transformation to high-forest lighter phases and permanent open areas

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are reduced with significant consequences for forest flora and fauna. Species dependent on cyclic changes (adapted to early successional stages) become threatened and gradually disappear from the landscape (Beneš et al., 2006; Freese et al., 2006; van Swaay et al., 2006; Van Calster et al., 2008; Baeten et al., 2009; Hédl et al., 2010; Kopecký et al., 2013).

In recent decades, interest in the reintroduction of coppicing in order to protect endangered species (Fuller, 2013; Vild et al., 2013) and obtain a sustainable source of energy (European Parliament, 2009; McKenney et al., 2011) has been steadily increasing in many regions of Europe, including England, Germany, Switzerland and the Czech Republic (EEA, 2006). For the successful restoration and sustainable management of coppice forests, detailed knowledge on the influence of management on species composition and biodiversity is needed. The assessment of relationships between management changes and subsequent species replacement can bring insights into factors driving species distribution and abundance.

Our study concerns the Pálava Protected Landscape Area (PLA), part of the Lower Morava UNESCO Biosphere Reserve (BR) in the southeastern part of the Czech Republic. In this study, we investigated changes in tree species composition and changes in herbaceous layer composition and diversity. Trees were studied through the past four centuries, and species of the herbaceous layer (following Gilliam, 2007) through the past five decades by focusing specifically on changes following coppice abandonment. Two types of information were used – archival forestry data and resurveys of semi-permanent plots in the 1950s and 2000s. On the basis of information on historical changes in tree species composition, our main goal was to test the hypothesis that the abandonment of coppicing caused significant changes in both tree and understorey species composition and affected the conservation value of forests protected within national, EU and international legislatives.

2. Materials and methods

2.1. Study area

The study area (Fig. 1) is situated in southern Moravia, in the northwestern corner of the Pannonian Lowland. It is the warmest and driest part of the Czech Republic with an average annual temperature of 9.6 °C, average annual precipitation of 524 mm, and large seasonal variability. Valuable natural areas have been preserved in the midst of the intensively cultivated landscape. Apart from a few isolated segments, there are two larger forests: Děvín Wood (400 ha covering most of Děvín Hill) and Milovice Wood (2500 ha). The limestone slopes of Děvín Hill (with altitudes from 260 to 549 m a.s.l.) represent a sharp environmental gradient (Fig. 2). The northwestern (NW) slopes have deep and fertile luvisols and leptosols. They are almost fully covered by thermophilous to mesophilous oak–hornbeam and ravine lime forests. The top and the southeastern (SE) slopes are exposed to sun and wind, soils are poorly developed and vegetation is mostly dry grassland with relatively small extents of ravine forests and thermophilous oak forests (Horák, 1969; Hédl and Rejšek, 2007). The gently undulating loess plateau of Milovice Wood (altitudes of 180–324 m a.s.l.) is covered by luvisols and represents one of the largest compact complexes of subcontinental oak forests in the region (Hédl et al., 2010). Small-scale plantations of non-native black pine (*Pinus nigra*), and scattered black locust (*Robinia pseudoacacia*) are also present.

For centuries, forests in this area were managed as coppice or coppice-with-standards. The coppice cycle was gradually lengthened from 7 years in the Middle Ages to 30–40 years in 1938. In the middle of the 20th century coppicing was abandoned in the whole area, resulting in a forest age structure unseen for at least seven centuries (Müllerová et al., 2014). Forests in the study area

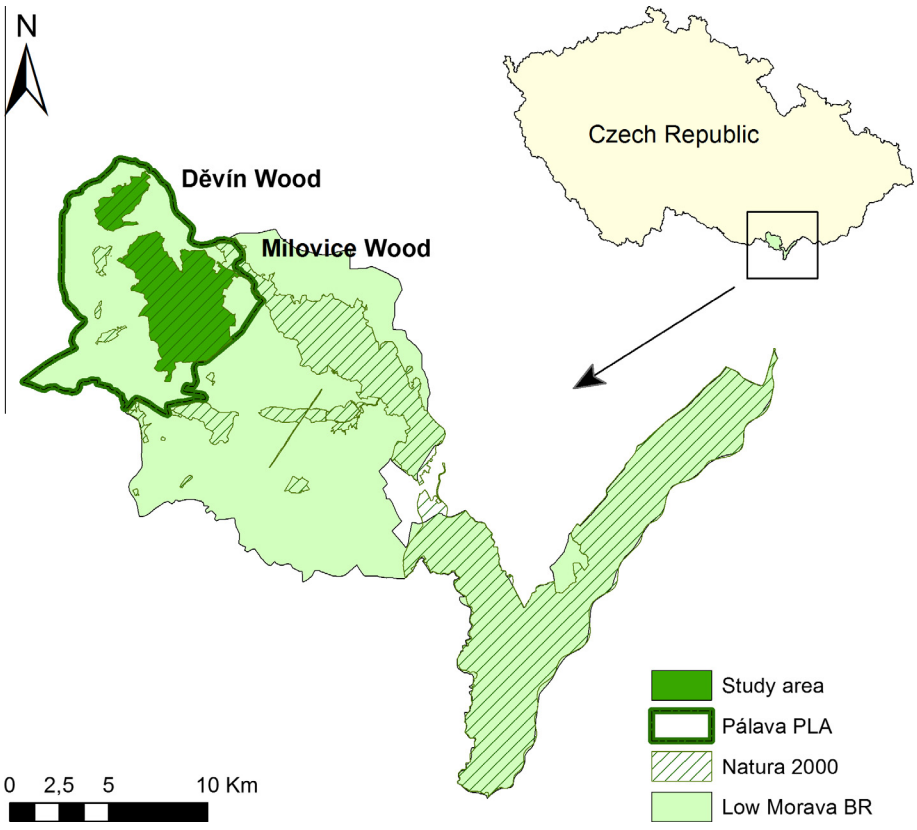

Fig. 1. Map of the study area with all type of protection marked (PLA = Protected Landscape Area, BR = Biosphere Reserve).