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Does a minimal intervention approach threaten the biodiversity of protected areas? A multi-taxa short-term response to intervention in temperate oak-dominated forests

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ABSTRACT

Efficient conservation management must be applied in protected areas in order to slow the loss of biodiversity in Europe. Regarding forests, a conservation approach based on minimal intervention prevails in most protected woodlands, thus facilitating the expansion of closed-canopy forests at the expense of open forests. To identify effective conservation strategies for protected forests, the minimal intervention or "hands-off" approach must be compared with active measures to support biodiversity.

We carried out a study in the oak-dominated forests of Podyji National Park (Czech Republic), an historically managed area left for natural succession since 1950. Twelve experimental clearings were created in closed-canopy forests within the core zone of the park; six of these clearings were connected to forest edges and open meadows, the remaining six clearings were isolated from open habitats within closed forest. To assess the importance of minimal intervention and active management measures in protected forests, we compared the richness and composition of insects, reptiles, birds and vascular plants in the clearings and in four reference habitats, including closed forest, forest edge, open forest, and meadow, in the first season following the intervention.

In comparison to closed-canopy forest, the clearings had higher species richness of butterflies, saproxylic and floricolous beetles, reptiles, and vascular plants but lower richness of moths and epigeic beetles, and similar richness of birds. For most groups, the species composition of clearings differed from that of closed forest or even the forest edge, indicating that the latter habitats cannot serve as a sufficient replacements for the conservation of open woodland species. The species richness of isolated clearings was generally lower than that of clearings connected to open habitats, and their communities contained a larger proportion of species associated with closed forest. Most threatened species were associated with clearings or open forest, closed forest and meadow hosted only a few.

The creation of the clearings in closed-canopy forests had a positive effect on overall species richness and supported threatened species in most model groups. It is thus a valuable management tool in the conservation of temperate woodland biodiversity. Our results also point to the importance of connectivity of open habitats in wooded landscapes. Further surveys of the clearings are needed to

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ascertain the effect of such interventions to see how communities change throughout succession, or alternatively to what extent hindering succession by repeated cutting may alter communities.

1. Introduction

Biodiversity conservation has long been a goal of European conservation policy (CBD, 2010; CEC, 1998). However, despite the fact that more than 25% of European land is afforded some level of protection for conservation, biodiversity continues to decline (EEA, 2009). One factor contributing to this decline may be unsuitable management practices in protected areas, or more specifically, the insufficient application of evidence-based conservation recommendations (Sutherland et al., 2004). A major concern involves the selection of efficient strategies for the conservation of biodiversity in forest ecosystems.

Today, most forests in Europe are closed, shady habitats. This contrasts with their past state, which was much more open and dynamic. The open structure was maintained by disturbances such as grazing and fires (Adámek et al., 2015; Bengtsson et al., 2000; Niklasson et al., 2010; Rackham, 1998; Szabó, 2010; Vera, 2000). These disturbances were later substituted by human silvicultural practices such as wood pasturing, controlled burning and coppicing. Wood pasturing and burning prevented full canopy closure and led to the formation of open, park-like habitats with numerous open-grown trees. In coppices, trees were usually cut down every 7–20 years (Szabó, 2010), which maintained a cyclical pattern of extreme changes in ground-level light penetration (Buckley, 1992; Joys et al., 2004). Traditionally managed woodlands were thus open, sunny, heterogeneous mosaics of forest in various stages of succession, which harboured a high richness of animals and vascular plants (Hédl et al., 2010; Benes et al., 2006; Bengtsson et al., 2000; Bugalho et al., 2011; Spitzer et al., 2008; Vodka and Cizek, 2013; Warren and Thomas, 1992).

However, the traditional management practices maintaining these disturbance regimes have largely been abandoned in most of Europe, especially over the last 200 years (Bergmeier et al., 2010; Müllerová et al., 2014, 2015; Tárrega et al., 2009). The formerly common, open woodlands have gradually been transformed into high closed-canopy forests in order to satisfy increased demand for timber or due to secondary succession. Due to the absence of regular disturbances, increases in canopy closure have also occurred in forests in protected areas. For instance, within nature reserves in the south-east of the Czech Republic, the expansion of closed-canopy forest has reduced the cover of open woodlands from 68.5% to 14.1% between 1938 and 2009 (Miklín & Čížek, 2013). Similar reductions have occurred across the European continent (Hartel and Plieninger, 2014; Rackham, 2003). As a result, species composition in forests has shifted from light-demanding and oligotrophic species towards more generalist, mesic and shade-tolerant species (Hédl et al., 2010; Kopecký et al., 2013; Van Calster et al., 2008; Van der Werf, 1991; Vild et al., 2013). Many species associated with open woodlands, including numerous plants, fungi, and animals that were common in the past have thus became rare or endangered.

In commercial forests, the maintenance of high canopy closure is economically justifiable, although even in these forests some forms of management may result in short-term canopy openings (e.g. selection cutting, thinning) (Pawson et al., 2013; Verschuyl et al., 2011). On the other hand, protected areas are mostly dedicated to biodiversity conservation. Management of protected forests therefore must consider the requirements of the species that inhabit those forests, including endangered species. Active management measures restoring or maintaining the open structure of forests in European protected areas are surprisingly rare (but see for instance Plieninger et al. (2015) for the use of wood pasturing), despite the fact that their need is emphasized by many studies concerning biodiversity of temperate forests (Götmark, 2013). Yet while active approaches to forest conservation management are continuously recommended by the scientific community, the "strict forest reserve" concept (Schultze et al., 2014) which prevents intervention is a standard practice applied to over 3 million hectares (or about 1.7% of forested area) in Europe (COST Action E4, 2000). Although traditionally managed open woodlands require a special approach to nature conservation (Götmark, 2013; Lindbladh et al., 2007), policies often consider coppicing or wood pasturing as undesirable disturbances to the "naturalness" of forests (Miklín and Čížek, 2014). Numerous studies compared the biodiversity of unmanaged (minimal intervention approach) and commercially managed forests concluding that minimal intervention favours biodiversity (Lassauce et al., 2013; Martikainen et al., 2000; Paillet et al., 2010). In protected areas, however, the choice is often between active conservation measures and minimal intervention approach rather than between the minimal intervention and commercial management. Yet there is little information comparing the effects of active conservation measures and the minimal intervention (Franc and Götmark, 2008; Götmark, 2013). Managers of protected forests thus lack basic information needed for qualified management decisions.

In order to quantify the effects of minimal intervention and active management approaches on biodiversity of protected forests, we carried out a multi-taxa study in the oak-dominated forests of Podyji National Park (Czech Republic). Twelve experimental clearings were created in unmanaged, closed-canopy forests of the core zone of the park. In the first season after their creation, eight model groups (butterflies, moths, epigeic, floricolous and saproxylic beetles, reptiles, birds and vascular plants) were sampled in the clearings and in adjoining reference habitats (including closed-canopy forest, open forest, forest edge, and meadow). To assess the effect of the active intervention we compared the species richness and the species composition of the model groups among the newly created clearings and the reference habitats. We also assessed the importance of individual habitats for sustaining threatened species in the sampling area.

2. Material and methods

2.1. Study area and design

This study was carried out in Podyji National Park (South Moravia, Czech Republic) (48°50′56″N, 15°53′13″E), an area covering 63 km^2 of the Dyje River canyon (ca 300 m a.s.l.). The canyon is characterised by nutrient poor, shallow soils. Until the Second World War, a large part of the area was managed by livestock grazing and coppicing, which kept the landscape open. After the war, these practices were abandoned, and secondary succession has led to an increase in canopy closure. Today, the area is covered with closed-canopy forests (hereafter referred to as "closed forest"), or more open remnants of the formerly coppiced and pasture forests (hereafter referred to as "open forest") on the upper slopes of the canyon.