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Habitat characteristics associated with occupancy of declining waders in Polish wet grasslands

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ABSTRACT

Populations of meadow waders have shown steep declines in Europe during recent decades. However, empirical evidence concerning habitat preferences of different species in east Europe is largely lacking. In this study we investigate occurrence of the Eurasian curlew (*Numenius arquata*), black-tailed godwit (*Limosa limosa*), common redshank (*Tringa totanus*) and northern lapwing (*Vanellus vanellus*) in 413 grassland plots (c. 50,000 ha in total) located in Polish lowland surveyed three times during spring of 2015 and 2016. Using hierarchical occupancy models corrected for imperfect detection we link local water conditions, forest cover and scattered trees and presence of cows and buildings with occurrence of waders. Presence of godwit positively correlated with flooding and wetness while negatively with drainage ditches and single trees. Redshank was positively associated with flooding and negatively with ditches and proximity to buildings. Lapwing was less often observed in proximity to buildings and at sites with numerous trees whereas curlews, showed no clear associations with any of the environmental variables investigated. Detectability of studied species (except godwit) was higher when corvids were present suggesting that species interactions may affect detection. Field survey conditions (e.g. time of day, number of visit) also contributed to detectability of all studied species. Our study suggest that water availability, including natural flooding, increases habitat quality for breeding waders, while single trees and farm buildings may reduce grassland availability for these species. Thus waders-oriented agri-environment subsidies, besides adjusting grassland management to breeding phenology, should also focus on wetness and openness of grasslands.

1. Introduction

Waders of lowland grasslands and wetlands are among the most threatened birds globally and several key populations of these species have shown steep declines in Europe during recent decades (Pearce-Higgins et al., 2017). Some of them are classified as globally Near Threatened (Pearce-Higgins et al., 2017) and a majority is considered Endangered or Vulnerable in the European Union (BirdLife International, 2015). There are various threats impacting waders in their breeding grounds, during migration and in wintering areas (Pakanen and Thorup, 2016; Pearce-Higgins et al., 2017). Among these threats, two linked factors have been suggested to contribute most to the decline of grassland waders in Europe: decreasing amount of high quality breeding habitat and high predation pressure causing low productivity of breeding populations (MacDonald and Bolton, 2008).

Wet grasslands and farmland wetlands, which are key habitats for waders, have been considerably affected by agricultural intensification during the last 50–70 years. Extensive areas of wetlands and wet meadows have been drained and converted to arable fields (Zedler and Kercher, 2005). In addition, large areas of grasslands have been abandoned as traditional agricultural production on grasslands became unprofitable (Leito et al., 2014), resulting in overgrowing with shrubs and trees (i.e. habitats unsuitable for species preferring short vegetation). In some regions, especially along seashores, exploitation and conversion to built-up areas have further reduced the area of wet grasslands and marshes suitable for waders. The area of wet grasslands in Europe has been calculated to decrease by 60% during recent decades and only fragments of a historically common European farmland habitat are remaining (Zedler and Kercher, 2005).

The quality of remaining wet grassland patches has also been

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strongly affected by human activities. First, most wet grasslands are affected by water regulations and drainage, making grasslands less wet with less pronounced seasonal flooding (Paillison et al., 2002; Vickery et al., 1997). Secondly, mowing frequency and grazing intensity have increased in most remaining grasslands during the last decades. These changes have resulted in a simplified vegetation structure and changed species composition of the vegetation, which in turn have reduced availability of suitable foraging habitats and nest sites for wet meadow birds (Hoste-Danyłow et al., 2010; Verhulst et al., 2011).

Beside land-use changes, predation is another serious threat to grassland waders. Several empirical studies across Europe have shown that productivity of breeding populations of grassland waders is far below the threshold values ensuring population stability due to predation of eggs and chicks (MacDonald and Bolton, 2008; Roodbergen et al., 2011; Berthold et al., 2017), but also nest destruction due to farming activities and cattle trampling (Berg et al., 1992; Berg, 1992; Pakanen et al., 2016; Sharps et al., 2016). In most of the European studies reporting low productivity of grassland waders predation of red fox (*Vulpes vulpes*) and also crows (*Corvus corone*) have been identified as the most important (Ottvall et al., 2005; Chylarecki et al., 2006), although the evidence for crows as predators may be over-estimated, as they are more apparent to people (Macdonald and Bolton, 2008). It is likely that the high predation pressure is linked with increased number of predators (e.g. fox population in Poland increased from 56000 to 202000 between 1990 and 2016, Pac et al., 2016); thus chick survival and breeding success have declined significantly over last decades in Europe (Roodbergen et al., 2011). However, a decline in adult survival of some species was also observed (Pakanen and Thorup, 2016). Furthermore, land-use changes and predation can interact in grasslands overgrown with trees, since they can offer perches for avian predators (Berg et al., 1992; Kentie et al., 2015) and detection of predators can be limited due to lower visibility (Koivula and Rönkä, 1998). In addition, drainage of wetlands can make them more accessible, allowing mammal predators to penetrate easily the drained area and move frequently along linear structures such as ditches (Bellebaum and Bock, 2009; Niemczynowicz et al., 2017).

Due to recent development and intensification of agriculture in Central and Eastern Europe, this region faces large changes in agricultural land-use and landscape composition, with potential large negative effects on farmland biodiversity (Baldi and Fargo, 2007; Tryjanowski et al., 2011; Reif and Hanzelka, 2016). For example, several grassland bird species, including grassland waders, have declined in numbers (Ławicki et al., 2011). At the same time, available conservation tools, like agri-environment schemes, seem to fail to protect grassland bird diversity in many regions (Batary et al., 2015) and probably also in eastern Europe (Żmihorski et al., 2016a). Therefore, more empirical knowledge concerning habitat preferences and drivers of distribution and abundance of different species is needed. However, few, if any, studies have conducted large-scale evaluations of habitat preferences of declining grassland waders in east Europe.

In this study we investigated habitat characteristics associated with occurrence of wader species in Polish grasslands. We conducted a two-year survey of the four species: Eurasian curlew (*Numenius arquata*), black-tailed godwit (*Limosa limosa*), common redshank (*Tringa totanus*) and northern lapwing (*Vanellus vanellus*) in the main grassland and wetland complexes in Poland. Here we selected most of the largest grassland areas in the country, being important breeding grounds for Polish populations of waders. Waders are known to avoid forest edges, scattered trees and other perches for avian predators and prefer wet and open grassland habitats. Therefore, we collected data on forest coverage and scattered trees, wetness of the grasslands, their flooding regime and occurrence of drainage systems (e.g. ditches) in 413 surveyed grassland plots. We predicted that occurrence of the four species should be negatively associated with forest cover and occurrence of single trees in the grasslands and density of ditches and positively associated with increased wetness and flooding at the sites.

As habitat composition and vegetation structure can affect observers' ability to detect the focal species when present, we performed occupancy modelling (Kery and Royle, 2016), which takes imperfect detection into account, and thus produce better estimates of the real occupancy than traditional habitat models. We also included interactions with corvids as many of the wader species are known to defend their territories against these species, thus potentially being easier to detect.

2. Methods

2.1. Study area

During 2015 and 2016 we monitored occurrence of the four meadow wader species in key lowland grasslands and inland wetlands in western central and eastern Poland. For the monitoring we selected most of the grasslands hosting breeding populations of meadow waders, mainly Eurasian curlew, in Poland (see below). Most of the grasslands were located in river valleys (mainly Warta, Noteć, Bug and Biebrza and their smaller tributaries, see Fig. 1) and were often intersected by oxbow lakes, channels and drainage ditches. 75% of inventoried areas were placed within Special Protection Areas of Natura 2000. These grasslands were mainly semi-natural habitats on organic or mineral soils. The vegetation largely consisted of meadow plant communities with a variety of herbaceous plant species including grasses, sedges (*Carex* sp.), rushes (*Scirpus* sp.) and other herbs, but some shrubs and scattered trees also occurred. The proportion of homogenous patches dominated by reeds, tall sedge communities and other (e.g. *Glycerietum maximae*, *Phalaridetum arundinaceae*) varied between the studied areas. In Biebrza valley open marshlands covered with mosses, sedges and reeds dominated. Most of the grasslands and marshlands were managed for hay production (usually mown up to 2 times per year) and cattle grazing (mainly all season with low intensity or late in season after hay-cutting). In general, the grasslands were moderately fertilized and, in some areas, undersown with grasses or clovers. Grasslands located adjacent to rivers were often flooded in spring.

2.2. Transect selection

As a first step, all areas in Poland with breeding populations of Eurasian curlew known from literature were selected. These areas, mostly grasslands and mires of total area of 5253 km^2, were divided into 1818 grid squares (2 × 2 km each, Chylarecki, 2013), of which 950 had grassland coverage (based on Corine Land Cover) lower than 120 ha, and thus were considered unsuitable for this survey. Out of the remaining 898 grid squares 413 squares that seemed to be the most suitable for the Eurasian curlew were selected by local observers and regional experts. The local experts selected squares in which curlews were observed recently (e.g. during inventory in 2013; Chylarecki, 2013) and other squares that seemed suitable for this species. In total 413 grid squares (2 × 2 km each) were selected for the purpose of field surveys in 2015 and 2016. All selected 413 grid squares are located in the grassland areas with a high diversity of birds and are potentially suitable for breeding waders. The selected sites have a high grassland cover (70% on average, SD = 30).

Within each grid square observers delineated one 2 km long transect in grassland habitats. Transect position was adjusted to local terrain conditions and could be curved or broken to avoid rivers and lakes, forests, villages etc. Bird sampling and habitat mapping was performed within 300 m on each side of these transects (2 km × 600 m = 120 ha per transect, 49 560 ha along all 413 transects).

2.3. Bird counts

Each transect was visited three times during the breeding seasons of 2015 and 2016: 10–20 April, 01–10 May, 01–10 June, which cover the