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Conflict between habitat conservation and Corncrake *Crex crex* brood protection in managed floodplain meadows

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ABSTRACT

Land use intensification caused severe population declines in many grassland bird species. For the Corncrake, a multi-brooded, ground-breeding rail that inhabits mostly agricultural grassland, more frequent mowing at earlier dates is a threat to nests and broods and induces dispersal of adults. We used an occupancy model that allows for staggered arrival and departure times to estimate within-season movements of male Corncrakes and analysed how departure probabilities, calling site occupancy and habitat suitability were affected by land use. This study covered two study periods before (1998–2000) and after (2012–2015) a change in the local management regime. Male Corncrakes showed continuous arrival and departure during the breeding season, but delayed mowing dates reduced departure probability in the second study period, which should enhance the probability for second broods because less calling sites were affected by mowing especially during early July. Late mowing, however, implies economical losses for farmers and cessation of land use expanded. On unused meadows litter heights increased and plant species richness and forb cover declined, thus preferred habitat conditions deteriorated. Calling sites in unmanaged meadows were abandoned by male Corncrakes after few years without land use. Postponing first mowing dates until broods fledge is effective in protecting Corncrake broods, because more chicks should have survived until fledging but habitat quality depends on annual management. Because currently mowing late in the season is unattractive to farmers, we suggest that future Corncrake habitat conservation should along with financial compensations promote and evaluate the utilization of late-cut biomass for energy production.

1. Introduction

Many bird species associated with agricultural grasslands experienced severe population declines during the last century (Vickery et al., 2001; Donald et al., 2006). The main driving factor is assumed to be land use intensification (Newton, 2004; Perlut et al., 2006). Mechanisation and more frequent mowing during the breeding season increased threats especially to ground-nesting birds (Vickery et al., 2001). Earlier mowing dates coincide with critical stages of the nesting period leading to higher nest loss and mortality of broods and even incubating adults (Grüebler et al., 2008; Broyer et al., 2014). Birds may also face an increasing predation risk when vegetation cover is removed (Newton, 2004; Luscier and Thompson, 2009). Short intervals between subsequent harvests reduce the chance of successful re-nesting to compensate first nest loss (Perlut et al., 2006; Grüebler et al., 2015). With large-scale habitat reduction birds are eventually forced to depart from breeding sites without successfully completing breeding attempts (Grüebler et al., 2015).

Therefore, postponing first mowing dates until broods fledge is an effective conservation measure for many ground-breeding grassland species (Luscier and Thompson, 2009; Perkins et al., 2013; Broyer et al., 2014). Besides protecting broods and adults from mowing operations, conservation actions are also needed to maintain suitable breeding habitats on the long term (Atkinson et al., 2005). Land use intensification alters habitat conditions, resulting in a loss of nesting sites, a reduction of food availability and may also increase predation

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pressure (Vickery et al., 2001; Newton, 2004). Therefore, many species show higher breeding success on set-asides or benefit from low-intensity land use (Verhulst et al., 2004; Atkinson et al., 2005).

For several species, however, low management intensity and especially longer periods without land use may deteriorate suitable habitat conditions (Nikolov, 2010; Brambilla et al., 2010). Vegetation succession negatively affects primarily birds breeding in open habitats (Laiolo et al., 2004; Sirami et al., 2007). Grassland specialists, in particular those dependent on short swards for nesting or foraging rely on regular management by grazing or mowing (Verhulst et al., 2004; Durant et al., 2008; Tanneberger et al., 2008). This becomes increasingly important where a widespread use of fertilizers promotes eutrophication and vegetation changes (Wesche et al., 2012). Predation pressure may also be increased in unmanaged swards, because of higher abundance of small mammals and their predators (Laidlaw et al., 2013). Conservation of ground-breeders thus often involves the challenge to protect broods against land use and sustain habitat quality by an appropriate management at the same time.

Corncrakes *Crex crex* are medium-sized rails that breed on the ground in tall grass vegetation. Breeding habitats are mostly in agricultural use and populations have strongly declined in the past all over western Europe due to an intensified grassland management (Green et al., 1997a). Even though conservation measures have been established in several European countries and the populations have locally recovered (O'Brien et al., 2006), Corncrake numbers are fluctuating or still declining in many parts of western Europe (Koffijberg et al., 2016). In eastern Europe, where the species is more abundant, agricultural intensification continues (Aunins and Priednieks, 2009; Sanderson et al., 2013). Its long breeding season which may last until early September (Donaghy et al., 2011) makes it especially vulnerable to losses of nests and chicks during mowing operations. Corncrakes usually produce two clutches per season and second broods are important to sustain breeding populations (Green et al., 1997b). Hence, conservation measures include delayed land use until at least August (Koffijberg and Schäffer, 2006). Such long delays cause problems for farming because of depletion in fodder quality (Brown and Nocera, 2017). This creates a need for a targeted mowing regime, adjusted to the actual occupancy of Corncrakes in each year.

Corncrake occurrence is indicated by loud advertising calls males give during the night. During egg formation, nocturnal calling activity is reduced for a few nights and males resume calling at the same or at a newly established calling sites when females start incubating (Tyler and Green, 1996; Schäffer, 1999). Males do not participate in incubation or brood-rearing. They are highly mobile during the breeding season and long-distant movements occur especially after their original calling sites are mown, but also without disturbance from land use (Schäffer, 1999; Mikkelsen et al., 2013; Bellebaum et al., 2016). Due to their mobility, arrival and nest initiation, including second broods, extends over a period of at least two months. Moreover, males, and hence potential broods, are not fully detectable with a single count (Peake and McGregor, 2001). Successfully adjusting management to Corncrake occurrence thus requires knowledge about the dynamics of site occupancy.

In this study we used an occupancy model that allows for staggered arrival and departure times to estimate the number of occupied calling sites over the season (see also Arbeiter et al., 2017a). We analysed how departure probabilities, calling site occupancy and habitat suitability were affected by land use. Our findings are discussed with regard to possible improvements in the management of Corncrake habitats in floodplain meadows.

2. Methods

2.1. Study site

This study took place in grassland polders comprising a total size of 54 km^2 in the Lower Oder Valley National Park in northeastern Germany (53°03′N, 14°18′E). The study area holds the largest Corncrake population (up to 250 calling males) in Germany and is an important breeding site for other ground-breeding meadow birds, such as Common Snipe *Gallinago gallinago*, Redshank *Tringa totanus,* Yellow Wagtail *Motacilla flava* and the threatened Aquatic Warbler *Acrocephalus paludicola*.

The floodplain meadows along the Oder River are inundated during winter until early April. Vegetation is dominated by Meadow Foxtail *Alopecurus pratensis*, Reed Canary Grass *Phalaris arundinacea* and sedges *Carex* spp. Most meadows are agriculturally managed by low-intensity grazing with cattle or mowing once or twice each year. The study covered two study periods, before and after a change in management. During the first study period 1998–2000, mowing or grazing started mainly after 1 June and half of the area was managed by the end of July. Since 2009 conservation measures were introduced and land use was delayed on meadows occupied by Corncrakes until at least 15 July or 15 August. On meadows mown between 15 July and 15 August a Corncrake friendly mowing practice with refuge strips is applied to protect adults and chicks (Bellebaum et al., 2016; Arbeiter et al., 2017c).

2.2. Corncrake census

Nocturnal counts of calling male Corncrakes were conducted simultaneously throughout the entire study area on two occasions in mid-May and mid-June as a part of the national park conservation activities since 1996. In the two study periods 1998–2000 and 2012–2015 additional surveys took place approx. every 10 days in two subareas (c. 20 km^2, representing 70% of all calling sites) between early May and late July. Positions of calling birds were mapped from exposed structures, such as dikes and driveways in the field and later transferred to a GIS. A calling site was defined by a circle of 200 m radius based on first recorded positions and all further records within this area were attributed to the same individual, supposing the average distance of neighbouring males is 250 m (Peake and McGregor, 2001). We assumed departure from calling sites, when no call activity was observed during three subsequent controls (30 days). Records after this time period were treated as a newly established calling site of a different male. We identified 412 calling sites of male Corncrakes, which were at least occupied once during the study periods. For each calling site we determined the number of years since the last management was conducted and whether mowing or grazing had already occurred in the same year before the respective survey.

Additionally, to assess the impact of mowing on potential broods, we calculated the proportions of calling sites mown or grazed within 50 days after the last calling record. After this time no flightless chicks are expected to be present, assuming that males abandon nest sites when females start incubating (Schäffer, 1999). We determined the timing of broods based on nests found ($n = 5$) and chicks observed or captured during mowing operation ($n = 47$). Chick age was estimated using body mass (Green and Tyler, 2005) and by comparing feather development with photographs of chicks of known age (D. Wend, unpublished). Then we calculated the date of the start of egg-laying, supposing an average egg-laying and incubation period of 25 days (Green et al., 1997a).

2.3. Habitat data

On their breeding grounds Corncrakes require tall vegetation providing cover, but sparse enough enabling the birds to easily move through (Green et al., 1997a). In floodplain meadows walking ability is mainly impaired by accumulated dead plant material and diverse and forb-rich vegetation is preferred for breeding (Arbeiter et al., 2017b). Therefore, to assess habitat suitability for Corncrakes, litter height and vegetation cover and composition were recorded within 200 m around