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The potential of military training areas for bird conservation in a central European landscape

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ABSTRACT

European biodiversity has suffered from serious declines during the past few decades, with alterations of land use practices resulting in a loss of fine-scale habitat heterogeneity being a dominant driver. This heterogeneity was maintained by extensive landscape management, which has gradually been replaced by either intensive exploitation or land abandonment. It has been suggested that military training can generate habitat heterogeneity that may support the existence of species of conservation concern, but studies rigorously testing the real importance of military training areas for biodiversity are lacking. Here we address this issue by analyses of two datasets. First, we compared land cover classes between all large military training areas (MTAs) and surrounding control areas (CAs) of the same size in the Czech Republic using multivariate redundancy analysis. We found that the difference in land cover between MTAs and CAs was significant and represented the strongest gradient in land cover classes: from various farmland and artificial habitats typical for CAs to forest and scrubland-grassland mosaic typical for MTAs. Second, we selected one of these areas and compared bird species richness between the MTA and the nearby CA using generalized linear mixed effects models. We found that the number of species of conservation concern was significantly higher in the MTA than in the CA. With respect to habitats, bird species richness was significantly higher in the MTA than in the CA for open habitats, but not for forest habitats. Our results are thus consistent with the view that military training creates areas that are different from the surrounding landscape in terms of land cover, and that this difference translates to a suitability for species of conservation concern. It is remarkable that the positive influence of military training is confined to open habitats, which are subject to the most intensive military activities and also suffer the highest degree of deterioration in European landscapes.

1. Introduction

The alteration of land use practices has caused vast changes in European biodiversity over the past few decades (Donald et al., 2006; Tryjanowski et al., 2011; Sutcliffe et al., 2015). Specifically, there have been declines of species abundance and biomass (Reif, 2013; Inger et al., 2015), a loss of species richness (Koleček et al., 2010) and a homogenization of ecological communities when specialist species restrict their distribution (Le Viol et al., 2012; Reif et al., 2013a), resulting in increased extinction risk and conservation concern about these species (Trivino et al., 2013; Koleček et al., 2014). At the same time, generalists may benefit from changes in human land use and become even more widespread (Shultz et al., 2005; Sullivan et al., 2016).

Factors underlying such dynamic changes in ecological communities involve various landscape processes including agricultural intensification, land abandonment, urbanization and climate change (Eglington and Pearce-Higgins, 2012; Davey et al., 2013; Morelli et al., 2016). Despite varying driving forces, all these processes result in reduced habitat heterogeneity (Devictor et al., 2007), which in central Europe had originally been maintained by extensive landscape management (e.g. traditional low-intensity agricultural practices and the use of forests for fuel wood or cattle grazing) resulting in a fine-grained mosaic of habitats experiencing various levels of disturbance (Báldi and Batáry, 2011; Tryjanowski et al., 2011). Such heterogeneity enabled the survival of species specialized to different successional stages, as well as species requiring the co-occurrence of diverse microhabitats (Reif et al., 2013b). These extensively managed landscapes currently host exceptionally high biodiversity (Rosin et al., 2016), but are

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quickly vanishing from European landscapes in parallel with the economic development of formerly marginal areas of Eastern Europe and the Balkans (Sutcliffe et al., 2015; Zakkak et al., 2015).

Therefore, from a conservation perspective, it would be highly beneficial to not only conserve traditionally managed landscapes (e.g. Batáry et al., 2015), but to also identify sites with fine-grained habitat heterogeneity resulting from modern human activities (e.g. Berg et al., 2016). Recent studies suggest that for birds, such localities may include un-reclaimed post-mining sites (Salek, 2012), urban wastelands (Meffert and Dziock, 2012) and military training areas (Warren et al., 2007). Military training areas are particularly promising because their existence and value for biodiversity is not transient, as is the case for sites where ecological succession proceeds quickly (Prach and Walker, 2011), and their overall environmental impact is not as controversial as for mining, which produces serious risks for human health due to emissions and noise (Smith et al., 2013).

However, despite claims for the potential conservation value of military training areas (Cully and Winter, 2000; Woinarski and Ash, 2002; Reif et al., 2011), we are not aware of any study providing a rigorous test of such value using a rigorous data collection design. The only exception is a study from North America that found no difference in bird community dynamics between a military installation and a biological park (Rivers et al., 2010), but this study was performed in a prairie environment, which is very different from the environmental conditions of central Europe. To fill this knowledge gap, we decided to test whether biodiversity differs between sites in a military training area and control sites using an extensive bird survey. We used birds because they are easy to record and thus enable representative sampling over large areas (Jiguet et al., 2012). Moreover, bird species of conservation concern are well recognized (BirdLife International, 2015), and there is sufficient information about the ecology of all European species (e.g. Cramp, 1977–1994). Birds are also often used as biodiversity indicators (e.g. Morelli et al., 2015).

Our first aim was to compare the habitat composition among all large military training areas and the same-sized surrounding areas in the Czech Republic, to test whether military training results in significant differences in local environmental conditions. Then we used data on bird species richness collected in one of these areas to test predictions that (i) bird diversity would be higher in the military training area than in the control area, and that (ii) this difference would be more pronounced for species of conservation concern. Since present-day biodiversity loss in central Europe is particularly high in open habitats and rather milder in forests (e.g. Reif, 2013; Ram et al., 2017), we predicted that the positive role of military activities would be more detectable in open habitats than in forest habitats. Therefore, we further predicted that (iii) the difference in bird diversity between sites in the military training area and control sites would be greater in open habitats than in forests.

2. Material and methods

2.1. Study area

Our study took place in the Czech Republic, central Europe. Five large areas are used for military training in this country, and we used all these areas for an analysis of land cover (Fig. 1). For each military training area, we delimited an area of the same size within its immediate surroundings as a control (Supplementary Fig. 1). We then compared the land cover composition between the military training areas and control areas, using Corine Land Cover database (CLC) classes for the year 2006 (European Environmental Agency, 2012). We also tested whether these control areas mirrored the national-wide average of the values of particular land cover classes using a simple analysis of variance (Supplementary Table 1), and found that while military training areas showed markedly different values from the national-wide average for five land cover classes, the control areas did not differ for all but one class (Supplementary Table 1).

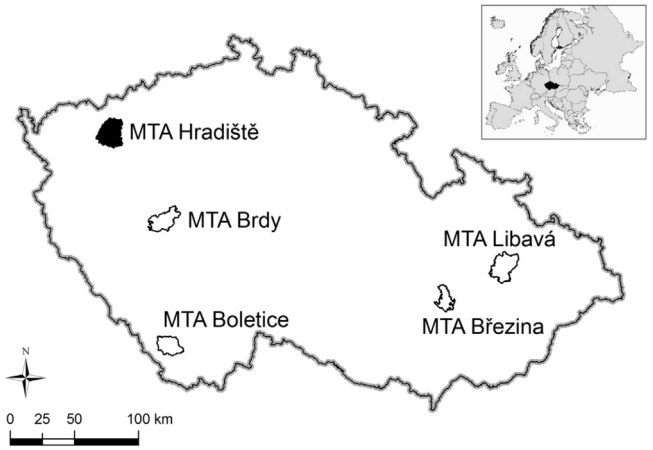

Fig. 1. Location of military training areas (MTAs) in the Czech Republic. The Hradiště MTA, which was used for bird counts, is filled in black. Inset shows the location of the Czech Republic within Europe.

In the next step, we selected one of these five large military training areas, called Hradiště, situated in Western Bohemia, for our investigation of bird species richness. We made this selection on the basis of accessibility for performing bird counts, but the results of the land cover comparison indicated that this area had a very similar land cover composition to the other large military training areas in the Czech Republic (see section 3.). For bird counts, we established a new control area near this selected military training area, aiming to fulfil the following rules: (i) to keep the size of the control area the same as the size of the military training area; (ii) to keep the land cover composition of the control area the same as the land cover of the Czech Republic; (iii) to locate the control area sufficiently close to the military training area to keep the environmental conditions (e.g. climate, hydrology) the same and, at the same time, to avoid double counts of the same bird individuals in the military training area and in the control area we set a minimum distance of 1 km and a maximum distance of 20 km between the military training area and the control area; (iv) to avoid sampling large cities, large industrial areas, mountain ranges and protected landscape areas, which all are absent in the military training area but occur in its surroundings; this imbalance could have resulted in trivial differences in bird community composition between military training area and control area masking biologically more interesting patterns. Given these constraints, this control area was located west of the military training area and was separated into two large parts due to the existence of a city and a protected landscape area between them (Fig. 2).

2.2. Bird sampling

We performed point counts to sample bird species richness (Bibby et al., 2000) and applied a stratified random approach for the selection of census points (following the recommendations in Voříšek et al., 2008). We first overlaid both the military training area and the control area using a grid with cells of 1 × 1 km. In next step, we randomly selected 10 cells from each area, taking the proportional coverage of forest and open habitats within each area