Corncrakes *Crex crex* in crops – population dynamics, habitat use and conservation strategy in two intensively managed arable farming areas in The Netherlands and Germany

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Breeding Corncrakes are usually associated with herbaceous meadows and floodplain habitats whereas breeding in crops is often considered to be of secondary importance. Here, we present data for two regions where nationally relevant breeding populations of Corncrakes are found in crop-dominated, intensively managed agricultural landscapes: Oldambt in the Netherlands (2007-2015 3–70 calling males, up to 188 in 2003) and Hellwegbörde in North-Rhine Westphalia, Germany (2007–2015 4–60 calling males). Calling Corncrakes were present annually, but abundance was subject to large annual fluctuations. For Oldambt, no overall significant trend in numbers could be detected for the period 1984–2015; in Hellwegbörde a significant positive trend was found in a sample plot counted since 1991. The majority of males arrived in the second half of May and first decade of June, with influxes of late-arriving birds in some years. In Oldambt, more than 80 % of all Corncrakes were found in winter wheat and alfalfa. In Hellwegbörde, more than 80 % of all calling sites were situated in winter wheat, winter barley, triticale and spring cereals. Highest densities occurred in alfalfa (either in commercial use in Oldambt, or used as set aside in Hellwegbörde). All these crop types have in common that they provide suitable vegetation structure and cover by the time Corncrakes arrive in May and early June. Alfalfa and set aside are also assumed to have highest food abundance.

Abundance, aggregations of calling males, patterns of seasonal occurrence, as well as direct observations of chicks all point out that in both study areas Corncrakes do breed successfully, although data to quantify the amount of successful breeders is absent. Corncrakes in crops generally benefit from much later harvest dates compared to mowing of grassland. Birds settling in late May and even through June (winter wheat until late June) still have good opportunities to breed undisturbed and raise chicks to independence. Commercial cultivations of alfalfa, however, do attract many Corncrakes but do not allow successful breeding due to early and frequent mowing. The main arrival period, in combination with the general harvest regime (peaking in August), suggest that Corncrakes in crops will be hardly able to raise two broods in order to sustain a stable population. Therefore, it is likely that numbers observed also result from immigration from elsewhere, for instance birds that have lost a clutch in early mown meadows and/or birds that are in search for suitable habitat for a second clutch after leaving a first brood earlier in the season.

In order to protect chicks of late broods and moulting adults it is necessary to promote agri-environment schemes that include corncrake-friendly harvesting techniques (harvesting from one side to another), or leave refuge strips unmown. Additional conservation measures include provision of suitable forms of set aside, either to offer suitable breeding habitat that is left undisturbed during the entire season, or to provide refuge cover during or after harvest. Land use changes due to the increase of intensive cattle farms (Oldambt) or agricultural biogas plants (Hellwegbörde), as well as cumulative effects of infrastructural developments like commercial areas, motorways and wind turbines (Hellwegbörde) may affect both Corncrake populations on the longer term. Conservation strategies should therefore also focus on maintaining sufficient large areas of suitable habitat.

Key words: Corncrake *Crex crex*, crops, alfalfa, population dynamics, habitat use, conservation strategy

1. Introduction

Breeding Corncrakes are usually associated with meadows with tall grass or herbs, predominantly used for hay making (Green *et al.* 1997a, Schäffer 1999). In large parts of the European breeding range, these habitats have become increasingly important in the past centuries, as original breeding habitat in dynamic riverine meadows, lowland marshes and mires more and more disappeared as a result of large-scale habitat destruction (Flade 1997). Even if the species' name in some languages indicates a historical association with crops (e. g. Corncrake in English, Kornknarr in Swedish and Åkerrikse in Norwegian), settlements in crops are nowadays rare in most countries, and often thought to be of secondary importance (Green *et al.* 1997a). In this paper, we present two case-studies where a nationally relevant breeding population of Corncrakes is entirely found in dry, intensively managed arable farmland landscapes: the Oldambt area in the province of Groningen, The Netherlands, and the Hellwegbörde in the state of North-Rhine Westphalia, Germany. In Oldambt, Corncrakes have been known since the late 1940s (Braaksma 1962, Voslamber 1989), in Hellwegbörde since the 1960s (Prünte & Raus 1970, Müller & Illner 2001). Settlements in a range of crop types are a common phenomenon in both areas, where traditional grassland for hay making is nearly absent. In this paper we describe the two regions, report data on population dynamics, breeding status, seasonal occurrence and habitat use. Finally, we discuss conservation measures for Corncrakes in crops, which are partly different to those in grassland.

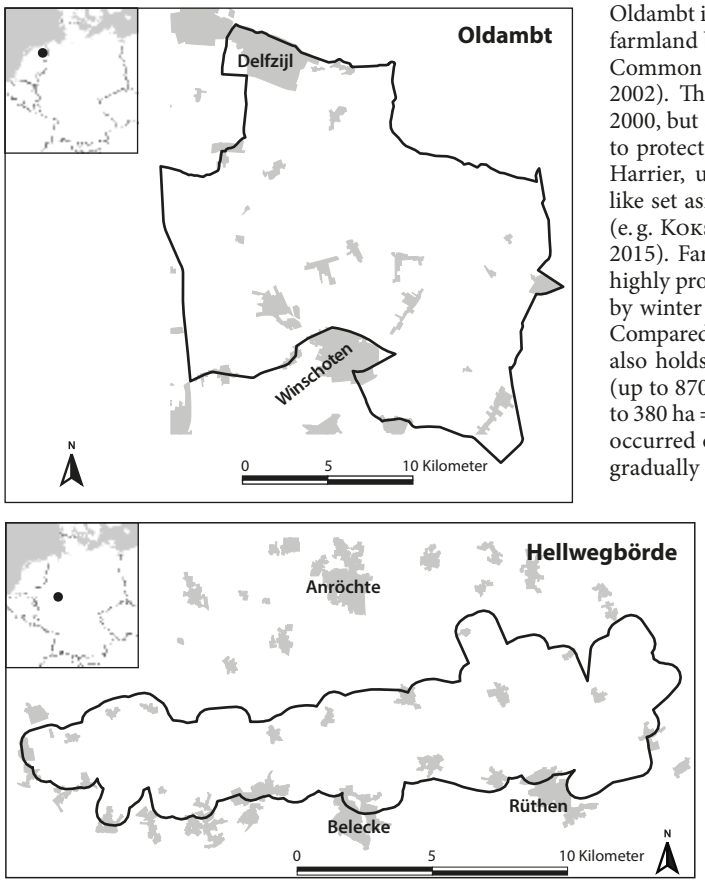

Fig. 1: Situation of Oldambt and Hellwegbörde study areas within The Netherlands and Germany and local overview of both study areas. – *Lage der Untersuchungsgebiete Oldambt und Hellwegbörde in den Niederlanden und Deutschland.*

2. Study areas

The **Oldambt area** is situated in the north-eastern part of The Netherlands, in the province Groningen and local district Oldambt (Fig. 1). Large parts of the area were temporarily part of the Dollard Bay (Wadden Sea) in the late Middle-Ages, and were successively embanked. Most of the area is situated around or just below sea level and represents a typical flat marine clay marsh. The area is among the most open landscapes in The Netherlands, only sparsely intersected with roads, ditches and canals, and with few scattered farm buildings and small woodlots (Fig. 2a). Structures like windfarms are still absent from the core breeding area for Corncrakes. Oldambt is known for its significant national populations of farmland birds, notably Montagu's Harrier *Circus pygargus*, Common Quail *Coturnix coturnix* and Corncrake (SOVON 2002). There is no formal protection regime like Natura 2000, but since the early 1990s, lots of effort has been spent to protect and improve breeding conditions for Montagu's Harrier, using different agri-environment schemes (AES) like set aside, field margins and specific crop-management (e. g. Koks *et al.* 2007, Kuiper *et al.* 2015, Schlaich *et al.* 2015). Farming is intensive and comes with well-drained, highly productive arable fields. Crops grown are dominated by winter wheat (2007-15 average 54 % of the study area). Compared to other arable areas in The Netherlands, Oldambt also holds a relatively large area of alfalfa *Medicago sativa* (up to 870 ha = 7 % in 1990) and caraway *Carum carvi* (up to 380 ha = 3 % in 1988; since 2000 nearly absent). Grassland occurred on a small scale in the mid 1980s (11 %), but has gradually increased recently (in 2015 25 %), due to arable fields increasingly being converted into highly productive improved grasslands for intensive cattle farming.

Also **Hellwegbörde** is a highly productive agricultural area that holds significant national breeding populations of Montagu`s Harrier, Marsh Harrier *Circus aeruginosus*, Corncrake and other farmland birds. It was therefore designated as special protection area (SPA; Joest & Illner 2013). The core breeding area of the Corncrake in Hellwegbörde is an open landscape along the "Haarstrang" uplands in the district of Soest (max. about 391 m a.s.l.). It consists mainly of agricultural fields with scattered settlements and woodlands (Fig. 2b). Compared to Oldambt, land use is more diverse in terms of the range of crops grown. The most dominant crop types are different winter cereals (60 %) and

oilseed rape (19 %). Semi-natural habitat types such as grassland and land set-aside under AES cover only a small part of the area. The area is intersected by five major roads. Since the early 1990's, about 116 wind turbines have been constructed within the area, including the Corncrakes' breeding range.

Fig. 2a: Typical habitat of the Corncrake in the Oldambt. – *Lebensraum des Wachtelkönigs im Oldambt.* Photo: K. Koffijberg

3. Methods

Field survey Corncrake

Census methods were based on nocturnal visits from dawn to dusk, focusing on the period of highest calling activity (Schäffer 1995, Tyler & Green 1996). Calling males were mapped on topographical maps or aerial photographs and usually located by cross-fixes to achieve highest accuracy. In both areas no recorder was used to stimulate males to sing.

In Oldambt, field surveys were carried out in a 27,000 ha study area between 1984 and 2015 (Fig. 1) and covering mainly the period 25th May-15th July. This period was derived from frequent censuses throughout the season in a fixed control area (Voslamber 1989). Before the end of May, accidental visits were made to check whether Corncrakes where present. Core areas were usually visited two to four times from the end of May onwards, other areas one to two times in the optimal time period (June). Nearly all searches for calling males were carried out on bicycle. Frequent stops were made to check for calling birds. Time effort between 1984 and 2015 ranged from seven to 18 visits per year (including visits with more than one observer active at once), each visit lasting from about 23:00 to 04:00 CEST. Surveys in 1993-1995 were incomplete and have been supplemented by non-systematic observations from local birdwatchers.

More detailed fieldwork was carried out in 2003 to assess breeding status and develop a management strategy for crop-breeding Corncrakes (Koffijberg & de Boer 2004). It consisted of weekly censuses in a fixed control area from mid May to mid August, including recordings of calling activity to assess breeding status (Schäffer 1995, Tyler & Green 1996). In addition, searches for Corncrake broods during harvest were made between 13th June and 9th August, on 16 fields where at least one calling male had been recorded before. These fields consisted mainly of winter wheat (7) and alfalfa (5). Age of observed chicks was classified according to an age-classification sheet made by D. Wend, based on captive chicks of known age.

In Hellwegbörde one to two surveys per year were carried out from 1991 to 2006, mostly in June in the 3,380 ha study area Menzel (Müller & Illner 2001). From 2007 to 2015 three to four surveys were carried out between 20th May and 10th July in a larger, 9,760 ha (8,500 ha open landscape) study area Haarstrang, which includes the study area Menzel. Visits were carried out from 22:30 to 4:00 CEST, by car and with frequent stops to record calling males. Overall time effort in the period 2007 to 2015 ranged from 13 to 24 visits with 48 to 80 hours each year for the entire study area.

After the season, maps with field data were entered in GIS to determine the number of territorial males. In Oldambt assignment of territories followed the guidelines from the national breeding bird monitoring, which implies that calling birds were only taken into account when heard between 20th May and 31st July (www.sovon.nl/soorten). New arrivals during subsequent visits were only counted when at least 1,000 m apart from existing settlements (to avoid duplicate counts). In Hellwegbörde, guidelines of Schäffer & Mam-

Fig. 2b: Typical habitat of the Corncrake in the SPA Hellwegbörde. – *Lebensraum des Wachtelkönigs in der Hellwegbörde.* Photo: R. Joest

men (2003) were applied, allowing new settlements during following visits at a distance of 200 m or more. This means that e. g. in terms of densities, Oldambt and Hellwegbörde are difficult to compare due to differences in effort, methods and interpretation of the data. However, as the same survey method in each study area was used over the entire time period, trends in numbers are very well comparable, as are analyses to study the association between Corncrake distribution and crop type.

Field survey land use

To determine habitat use of calling males, crop type of each calling site was recorded in the field during nocturnal censuses or checked during daytime. Crop types were: winter wheat, winter barley, alfalfa (commercially grown in Oldambt, only as set-aside within AES in Hellwegbörde) oilseed rape, triticale, spring cereals, set-aside, grassland, caraway (Oldambt), grass-seed, fodder grass, clover and others. Maize, sugar beet and potatoes, which still have bare ground in May/June, were combined in analyses as maize. Spring cereals (e. g. spring wheat, barley and oats) where combined because of their similarities in growth phenology. In both study areas they covered less than 5 % in most years, with the exception of 2012 in Hellwegbörde, when large parts of winter cereals had to be re-sown after freezing in winter. In both study areas, land use was recorded also for a large proportion of the overall study area. In Hellwegbörde this was conducted each year in 2007 - 2015 (2,830 – 4,850 ha), in Oldambt in eight years between 1987 and 2000 (10,118 – 17,692 ha). For 2007 - 2015 crop data for Oldambt were derived from the official agricultural statistics, available as a geodatabase from www.pdok.nl. In both areas, general notes on the progress of harvest were made in some years.

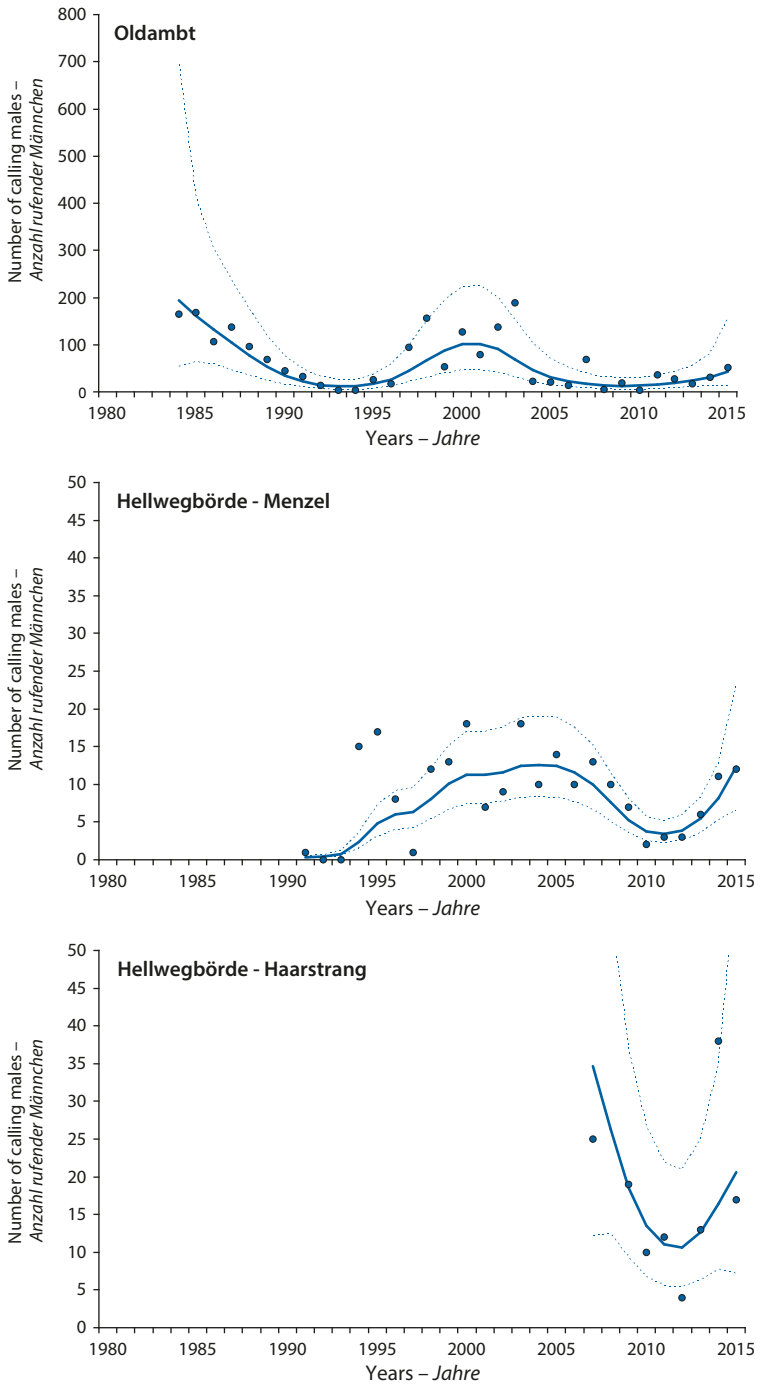

Fig. 3: Trends in numbers of calling males in Oldambt and Hellwegbörde (shown for both the long term data available for the study area Menzel and for the entire study area Haarstrang (which includes Menzel) from 2007 onwards). Given are annual numbers (dots), the overall trend (bold line) and its 95 % confidence interval (dashed line). Trends were calculated with the TrendSpotter package (Visser 2004, Soldaat *et al.* 2007). – *Bestandsentwicklung rufender Wachtelkönige im Oldambt und in der Hellwegbörde (langjährig untersuchtes Teilgebiet Menzel, sowie Gesamtgebiet Haarstrang ab 2007). Angeben sind der Bestand (Punkte) und der mit Trendspotter berechnete Trend (Visser 2004, Soldaat* et al. *2007), sowie die 95 %-Konfidenz Intervalle.*

3. Results

Population size and trends

Both in Oldambt and Hellwegbörde (latter with two separate data series), the number of calling males showed large annual variation. In Oldambt, numbers ranged from 3 in 1994 and 2010 to 188 in 2003 (Fig. 3). Before the study period, in 1979, an estimated 220 calling males were recorded (Voslamber 1989). During 1984-2015 distinct peak years were 1984 (165 calling males), 1985 (168), 1987 (137), 1998 (156), 2000 (127), 2002 (138) and 2003 (188). Poor years were 1993 (3), 1994 (4), 2008 (6) and 2010 (3). No significant trend in numbers could be detected over the period 1984-2015 (Fig. 3).

In Hellwegbörde, the number of calling males in the long term study area Menzel ranged from 0 to 18 in 1991-2015 (Fig. 3). No obvious peak years occurred, but several years with low abundance. There was asignificant positive trend since 1991 (annual population change 1.17, Fig. 3). In the larger study area Haarstrang (which includes Menzel), numbers varied between 4 and 60 from 2007 to 2015, with a distinct peak in 2008 (Fig. 3). Probably due to the rather short data series, no significant trend in numbers could be detected (Fig. 3). Even though situated in two entirely different regions, 200 km apart, annual numbers of calling males in Oldambt and in the long term study area Menzel in Hellwegbörde were significantly positively correlated ($r = 0.393$, df 30, $p < 0.05$).

Seasonal occurrence

Data from a frequently visited control area in Oldambt in 2003 show that first arrivals occurred during the last ten days of May (Fig. 4). By mid June, 50 % of the males had arrived and calling activity ceased as late as 7th August. Numbers of males present, and calling intensity, showed a bi-modal pattern, with peaks around mid June and around 10th July (not shown, Koffijberg & de Boer 2004). The overall survey data from 2007–2015 confirm that most males arrive in June, but also point at small numbers starting to call from early May onwards in some years. During 2007–2015, more than half (52 %) of all calling males arrived before 10th June. In some years, late influxes occurred, e. g. in late June in 2007 (19 % of males in that year) and in mid July 2011 (56 % of males in that year). Seasonal occurrence in Hellwegbörde was more difficult to assess, as no systematic recordings were made in the early and late parts of the season. Data from the surveys reveal that 58 % of all males arrived before 10th June (Fig. 4), roughly similar to Oldambt. Exceptional late arrivals

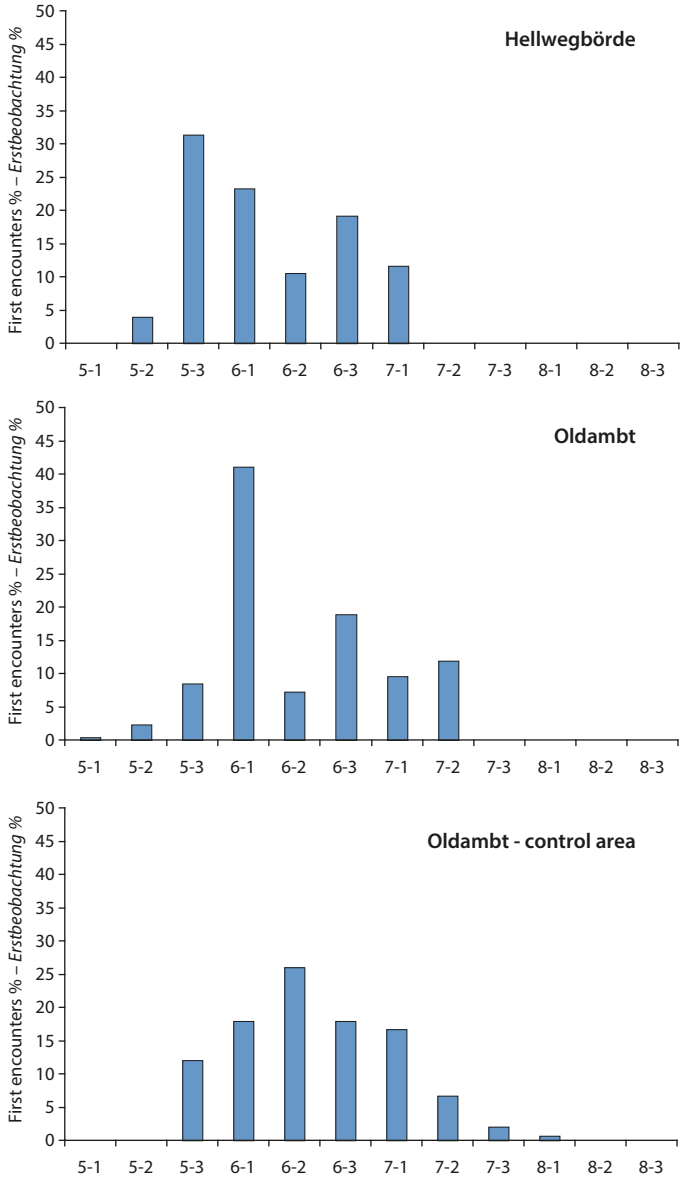

Fig. 4: Arrival of calling male Corncrakes in Oldambt and Hellwegbörde in 2007-2015. Shown is the date of first arrival (i. e. first contact within a "territory"), aggregated for 10-day periods. For Oldambt both results of weekly surveys in 2003 are shown (control area, independent of period of fieldwork, after Koffijberg & de Boer 2004), as well as general survey data. – *Phänologie des Wachtelkönigs im Oldambt und in der Hellwegbörde 2007–2015. Angeben ist der Zeitpunkt des erstmaligen Auftretens innerhalb einer Dekade. Für das Oldambt ist auch das vom Erfassungsaufwand unabhängige Ergebnis wöchentlicher Kontrollen vom 16. Mai bis zum 13. August gezeigt (*Koffijberg & de Boer *2004).*

occurred in 2008 (58 % of all males recorded after 20th June). Due to lack of surveys after 10th July, it is not known how long males remain active in the area.

In the period from 2007 to 2015, harvesting in Hellwegbörde started with winter barley in the last decade of July and peaked with triticale, wheat and spring cereals in the second decade of August. This is much later than mowing of grasslands in North Rhine-Westphalia, even those under AES options. In Oldambt, harvest (mowing) data of alfalfa started from late May onwards, followed by harvest of caraway and oilseed rape (mid June), winter barley (mid July) and winter wheat (end of July/early August) (Koffijberg & Nienhuis 2003). Also here, harvest of crops is late, compared to Dutch floodplain meadows (usually 15th June or 1st July, when under regime of AES).

Breeding records

Both in Hellwegbörde and Oldambt, there is evidence that birds reproduce successfully. In Oldambt, accidental breeding evidence was collected in the 1990s, including both records of nests and small chicks observed during harvest (Koffijberg & Nienhuis 2003). Detailed fieldwork in 2003 revealed occurrence of chicks in at least 6 out of 16 checked fields, all recorded between 1st and 9th August (Koffijberg & de Boer 2004). In another field, it was not clear if the two observed birds were large chicks or moulting adults (an adult Corncrake in full wing moult was hit by a tractor during harvest of winter wheat in August 2003). All chicks were observed in winter wheat and barley (both winter and summer). Checks during harvest of alfalfa between 13th June and 5th August only revealed adults escaping from machinery; chicks were never observed. Age of chicks in barley and winter wheat varied from about 7 days old to about 35 days old. In three fields age was not assessed as chicks were only recorded by their contact calls, which usually are made by small (<14 days old) chicks that still accompany the female (D. Wend, pers. comm.). Overall, the majority of chicks recorded (88 %) were younger than 14 days, suggesting hatching dates in the last decade of July and onset of laying by late June.

Direct evidence for breeding in Hellwegbörde was obtained for the first time in 1970, when one clutch was found (Harengerd 1971). Since then occasional observations of chicks and family groups have been made by ornithologists (e. g. 1998 and 1999, Müller & Illner 2001), and during harvesting activities by conservationists (e. g. 2012) and farmers (e. g. 2013, 2014).

Habitat use

Most Corncrakes in the two areas were recorded in winter cereals and alfalfa. In Oldambt in 2007–2015, more than 80 % of all Corncrakes were found in winter wheat and alfalfa (Fig. 5). Other crops only held small numbers of Corncrakes (albeit densities might be higher, see below). In Hellwegbörde during the same period, more than 80 % of all calling sites were found in cereals, especially winter wheat, winter barley and triticale. No Corncrakes were found in maize, sugar beet and potatoes, although these were present (sometimes at large scale) in several years in at

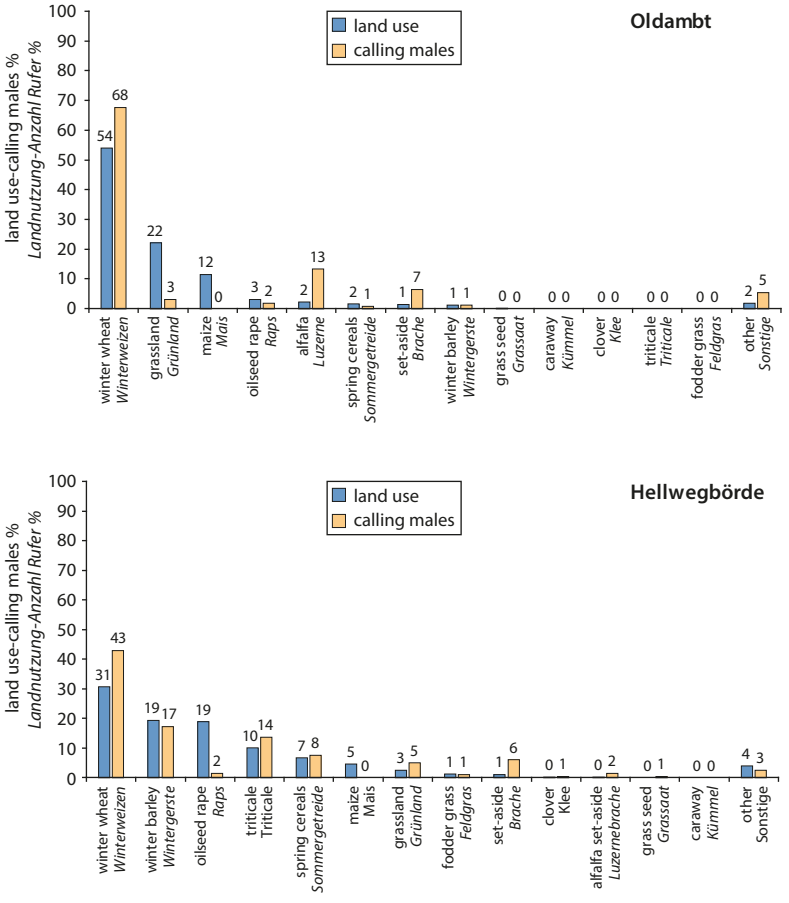

Fig. 5: Land use and location of calling sites of Corncrakes in Oldambt and Hellwegbörde in 2007-2015. – *Flächennutzung und Lage der Rufstandorte des Wachtelkönigs im Oldambt und in der Hellwegbörde 2007-2015.*

least one of the study areas. Only few Corncrakes were heard in grassland.

In terms of densities, alfalfa and set-aside were the crop types with highest densities in Oldambt during 2007–2015 (Fig. 6), as were 'other' crop types. These partly referred to small fields with accidental Corncrake recordings, but also include the small wetland reserve "De Tjamme" in the study area. In Hellwegbörde densities were highest in alfalfa-like crops as well (alfalfa used as set-aside within AES as well as clover). In addition, grass seed and set aside supported high densities. Densities in winter wheat and winter barley were much lower, both in Oldambt and Hellwegbörde.

4. Discussion

Crop-breeding Corncrakes in a wider perspective

Our data show that at least on a regional scale, crops may represent an important breeding habitat for Corncrakes. Both Oldambt and Hellwegbörde have supported large numbers of Corncrakes regularly for several decades. Numbers involved, aggregations of calling males, seasonal occurrence and records of confirmed breeding make it likely that both study areas are core breeding areas for Corncrakes (cf. Schäffer 1994), and not refer to accidental settlements as often has been suggested (cf. Green *et al.* 1997a). In a broader context, Oldambt is one of the most important breeding areas for Corncrakes in The Netherlands, since 2007 holding on average 20 % of the national breeding population (up to 43 % in 2015) (data Sovon Vogelonderzoek Nederland). In the 1980s, when the floodplain meadows of the Rhine experienced an historical low, the national share of the Oldambt population was even 67 % on average, thus representing the single most important breeding site in the country. Hellwegbörde represents the single most important breeding area in North-Rhine Westphalia (Grüneberg *et al.* 2013) and is among the larger core breeding sites in Germany (Gedeon *et al.* 2014).

Why Corncrakes occur in high numbers specifically in the two regions described in this paper still remains an intriguing puzzle. Crop-breeding has been reported from other areas and other countries, but not on the scale as described here (Green *et al.* 1997a). Both study sites presented here are characterized by high abundance of several other farmland breeding birds (Sovon 2002, Joest & Illner 2013). They are dominated by large fields and an open landscape, occurring on highly productive soil types. For Oldambt, Koffijberg & Nienhuis (2003) have hypothesized that crop-breeding could be a result of the large field size (allowing the typical clustering of calling males), the specific combination of suitable crop types (caraway and alfalfa even account for large share of national production), combined with the damp, clayish and calcareous-rich soils, which might increase food abundance (especially in comparison to other arable areas).

To what extent breeding populations in both areas are self-sustaining remains unclear as well, since evidence on timing of breeding and overall breeding success is scant. Compared to many grassland areas, seasonal occurrence of calling males is rather late (main arrivals from end of May onwards, and calling males remaining active as late as the first decade of August, cf. Fig. 4),

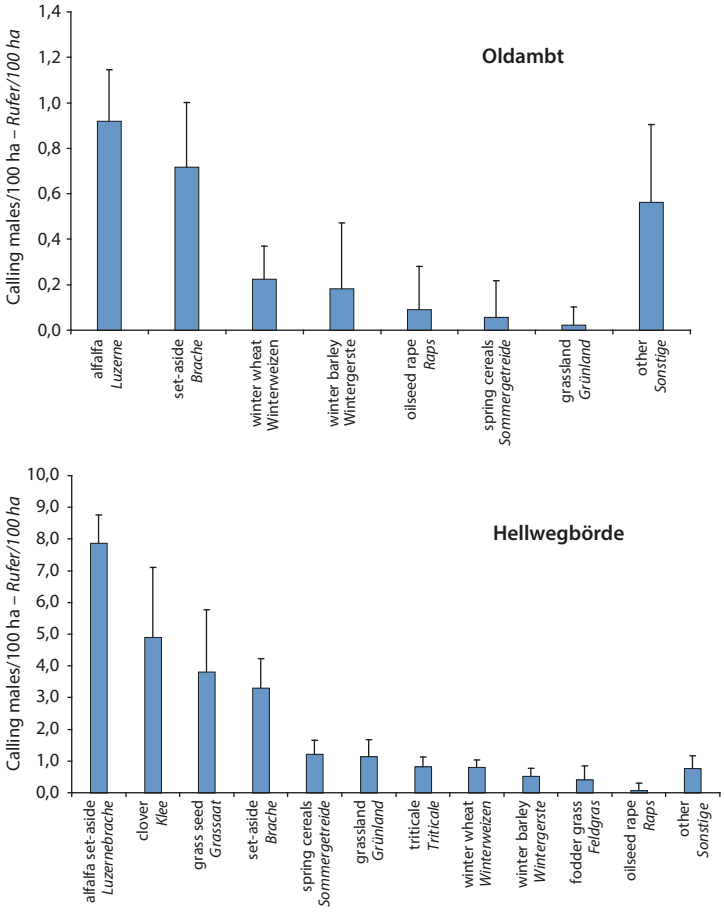

Fig. 6: Average densities ± SE of Corncrakes in Oldambt and Hellwegbörde in 2007-2015 in different land use types. – *Dichte des Wachtelkönigs im Oldambt und in der Hellwegbörde 2007-2015 in verschiedenen Nutzungstypen (± Standardfehler).*

although arrival in The Netherlands between e. g. the floodplain meadows of the Rhine does not really differ from that in Oldambt (Koffijberg, unpublished). Records of chicks in Oldambt in early August suggest that clutches may start as late as the end of June (see section Breeding records).

Both sites were occupied in all years of the study, but numbers showed considerable annual variation (Fig. 3). Compared to grassland (even with AES), Corncrakes in crops generally benefit from much later harvest dates. Harvest of most crops does not start before Mid-July, with main harvest period of winter wheat (in which most settlements occur) being the beginning of August for Oldambt and the middle of August for Hellwegbörde (later due to height above sea level). Assuming a breeding cycle of about 50 days from settlement to raise chicks to independence at two weeks (Green *et al.* 1997a), Corncrakes settling in winter wheat until about 15th June (Hellwegbörde up to 25th June) in theory would have good opportunities to breed undisturbed and raise chicks from at least one brood to independence. This period also matches well with the majority of arrivals (Fig. 4). Earliest arriving birds in May would have a theoretical possibility to raise two broods in winter wheat when harvest starts in September, but this is likely to happen only accidentally.

Besides, settlements in alfalfa, oilseed rape, caraway, grass seed and winter barley are already harvested in June or in the second half of July (winter barley), thus setting Corncrakes at risk of being disturbed, or killed by harvest activities. In commercial use, alfalfa is mown several times from late May onwards, with an interval of on average nine weeks between subsequent cuts (situation Oldambt). Koffijberg & Nienhuis (2003) showed that Corncrakes in Oldambt in 1998-2001 were not able to incubate a clutch undisturbed until hatching under this management regime. Corncrakes do settle in alfalfa fields after the first cut, but only after at least three weeks after the previous mowing date (when vegetation has regrown), thus not having time enough to incubate successfully before the second cut takes place. Hence, all settlements in this crop will remain unsuccessful. This was also confirmed by fieldwork in 2003, when no chicks were seen (Koffijberg & de Boer 2004). It is not known to what extent adult Corncrakes are at risk of being killed when alfalfa is mown, but it may happen because of the high-speed and heavy machinery involved in mowing (mowing swaths of 9.7 m at once and up to 15 ha/hour). Field checks in 2003, however, could not confirm this.

To conclude, it is very unlikely that many Corncrakes in crops will be able to raise more than one brood to independence, and thus will reproduce below the threshold of about five fledged chicks per female, needed to sustain a stable population (Green *et al.* 1997b). Compared to Oldambt, Corncrakes in Hellwegbörde might be more successful, given the larger amount of settlements in winter cereals and the later harvest period due to its height above sea level. In both areas it is likely that part of the settlements depend on immigration from elsewhere, which might also explain the significant positive correlation in numbers between Oldambt and Hellwegbörde, suggesting large-scale factors on population level to operate (cf. Koffijberg *et al.* 2016). Also late influxes in some years (Hellwegbörde in 2008, Oldambt in 2007 and 2011) can be seen in this context. Even so, successful breeding in crops may still support to overall population level, as it may represent birds that had failed to reproduce in e. g. early mown meadows at all and/or birds that were in search for suitable habitat for a second clutch after leaving a first brood in e. g. meadows in May or June.

Are crops a substitute for grassland?

The crops, which held large numbers or supported highest densities of calling males, all have in common that they have tall vegetation and achieve full soil coverage in May, by the time Corncrakes arrive. A vegetation height of 20-30 cm is generally considered a prerequisite for Corncrakes, as is a high vegetation cover to remain concealed in vegetation (Schäffer 1999, Green *et al.* 1997a). These conditions are met by e. g. all winter cereals, oilseed rape, alfalfa and caraway (Koffijberg & Nienhuis 2003). Also the herbaceous vegetation or crops used as set aside in our study areas meet these criteria. A crop type like alfalfa is probably very attractive for Corncrakes, as it is tall, has a very high vegetation cover, but is rather open on the soil floor, enabling the birds to move around smoothly. In this respect, it may resemble herbaceous-rich and semi-natural grassland with a low-intensity management regime. Vegetation measurements in Oldambt in 2002 showed that by mid May and mid June, sugar beet, maize and potatoes, which were avoided by Corncrakes, were still less than 20 cm tall on average, and did not reach 100 % vegetation cover (Koffijberg & Nienhuis 2003).

Apart from vegetation characteristics, food availability may be an important driver for crop-breeding Corncrakes, perhaps even more so than in grassland considering the extensive use of various pesticides (Boatman *et al.* 2004). In a recent study on breeding Skylarks *Alauda arvensis* in Oldambt, Kuiper *et al.* (2015) found highest densities of invertebrates from late May onwards in unmanaged field margins (i. e. set aside), followed by alfalfa. In direct comparison, invertebrate abundance was much lower in winter wheat. Preference of Corncrakes for alfalfa and set aside thus not only matches with suitable vegetation structure, but also coincides with higher food abundance. In Oldambt, where fields with alfalfa are usually maintained for 3-4 years, density of Corncrakes even increased with age of the field, suggesting possible increase in invertebrate prey due to absence of ploughing for several years in a

row, thereby also improving wintering conditions for invertebrates (Koffijberg & Nienhuis 2003). Given the large numbers settling in winter cereals, also these crop types apparently provide suitable breeding conditions, despite their lower food abundance. In Oldambt, spatial analyses showed that distribution of Corncrakes could be best explained by the numbers of calling males already present (calling males attracting others to settle, cf. Schäffer 1999, Schipper *et al.* 2011), a calcareous and dry soil type, and distribution of fields of alfalfa, caraway and winter wheat (Koffijberg & Nienhuis 2003). This suggests that at least winter wheat also on its own may attract Corncrakes. In Hellwegbörde, crops like caraway and alfalfa (at least on large scale) were absent, and most Corncrakes settled in (winter) cereals like wheat and triticale. Thus, also without very attractive crops like alfalfa in vicinity, settlements in winter cereals do occur frequently.

Conservation measures

Conservation of Corncrakes on farmland is difficult due to the unknown location of nests and highly mobile family groups. Compared to grassland, the delay of harvest is often not feasible economically, or even impossible at all. However, this might partly be less urgent, because harvest generally starts later (July-August) than mowing of grassland (May). Hence, to protect mobile chicks of late broods and moulting adults it is necessary to adopt Corncrake-friendly harvesting techniques. In fields where the occurrence of calling males indicates the possible presence of chicks, harvesting or mowing should be done from one side to the other. Preferred direction of harvest is towards neighbouring fields (or field margins and ditches) where vegetation will remain after harvest has been completed and birds thus can move to without leaving vegetation cover. Crop types that are harvested later (e. g. spring-sown cereals, like occurring in Hellwegbörde and fields with potato or sugar beet in both areas) might represent suitable refuges after harvest of winter cereals, as vegetation remains here well into August and later. Set aside field margins or refuge strips may also provide cover for moulting birds and chicks to survive in August when most fields have been harvested.

Alternatively, refuge strips in the centre of the field can be left unharvested, to provide cover during harvest. Studies in grassland-breeding Corncrakes in France (Broyer 2003), Ireland (Tyler *et al.* 1998) and Germany (Arbeiter *et al*. 2015) confirm that these provide shelter for chicks and adults and therefore increase survival during mowing. It is likely that such refuges will work on arable land, too, but research will be necessary to investigate its best size and efficiency. If left until winter, these refuge strips in crops may also provide food for wintering passerines, so a possible AES could serve more than one purpose at once. To increase the chance of chicks at least to survive harvest, the heights of stubble should be as high as possible. Experiences in Oldambt in 2003 showed that chicks were able to survive in high stubble during harvest as they still find possibilities to remain concealed.

Another management option is the introduction of set aside 'crops' or herbaceous-rich field margins, which have proven to be attractive breeding habitat in both Hellwegbörde and Oldambt. Such safe breeding habitats should be provided by a specific AES suitable for Corncrakes and implemented at a larger scale. In Hellwegbörde set aside measures so far have only covered less than 2 % of the area. Additional effort is needed to reach a sufficient area (Joest & Illner 2013, LANUV 2015). In Oldambt, set aside field margins covered about 1-2 % of the area. Moreover, they were not specifically managed for Corncrakes and usually mown in July unless a specific request for delayed mowing was issued. Creation of large fields with alfalfa for food provision of raptors, as implemented as AES recently in several parts of The Netherlands, requires frequent mowing to make voles available to raptors (Schlaich *et al.* 2015), and therefore is not suitable at all for Corncrakes (it even provides an ecological trap, as Corncrakes will be attracted when this AES is applied in their core breeding area).

Future prospects

The large scale intensification of arable farming that has caused substantial declines among many European farmland birds is likely to touch crop-breeding Corncrakes as well. Apart from harvest activities and lack of save refuge habitats, a factor affecting Corncrakes might be the decline of invertebrate prey due to pesticide usage (Wilson *et al*. 2009, Boatman *et al.* 2004, Jahn *et al.* 2014). Besides, in both study areas an increasing part of the area is planted with unsuitable (or early mown) crops (or improved grassland for silage production), caused by increased biogas plants (Hellwegbörde) or an increase in intensive cattle farming (Oldambt). Parts of the area formerly used by Corncrakes in Oldambt were already abandoned in the late 1990s due to this development (Koffijberg & Nienhuis 2003). In Hellwegbörde, also other infrastructures like commercial areas or motorways decrease size of suitable breeding spots, whereas traffic noise from roads and motorways may prevent settlement of calling males due to masking effects on the territorial call. The same effect probably holds true for noise from wind turbines (Garniel *et al*. 2007, Frühauf 2010, Langgemach & Dürr 2015). Cumulative effects and fragmentation of habitats by these factors have to be taken into account in conservation efforts as well. A study on Corncrakes in the floodplain meadows of the River Rhine indicated that Corncrakes are area-sensitive, probably because males tend to occur in clusters of territories (Schipper *et al*. 2011). Koffijberg & Nienhuis (2003) showed that in

Oldambt a high diversity of crop types, representing small fields and a fragmented landscape, negatively affected Corncrake abundance. Conservation strategies therefore should also focus on maintaining sufficient large areas of suitable crops.

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5. Zusammenfassung

Joest, R. & K. Koffijberg 2016: Wachtelkönige *Crex crex* auf Ackerland – Bestandsentwicklung, Status, Lebensraum und Schutzmaßnahmen in zwei Gebieten in den Niederlanden und Deutschland. Vogelwelt 136: 163 – 173.

In weiten Teilen Europas sind Wachtelkönige typische Brutvögel des extensiv genutzten Grünlands. Das gelegentliche Vorkommen in Feldfrüchten gilt daher als Ausnahme oder von geringerer Bedeutung. In dieser Arbeit stellen wir zwei Gebiete vor, in denen auf nationaler Ebene relevante Populationen des Wachtelkönigs in intensiv genutzten Ackerbauregionen leben: das Oldambt in der Provinz Groningen in den Niederlanden (2007-2015 3–70 rufende Männchen, max. 188 2003) und die Hellwegbörde in Nordrhein-Westfalen (2007–2015 4–60 rufende Männchen). Für das Oldambt ergab sich für den Zeitraum 1984 bis 2015 keine signifikante Populationsveränderung. Für die Hellwegbörde ergab sich für den Zeitraum 1991 bis 2015 ein signifikant positiver Trend. Die Größe der Populationen, die Bildung von Rufergruppen und das zeitliche Muster des Auftretens lassen zusammen mit gelegentlichen direkten Brutnachweisen darauf schließen, dass es sich in beiden Gebieten um reproduktive Kernpopulationen der Art handelt, wenngleich es unwahrscheinlich ist, dass Wachtelkönige regelmäßig zwei Jahresbruten in Äckern aufziehen können.

In beiden Regionen erfolgte die Besiedlung durch rufende Männchen in mehr als der Hälfte der Fälle vor dem 10. Juni. Allerdings gab es einige Jahre mit späteren Einflügen. Für den Zeitraum 2007 bis 2015 wurden im Oldambt mehr als 80 % aller Rufer in Winterweizen und Luzerne festgestellt, in der Hellwegbörde in Winterweizen, Wintergerste, Triticale und Sommergetreide. Bezogen auf das Flächenangebot wurden die höchsten Dichten rufender Männchen in Luzerne und Stilllegungen erreicht. In den auf Grund ihres großen Flächenanteils am häufigsten besiedelten Getreidesorten Winterweizen und Wintergerste waren die Dichten dagegen geringer. Mit Ausnahme von Luzerne, die häufiger gemäht wird, profitieren Wachtelkönige in Feldfrüchten von der im Vergleich zum Grünland späteren Mahd bzw. Ernte. Vor Ende Juni mit der Brut beginnende Wachtelkönige haben eine gute Chance, erfolgreich zu brüten und Jungvögel aufzuziehen. Für den Schutz der Jungvögel aus späten Bruten und mausernder Altvögel ist es jedoch notwendig, bei der Ernte auf die Vögel Rücksicht zu nehmen (Mahd von einer Seite beginnend, Belassen von nicht gemähten Rückzugsstreifen). Eine weitere Schutzmaßnahme ist die Schaffung von sicheren Brutplätzen und Schutzstreifen durch geeignete Stilllegungen im Rahmen von Agrarumweltprogrammen. Änderungen der Landnutzung durch Intensivierung der Rinderhaltung (Oldambt) oder Biogasanlagen (Hellwegbörde) sowie die kumulativen Effekte von Infrastrukturentwicklungen wie Gewerbegebiete, Straßen oder Windenergieanlagen können die Populationen negativ beeinflussen. Schutzmaßnahmen sollten die Erhaltung ausreichend großer Gebiete mit für den Wachtelkönig geeigneten Nutzungsformen zum Ziel haben.

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Corncrake habitat: Murnauer Moos, Germany. – *Wachtelköniglebensraum Murnauer Moos.* Photos: H.-J. Fünfstück
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