Recent population status and trends of Corncrakes *Crex crex* in Europe

Kees Koffijberg, Caspar Hallman, Oskars Keišs & Norbert Schäffer

Koffijberg, K., C. Hallmann, O. Keišs & N. Schäffer 2016: Recent population status and trends of Corncrakes *Crex crex* in Europe. Vogelwelt 136: 75 – 87.

In the mid-1990s, thriving Corncrake populations were discovered in many eastern European countries, leading also to downlisting the species on the global and European Red Lists. The collapse of collective farming systems provided the species with excellent breeding opportunities, and possibly as a result of movements from these eastern populations, also the relict populations in many western European countries are assumed to have benefited from this development. On the far western and southern fringes of the European breeding range, most populations have continued to decrease until recently, often associated with contraction of the national breeding range. However, in Scotland (UK) numbers increased steadily since the beginning of conservation measures in the mid-1990s, up to a plateau level from 2007 onwards.

A review of national breeding bird data shows that between countries distinct patterns exist in trends and annual fluctuations. On one side, Ireland, Scotland and France appear to have small annual changes, probably determined by local breeding conditions. On the other side, many other European countries report highly varying numbers from year to year. Some of them share similar years of peak abundance, e. g. 1998, 2000, 2002, 2003 and 2007, suggesting responses of Corncrakes to synchronous large-scale factors operating at European level. These patterns also suggest that Corncrake abundance in several countries on the European continent depends to a great extent on immigration from the core breeding states in eastern Europe, eventually in combination with fluctuations in productivity. Examples from ringing data, recently added with evidence from satellite-telemetry, show that male Corncrakes may wander considerable distances (up to 1,500 km) over the continent within one breeding season. Such movements partly will be the result of disturbance from mowing, but they may also reflect searches for suitable habitat for second broods. Causes for years with peak abundance are still poorly understood. Ringing data from the British Isles and France show that males in these countries show much smaller within-season movements, indicating a higher degree of natal and breeding philopatry and different dispersal strategies. This also explains why distinct years of peak abundance in neighbouring countries like The Netherlands, Germany and Denmark are not observed at all on the British Isles or in France. Also the lack of expansion in breeding range in UK, despite a population recovery, is likely to be the result of the lack of dispersal. These phenomena also correspond with subtle differences in genetic population structure, differences in morphological characters and perhaps also different migration routes and wintering areas.

Despite the estimated large Corncrake populations occurring in eastern Europe and its secure Red List status, global population assessments and our review of national trends indicate large differences in abundance within the European breeding range, and pronounced annual fluctuations in numbers in many countries, including persistent declines in the west and south. Given the ongoing changes in land-use and the species' sensitivity to changes in farming practise, it is also not clear if fortunes of Corncrakes, including those in the core breeding range, are secure on the long term. Many of the estimates with 10,000+ Corncrakes come with large uncertainties, and in several of the major countries like Russia a proper monitoring is lacking (but is also challenging), leaving us in the dark when it comes to future prospects of the species. Therefore, we strongly recommend co-ordinated and reinforced survey effort, at least prior to the next overall population assessment.

Key words: Corncrake *Crex crex*, breeding population, trends, dispersal, migration strategy

1. Introduction

The Corncrake has experienced historical population declines throughout large parts of its breeding range (Green *et al.* 1997, BirdLife International 2004). Decreases were already reported in the early 20th century and were initiated by increased use of mechanised mowing, allowing a more condensed mowing regime and causing greater losses among clutches and chicks (Koch 1932, Norris 1947, Broyer 1994, Green 2008). Further declines occurred in the past decades due to habitat destruction and ongoing intensification of agricultural practices, for instance abandonment of traditional hay-making, increased use of silage and further advancement in mowing dates (Stowe *et al.* 1993, Green & Stowe 1993, Sheppard & Green 1994, Broyer 1994, Green 1996, Ottvall & Petterson 1998). Only in eastern European countries, where original floodplain meadow ecosystems persisted and farmland management is less intensively, the species was generally able to maintain high densities (Green & Rayment 1996, Flade 1997, Mischenko 2016).

In the mid-1990s, surveys in the Baltic States, European Russia and other eastern European countries revealed thriving populations in this part of the breeding range (e. g. Elts 1997, Keišs 1997, Mischenko *et al.* 1997, Mischenko & Sukhanova 1999). Especially since 1997, Corncrakes also have shown population recoveries across many countries in Western-Europe. Several studies have associated this phenomenon with the high abundance of the species in eastern Europe (Koffijberg & van Dijk 2001, Schäffer & Green 2001, Schäffer & Koffijberg 2004). In addition, conservation schemes in some western European countries locally improved opportunities for successful breeding, as observed in Scotland (O'Brien *et al.* 2006, Wotton *et al.* 2015). Following the discovery of large breeding populations in eastern Europe and western Siberia, IUCN/BirdLife International downlisted the Corncrake successively from a "Vulnerable" globally threatened species in the IUCN Red List (1994) to a "Species of Least Concern" (2012). Today, its status in Europe is even regarded as "Secure" (BirdLife International 2015). In many countries throughout the breeding range, however, numbers of calling males are subject to pronounced annual fluctuations, whilst the increases from the late 1990s and early 2000s partly seem to have turned into a decrease in some countries in recent years (e. g. Bellebaum *et al.* 2016, Pykal & Flousek 2016).

Apart from these general population assessments, no attempts have been made so far to investigate dynamics in numbers of breeding Corncrakes. In this paper the current population status and trends in numbers are reviewed in more detail for a large number of countries in the species' breeding range, by making use of population statistics provided by BirdLife International (2004, 2015) and especially by analysing national census data. In focus are population dynamics and patterns in annual fluctuations for the period after 1995. When available, older data were retrieved as well to put recent trends in a broader context. Finally, possible mechanisms behind the observed population trends and their implications for the species' conservation are discussed.

2. Data and methods

General population statistics were taken from BirdLife International (2004) and the European Red List of Birds (BirdLife International 2015). These population assessments were based on enquiries among national monitoring agencies and BirdLife partners. For the European Red List in 2015, data from EU-countries were derived from national reports (see http://ec.europa.eu/environment/nature/knowledge/rep_birds/index_en.htm). Data from BirdLife International (2004) mainly referred to the period around 2000 (population status) and 1990-2000 (trends). For the European Red List of Birds population status was mainly assessed in 2008-2012 and population trends reviewed for the period 1980-2012 (long-term trend) and 2000-2012 (short-term trend). In both reviews, data quality was highly variable, both regarding population data and trend information.

In order to allow a closer comparison of national trends between countries, Corncrake census data from 18 countries were analysed (Table 1). Data were collected for the period 1968-2014, with a focus on 1995-2014. Corncrake surveys were either carried out by national census schemes or monitoring of key sites with (nearly) full coverage, monitoring of core breeding regions, monitoring of a network of sample sites from which national trends could be calculated, or national totals derived from a combination of monitoring data and non-systematic data. Hence, data quality differs per country, varying from high-accuracy data with (nearly) full coverage to censuses in key regions or a network of sample sites, thought to be representative for the entire country. Only in the European part of Russia sample plots were likely to cover too few sites to be used as a proxy for national trends (Mischenko & Sukhanova 2006, Mischenko 2016), but these data have been included as well to cover at least part of the large Russian population.

In all countries census data referred to nocturnal counts of calling males, which are commonly used to assess population size and trends in the species (Schäffer 1994). Counting intensity and methods to determine total numbers from the censuses slightly differed between countries. In many national surveys maxima from a series of counts were taken, in other countries multiple visits were used to determine the number of calling males. Since the same routines in a single country have been used from year to year, the data reported here will reflect true annual population changes.

For 12 countries with long and high-quality data series (cf. Table 1) trends in numbers of calling males were calculated, using the TrendSpotter package, with the annual numbers of calling males in each country as response variable. TrendSpotter provides a smoothed trend over time by using a Kalman filter (Soldaat *et al.* 2014), while accounting for serial autocorrelation. To investigate differences in the amplitude of fluctuations, the standard deviation of the residuals from the trend model were used (log-transformed). Furthermore we calculated correlation coefficients between the annual numbers in countries to seek for common pat-

terns in trends. All these statistics were carried out with the R software package (R Development Core Team 2015).

3. Results

3.1 International population status and trends

Around 2000, the European breeding population of Corncrakes was estimated at 1.3 to 2.0 million calling males, of which 83 % occurring in only six countries: Russia (European part), Ukraine, Romania, Belarus, Poland and Latvia. In contrast, 14 out of 38 countries (37 %) held 250 or less calling males, most of them situated in Northwest and South Europe. In 2008-2012 similar figures were retrieved: an estimated 1.29 to 2.12 million calling males, of which even 92 % in the six countries mentioned before. The successive trend assessments in 2004 and 2015 showed a temporary increase in many (16 out of 38) national Corncrake populations in the 1990s (Fig. 1). After 2000, however, only few countries (3 out of 41) have reported increas-

Table 1: Overview of national data on breeding Corncrakes. Data refers to: (1) national census scheme or monitoring of key sites with (nearly) full coverage; (2) censuses in important regions; (3) network of sample sites allowing national trend calculations; (4) sum of all calling males, from combination of monitoring data and non-systematic data. Period gives first and last year of the data series (number of years available in 1995-2014 given separately), Range in numbers represents the lower and upper population figures for the available data series. – *Übersicht von nationalen Bestandsdaten aus (1) Monitoring mit (nahezu) landesweiter Abdeckung; (2) Erfassungen in wichtigen Regionen; (3) Erfassungen auf Probeflächen, die eine Bestimmung von nationalen Trends ermöglichen; (4) Summen aller beobachteten rufenden Wachtelkönige. Periode entspricht die Länge der Datenreihen (Anzahl Jahre 1995-2014 gesondert angegeben). Min – Max stellt die Spanne in Bestandsangaben dar.*

Country – *Land*	**Data type – *Daten***	**Period – *Zeitraum***	**Coverage 1995-2014 – *Abdeckung 1995-2014***	**Range in numbers – *Min-max***	**Sources –*Quellen***
Belgium (BE)	4	2000-2014	15	1 - 31	Verbelen *et al.* 2016
Czech Republic (CZ, 2 regions)	2	1998-2014	14	66 - 146	Pykal & Flousek 2016
Denmark (DK)	4	1977-2014	20	20 - 529	Thorup 1999, Nyegaard *et al.* 2014, O. Thorup & K. Fredsø pers. comm.
Finland (FI)	4	1995-2003	9	461 - 7597	P. Parkko & M. Asikainen (Birdlife Finland) pers. comm.
France (FR)	1	1976-2013	14	277 - 1310	Broyer 1985, Broyer *et al.* 1994, Deceuninck 2010, Hennique *et al.* 2014
Germany - Brandenburg (BRB)	4	1995-2012	17	138 - 509	Ryslavy 2009, T. Ryslavy (LfU).
Germany – Nordrhein-Westfalen (NRW)	4	1971-2000	5	5 - 270	Müller & Illner 2001
Germany – Schleswig-Holstein (SH)	4	1990-2014	20	16 - 377	Jeromin & Koop 2009, B. Hälterlein & B. Koop (OAG Schleswig-Holstein) pers. comm.
Hungary (NE part, HU)	2	1997-2014	16	75 - 746	Boldogh *et al.* 2009, S. Boldogh pers. comm.
Ireland (IE)	1	1974-2014	20	128 - 230	O'Meara 1979, Mayes & Stowe 1989, Sheppard & Green 1994, Casey 1998, A. Donaghy pers. comm.
Latvia (LV)	3	1989-2014	20	818 - 1710	Keiss 2004, O. Keiss
The Netherlands (NL)	1	1968-2014	20	41 - 586	Koffijberg & Schoppers 2009, Boele *et al.* 2016
Norway (NO)	4	1984-2014	20	29 - 231	Isaksen 2006, Ranke & Øien 2011, Ranke *et al.* 2013, Heggoy & Øien 2013
Russia (European part, RUS)	3	1995-2005	11	267 - 1971	Mischenko & Sukhanova 1999, Mischenko & Sukhanova 2006
Sweden (SE)	4	1989-2008	12	212 - 1900	Ottosson *et al.* 2012, R. Ottvall pers. comm.
Switzerland (CH)	4	1970-2014	20	12 - 92	Schmid & Maumary 1996, Heer *et al.* 2000, Inderwildi & Müller 2015
United Kingdom (GB)	1	1978-2014	20	537 - 1275	Cadbury 1980, Hudson *et al.* 1990, Green 1995, Green & Gibbons 2000, O'Brien *et al.* 2006, Wotton *et al.* 2015
Estonia (EE)	3	1983-2014	20	71 - 691	J. Elts & R. Nellis pers. comm.

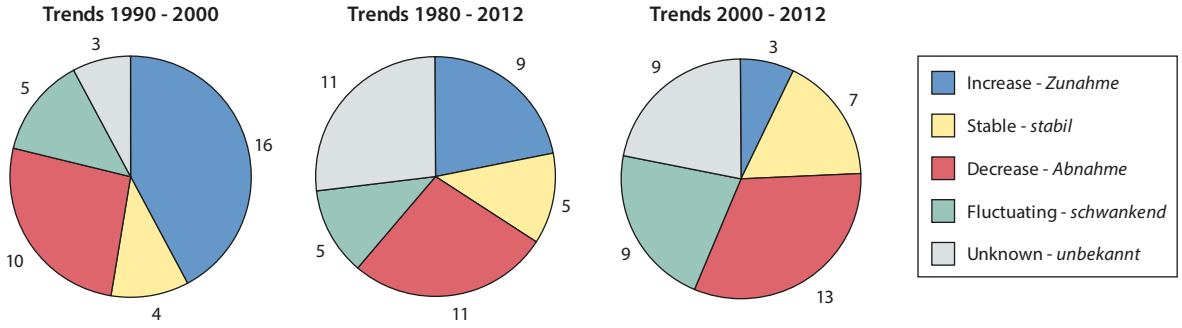

Fig. 1: Overall trend assessments for European Corncrake populations, period 1990–2000 after BirdLife International (2004), 1980–2012 and 2000–2012 after BirdLife International (2015). Shown is the number of countries and their trend assessment. – *Bewertung von Wachtelkönig-Bestandstrends in Europa für 1990–2000 (nach* BirdLife International *2004), 1980–2012 und 2000–2012 (beide nach* BirdLife International *2015). Dargestellt ist die Anzahl an Ländern und deren Trendbewertung.*

ing numbers, whereas stable or fluctuating numbers prevailed in 39 % of all countries. In all periods, also downward trends still occurred, even becoming dominant after 2000. For the long-term trend assessment 1980-2012 these partly also reflect the ongoing historical declines, which continued into the 1990s, and which have persisted until today in e. g. France (see also Fig. 2). From a comparison of long- and short-term trends it seems that mainly countries in the far western and southern fringes of the breeding range have experienced declines until recently. Besides Ireland and France these are e. g. Italy (see also Pedrini *et al.* 2016), Slovenia, Croatia, Bosnia-Herzegovina, Bulgaria and Turkey.

When looking at national trends in more detail, they confirm that ongoing declines in the two past decades have occurred in France, from 1995 onwards even with an average rate of 8 % per year (Table 2, Fig. 2). In 2015, the lowest number ever was recorded (200 calling males, E. Beslot pers. comm.). Also Ireland encountered a significant decrease until recently, but numbers have increased significantly from 2005 onwards (notably after 2012), associated with a positive response to conservation action (A. Donaghy pers. comm.). Denmark, Latvia, Norway and UK all show a significant increase in numbers since the start of their monitoring work from the late 1970s and 1980s onwards (usually with highest increase rate from 1995 onwards). In other countries, long-term trends are variable, due to the different years data series were available. When looking at the period after 1995, six out of 12 countries recorded a significant increase, whereas for five countries no sig-

Table 2: Summary of trends in numbers of calling males, computed with TrendSpotter. Long-term trends (with year of start) and short-term trends are shown separately. Given are the annual population change and a classification of the trend according to Soldaat *et al.* 2007: + increase, = stable, - decrease (all significant, $p < 0.05$), F fluctuating, i. e. non-significant trend. – *Zusammenfassung langfristiger (mit Startjahr) und kurzfristiger Bestandstrends. Dargestellt ist die jährliche Bestandsänderung, mit Einordnung des Trends (signifikante Trends als + Zunahme, = stabil, - Abnahme; nichtsignifikante Trends als F fluktuierend, nach* Soldaat *et al. 2007).*

Country – *Land*	**Long-term population trend – *Langfristiger Bestandstrend***			**Short-term trend after 1995 – *Bestandstrend seit 1995***	
	Change – *Bestandsänderung*	**Trend – *Trend***	**Start – *Startjahr***	**Change – *Bestandsänderung***	**Trend – *Trend***
Denmark	1.10	+	1977	1.17	+
Estonia	1.01	=	1983	1.04	+
France	0.94	-	1976	0.92	-
Germany – Brandenburg	n. a.			1.02	F
Germany – Schleswig-Holstein	1.12	+	1990	1.06	F
Hungary	n. a.			1.03	F
Ireland	0.93	-	1974	1.02	+
Latvia	1.03	+	1989	1.03	+
The Netherlands	0.98	=	1968	1.02	F
Norway	1.01	=	1984	1.07	+
Switzerland	1.03	=	1970	1.09	F
United Kingdom	1.02	+	1978	1.04	+

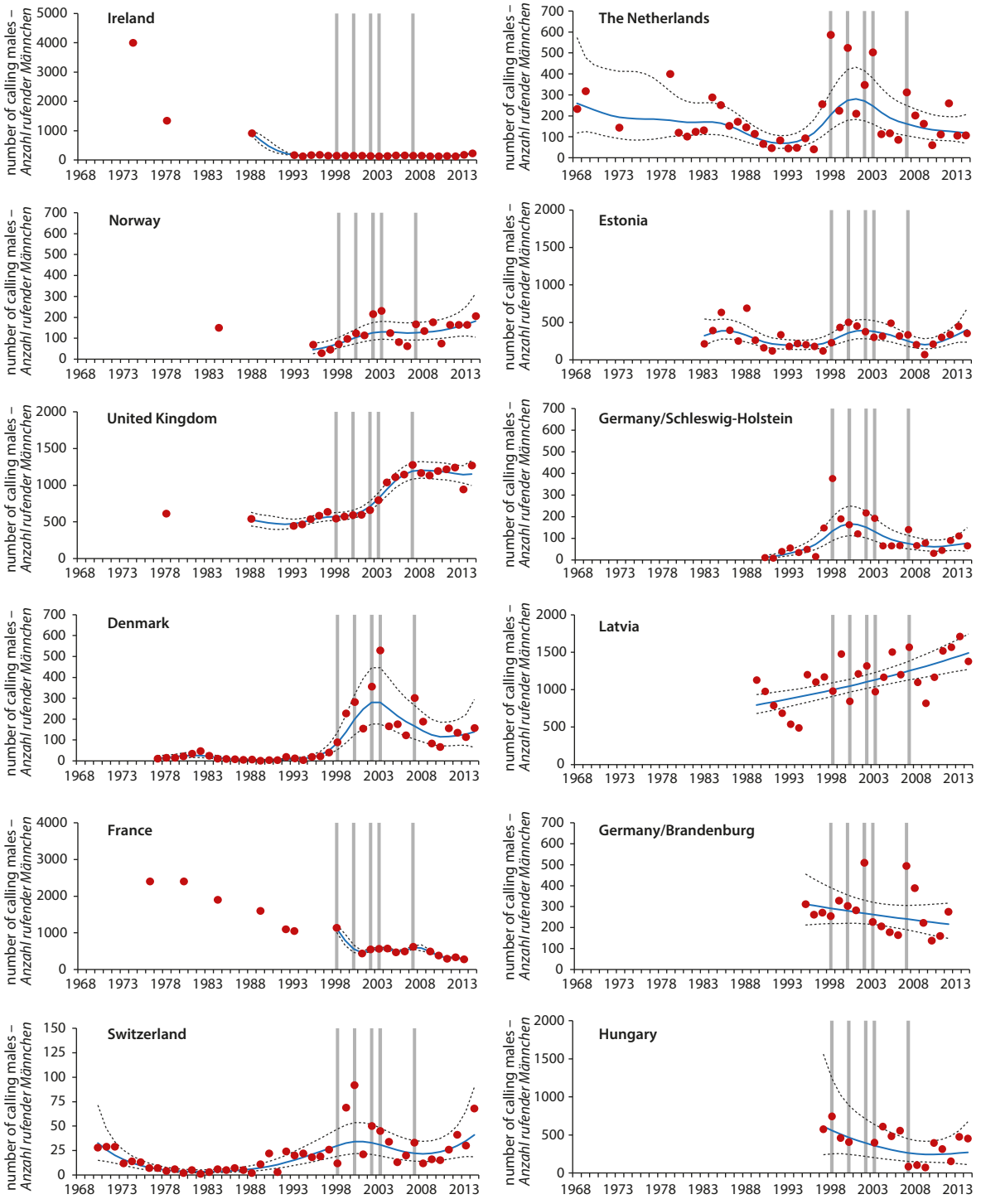

Fig. 2: Trends in Corncrake numbers for a selection of countries with longer data series. Shown are annual numbers of calling males (dots), the modeled trend (bold line) and the 95 % confidence intervals of the trend model (dashed lines). Obvious peak years, with counted numbers lying outside the upper 95 % confidence limit of the trend model and appearing in more than one country, are shaded. – *Trends der Wachtelkönigbestände in ausgewählten Ländern mit längeren Datenreihen. Dargestellt sind die jährlichen Bestände rufender Männchen (Punkte), der Bestandstrend nach TrendSpotter (fette Linie) mit 95 % Konfidenzintervall (dünne Linie). Einflugjahre mit Beständen größer als die obere 95 %-Konfidenzgrenze in mehr als einem Land zeitgleich sind grau hinterlegt.*

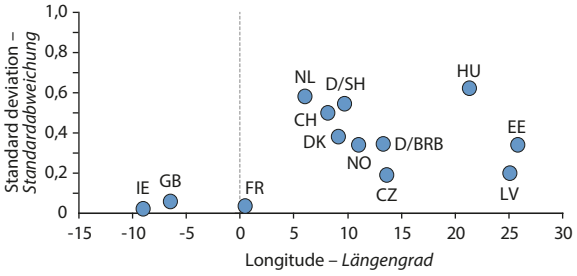

Fig. 3: Amount of fluctuation in annual numbers of Corncrakes per country in 1995-2014, expressed by the standard deviation of the residuals from the TrendSpotter trend models (see Fig. 2). Countries are ranked according to longitude, see Table 1 for country abbreviations. – *Stärke der Fluktuationen von Wachtelkönigbeständen pro Land 1995–2014, dargestellt als die Standardabweichung der Residuen des Trendmodells (Abb. 2). Länder geordnet nach Längengrad, Kürzel für Länder. s. Tab. 1.*

nificant trend could be detected (Table 2, Fig. 2). In the UK, the initial increase from the mid-1990s onwards reached a plateau level after 2007.

3.2 Patterns in annual fluctuations

In many countries for which long-term trend data could be accessed, abundance of Corncrakes was characterised by pronounced ups and downs (Fig. 2). There is a striking difference, however, between countries. Especially some countries in the western part of the species' continental breeding range show considerable annual fluctuation in abundance, for instance The Netherlands, Denmark, parts of Germany and Switzerland. Contrastingly, in France, UK and Ireland, fluctuations are nearly absent (apart from the pronounced decline in UK in 2013 caused by unusually cold spring weather, see Beaumont & England 2016). These differences are also expressed by the residuals from the TrendSpotter trend models (Fig. 3), which differ significantly between Ireland, UK and France and all other countries, situated on the European continent ($t = -4.038$, $df. = 11$, $p = 0.002$). Highest rates of fluctuation were recorded in The Netherlands, Schleswig-Holstein in Germany, Switzerland and Hungary.

Some of the observed fluctuations come with pronounced peak years, observed in one or more countries simultaneously (Fig. 2). Synchronized peak abundance (including countries from Table 1 for which no formal trend analysis was carried out), was especially recorded in 1998 (The Netherlands, Schleswig-Holstein, Niedersachsen and Nordrhein-Westfalen/Germany), 2000 (Belgium, The Netherlands, Switzerland, Denmark), 2002 (The Netherlands, Schleswig-Holstein and Brandenburg/Germany, Switzerland, Denmark, Norway, Sweden, Latvia), 2003 (The Netherlands, Schleswig-Holstein, Switzerland, Denmark, Norway) and 2007 (The Netherlands, Schleswig-Holstein and Brandenburg in Germany, Denmark, Latvia). Similarities in annual abundance are also expressed by sig-

Table 3: Correlation of annual Corncrake abundance between countries (see Table 1 for abbreviations), for the period 1995-2014. Significant correlation coefficients ($p < 0.05$) shaded and printed in bold. – *Korrelationen zwischen Wachtelkönigbeständen in den unterschiedlichen Ländern von 1995 bis 2014 (s. Tabelle 1 für Länderkürzel). Signifikante Korrelationskoeffizienten sind grau hinterlegt und fett gedruckt.*

	GB	IE	FR	BE	NL	CH	SH	BRB	NRW	DK	NO	FI	SE	CZ	LV	RUS	HU	EE
GB	1.00	-0.04	**-0.63**	-0.06	-0.40	-0.17	**-0.50**	-0.22	-0.34	0.00	0.37	0.10	0.56	**-0.68**	0.36	0.20	**-0.56**	-0.05
IE		1.00	0.31	-0.39	-0.36	0.17	-0.21	0.05	-0.61	-0.29	-0.11	-0.34	-0.53	-0.26	0.27	-0.42	0.32	0.20
FR			1.00	0.18	0.38	-0.41	0.46	0.24	-1.00	-0.21	-0.43	-0.80	-0.61	0.06	-0.40	-0.55	0.54	-0.36
BE				1.00	**0.56**	0.24	0.34	0.13		0.24	0.01	-0.64	0.11	0.20	-0.28	-0.17	-0.26	-0.07
NL					1.00	0.35	**0.86**	0.35	**0.88**	**0.57**	0.27	0.10	0.22	0.50	-0.37	0.16	0.17	0.15
CH						1.00	0.20	0.32	0.30	**0.51**	0.40	0.40	0.09	0.35	0.03	0.32	-0.01	**0.53**
D.SH							1.00	0.35	**0.91**	0.37	0.13	0.01	0.10	0.33	-0.19	0.22	0.43	0.14
D.BRB								1.00	-0.06	0.38	0.35	0.42	0.51	0.34	0.19	-0.15	-0.46	0.14
D.NRW									1.00	0.59	0.60	0.39	**0.83**	-0.67	-0.30	0.40	0.37	0.52
DK										1.00	**0.68**	0.39	0.43	**0.58**	-0.02	0.00	-0.20	**0.44**
NO											1.00	0.46	0.52	0.36	0.17	-0.10	**-0.53**	0.23
FI												1.00	0.59	0.74	0.14	0.35	-0.72	**0.85**
SE													1.00	0.00	-0.06	0.32	**-0.85**	0.13
CZ														1.00	-0.41	-0.14	0.08	0.45
LV															1.00	0.16	-0.08	**0.47**
RUS																1.00	0.10	0.39
HU																	1.00	0.18
EE																		1.00

nificant positive correlations of numbers in a cluster of countries represented by Belgium, The Netherlands, Schleswig-Holstein and Nordrhein-Westfalen in Germany, Switzerland and Denmark (Table 3). Furthermore, annual abundance in the eastern part of the Baltic, incl. Finland, is positively correlated. Numbers in Ireland, UK and France are negatively correlated (significant for UK and France).

4. Discussion

4.1 Current status of the European breeding population

Following historical declines in large parts of the breeding range, Corncrakes have shown population recoveries in many countries from the 1990s onwards. The series of peak years between 1998 and 2003 seem to be part of a general population high, in line with the assumed increase of the overall breeding population in the 1990s (BirdLife International 2004, 2015). During these years Corncrakes were more abundant in many countries, both in the western part of the continental range (e. g. The Netherlands, Germany, Denmark, Norway) and in countries which constitute the core breeding areas in eastern Europe (e. g. Baltic States, Poland, Czech Republic, Slovakia, Slovenia, Romania and Moldova; BirdLife International 2004, Pykal & Flousek 2016). However, especially on the far western and southern fringes of the European breeding range, declines continued until recently. A notable exception in this context is the situation in Scotland, where a population recovery appeared from the mid 1990s onwards, in response to concerted conservation action (O'Brien *et al.* 2006). Very recently, and after a significant contraction of the national breeding range, similar observations have been made in Ireland (A. Donaghy pers. comm.).

The general increase in Corncrake numbers in the late 1990s has been commonly attributed to optimal breeding opportunities and high reproduction rates in eastern Europe. Corncrakes are assumed to have benefited from the collapse of collective farming systems and abandonment of large agricultural areas in the late 1980s and early 1990s (Schäffer & Green 2001, Keišs 2003, 2005, Mischenko 2016). Since annual survival is low (0.20-0.30, Green 1999, Green 2004), Corncrake populations are highly sensitive to changes in reproduction rates (Green *et al.* 1997). Hence, favourable breeding conditions and increased productivity in eastern Europe are thought to have boosted the total breeding population, resulting in high abundance in e. g. the Baltic States and Russia, where total population size in the 1990s was estimated well above 1 million calling males (BirdLife International 2004).

It is likely that this development has also contributed to the observed population increase in many countries in the northwestern part of the European continent, where small populations in the mid 1990s were often close to extinction and numbers started to recover in the late 1990s. This hypothesis is supported by findings from Wettstein *et al.* (2003a, 2003b), who found a moderate to high gene flow from northeast to southwest throughout the European continent. In some parts of Northwest Europe, increases have continued until recently (e. g. Norway), but in others numbers tended to go down after 2005 (e. g. The Netherlands, Schleswig-Holstein in Germany, see also Bellebaum *et al.* 2016, Pykal & Flousek 2016).

4.2 Is there evidence for different breeding populations in Corncrakes in Europe?

On the British Isles and in France, any impact from the agricultural changes in eastern Europe and subsequent population response by Corncrakes is very unlikely, as numbers of calling males did not show similar trends and patterns in abundance, in comparison to those observed in neighbouring countries on the European continent (Fig. 2, Table 3). At least in Ireland and Scotland, annual abundance mainly seems to depend on local breeding conditions, in combination with conservation effort (O'Brien *et al.* 2006, Beaumont & England 2016). Moreover, Corncrakes from Ireland, Britain and France show different dispersal behaviour, compared to birds in other countries. Ringing data from The Netherlands, Germany and the Czech Republic indicate that male Corncrakes may wander distances up to 1,500 km within one breeding season (see Tab. 4 in section 4.3). Extensive ringing effort on the British Isles revealed longest movements of adult males detected within one breeding season of 45 km and 18 km respectively (R. E. Green pers. comm.), despite widespread recapture effort, which could have detected movements of hundreds of kilometres (Green 1999). Furthermore, long-distance natal and breeding dispersal between years is also unusual in Britain and Ireland (Green 1999). This limited dispersal also explains the phenomenon that, despite a recovery in numbers, Corncrake distribution in UK is still confined to the westernmost part of Scotland, where the species persisted during the long period of declines across the rest of UK. In France, long-distance movements within a breeding season were not observed as well (F. Noël pers. comm.). In addition, Wettstein (2003b) hypothesised a higher degree of philopatry among French birds than birds elsewhere on the European continent (data for British Isles were not included), according to analyses with trace elements and stable isotope ratios.

Further differences also exist with respect to (timing of) migration and perhaps also wintering strategies. Ringing data give evidence that birds from the British Isles move through France and the extreme eastern part of Spain to their wintering sites in Africa (Wernham *et al.* 2002), whereas birds from more eastern populations on the European continent seem to move

through the Middle-East (Petterson 1992, Peške & Vlček 2015). Recent studies with geo-locators have confirmed the movements from UK-ringed birds, and have also revealed a double migration with birds first moving south to wintering sites in West-Africa and, later in the winter east-south-east to the Congo Basin (Green 2013). A recovery from a Dutch-ringed bird during spring migration in Syria (van den Bergh 1991, Walther 2008) and movements of satellite-tagged birds from Czech Republic (Peške & Vlček 2015) in spring and autumn indicate an eastern migration route of birds breeding in those countries.

Different migration strategies are also reflected in arrival patterns in spring. Arrival of males in Britain and Ireland takes place around 20th April, in Northwest France even in March and first half of April (Koffijberg unpublished). In other countries on the European continent, however, males usually arrive in the first week of May or the very last days of April, thus one to two weeks later than on the British Isles. The small variation in arrivals over a vast range of countries, including Russia, Estonia, Latvia, Sweden, Poland, Hungary, Slovakia, Czech Republic, Germany, Denmark and The Netherlands suggests a highly synchronized wave of arrivals taking place in early May, probably entering Europe through the Middle-East. Increased use of geo-locators or GPS loggers could probably help to get more insight in the migration patterns across the breeding range, but will involve considerable effort, given the low annual survival and differences in breeding philopatry.

Furthermore, Corncrakes in France, Ireland and Scotland are on average heavier and larger in structural size than birds from other countries (Keišs *et al.* 2004, Schäffer & Koffijberg 2004, Fourcade *et al.* 2016). All these differences between Britain and Ireland and France on one side, and other European countries on the other side, fit fairly well in the observed subtle differences in genetic structures across Europe (Wettstein (2003a, b, Fourcade *et al.* 2016). Fourcade *et al.* (2016) were able to distinguished genetic clusters for Scotland, western France/Italy and populations on the German/Polish border and further east (i. e. east of 12° E).

4.3 Are Corncrakes moving vagabonds across continental Europe?

The ups and downs in annual numbers of calling males in many countries on the European continent suggest a high amount of immigrants arriving in these countries in varying numbers from year to year, perhaps in combination with (local) fluctuations in annual productivity. In case of immigration, it is likely that such birds originate from the large core populations in the eastern part of the breeding range. There is evidence from ringing, that male Corncrakes frequently move considerable distances on the European continent within one breeding season in various directions (Table 4). Recent data from satellite-tracked males in Czech Republic confirm these movements (Peške & Vlček 2015). Such behaviour is probably more common throughout continental Europe, but poorly known since intensive ringing is only carried out in a few regions and recapture probability is low. The many records from the Czech Republic are the result of a co-ordinated national ring-

Table 4: Examples of long-distance movements (>100 km) of male Corncrakes within the same breeding season (May-August). – *Beispiele von Wanderungen von Wachtelkönig-Männchen über Distanzen von 100 km oder mehr innerhalb einer Brutsaison (Mai bis August).*

Ringed – *Beringt*	**Recovered or recaptured** – *Wiederfund oder Wiederfang*	**Source** – *Quelle*
23rd May 1972, Tiel, Gelderland, The Netherlands	1st August 1972, Gulbene, Latvia, 1,489 km ENE	van den Bergh 1991
5th June 1995, North-Bohemia, Czech Republic	6th July 1995 West-Bohemia, Czech Republic, 216 km SSW	Bürger *et al.* 1997
14th May 1996 Hradiste-Doupov, Czech Republic	31st May 1999, Polka, Czech Republic, 145 km SE	Cepák *et al.* 2008
5th May 1998, Luková, Czech Republic	15th May 1998, Koryukivka, Ukraine, 1,116 km ENE	Cepák *et al.* 2008
4th June 1999, Sumava Mts., Czech Republic	1st July 1999, Jura, Switzerland, 613 km WSW	Cepák *et al.* 2008
14th June 2000, Horovice-Nerezin, Czech Republic	3st July 2000, Koprivna, Czech Republic, 221 km E	Cepák *et al.* 2008
8th June 2007, Budenin, Czech Republic	18th July 2007, Mohra, Thüringen, Germany, 342 km NW	Cepák *et al.* 2008, Bairlein *et al.* 2014
28th May 2012, Schwedt/Oder, Germany	16th June 2012, Valtířov-Vranov, Pilsen region, W Bohemia, Czech Republic, 391 km S	Jiří Vlček pers. comm.
20th May 2013, Předboř, district Jihlava, W Moravia, Czech Rep.	13th June 2013, Heroltice, N Moravia, Czech Republic, 102 km NE	Cepák & Klvaňa 2014

ing programme that has been carried out since 1994 (Bürger *et al.* 1997, Cepák *et al.* 2008).

Factors triggering long distance movements of males within one breeding season are still poorly understood. Besides, it is not known if females behave in a similar way, as mainly males are ringed, because they are more easily trapped by tape-lure. Movements of some males were obviously associated with disturbance by mowing, e. g. birds that went from The Netherlands to Latvia and from Germany to Czech Republic. This also fits in the findings of Hoffmann (1997), who studied displacements of 100 radio-tracked males in Poland, after they had been disturbed by mowing. Of this sample, an estimated 60 % moved to areas outside a 100 km radius around the study site, suggesting that mowing might initiate considerable long-distance movements in Corncrakes. However, most of the Czech-ringed birds moved without obvious reason (J. Pykal pers. comm.). Data from radio-tracked males in the Lower Oder valley in Germany and the floodplain meadows of the Rhine in The Netherlands also demonstrated that during the breeding season males frequently left the area, partly but not exclusively because of mowing (Bellebaum *et al.* in prep.). Since Corncrakes usually produce two clutches in a breeding season (Green *et al.* 1997), such within-season movements may reflect searches for suitable breeding sites for a second brood, or a replacement clutch after the first brood has been disturbed. Several authors have pointed at shifts in distribution of breeding sites due to changes in vegetation structure throughout the breeding season (Flade 1991, Schäffer 1999, Green 1996). In a similar context, Corncrakes are known to move from lowland to mountainous areas during the breeding season, anticipating on a later start of the vegetation season on higher altitudes in spring (Delov & Iankov 1997).

Another aspect that is not very well understood yet is the mechanism behind years with peak abundance, in some countries appearing at the same time, implying common factors to operate. Koffijberg & van Dijk (2001) hypothesized that the influx in 1998 was triggered by heavy rainfall in Northwest Russia, leading to unfavourable breeding conditions at many breeding sites (as was confirmed by reports from local birdwatchers). Mischenko & Sukhanova (2006) explained low numbers in their Russian study plots in 2002 (also coinciding with peak-occurrence in some West-European countries) by extraordinary dry conditions in most river valleys. Other authors have mentioned weather conditions, notably precipitation, as well to be a driver of local numbers and distribution (e. g. Niedersachsen, Germany, Flade 1991, Schröder *et al.* 2007; Hungary, Boldogh *et al.* 2007). An explorative analysis of weather data provided by Klein Tank *et al.* (2002), however, was not able to detect any consistent and significant relationships with precipitation or temperatures in May-June, along a gradient of countries from Russia to The Netherlands (Koffijberg & Nienhuis unpublished). This does not imply that large-scale weather patterns do not matter, but it is more likely that Corncrake abundance depends on many more (and partly inter-related) local and regional factors, like e. g. habitat quality (vegetation structure), food availability, annual variation in mowing dates and fluctuations in productivity. This makes it very difficult to unravel causes for years with peak abundance.

4.4 Implications for conservation and management

Today, the Corncrake is globally listed as a species of 'Least Concern' in the IUCN Red List (IUCN/BirdLife International 2011) and in Europe its status is regarded as secure (BirdLife International 2015). However, we observe large differences in abundance and annual fluctuations in numbers within the European breeding range. Corncrakes breeding on the western and southern fringes of the breeding range still show overall ongoing declines, in France also in conjunction with a significant range contraction (Hennique *et al.* 2014). In Ireland, breeding sites in the south-western part of the country were abandoned recently, and birds now mainly concentrate in Donegal, where numbers recently increased as a result of conservation measures. Corncrakes in Scotland have recovered in response to conservation measures as well, but they have not yet re-occupied former parts of their breeding range within the UK, and their limited dispersal behaviour implicates that such an expansion may be very unlikely in future. In this context, also range expansions in Ireland and France do not seem very likely. Besides, the ongoing declines in France have not stopped yet.

For other western European countries, there is evidence that they at least partly depend on immigration from the large core populations in Eastern Europe. This also makes recolonisation of new breeding sites possible, on the provision that appropriate conservation action is undertaken. Site-specific data from The Netherlands show, that breeding sites established during the peak years around 2000, and having late-mowing regimes, have been occupied ever since (Koffijberg & Schoppers 2009). The same also applies to the Norwegian breeding population, which was able to keep the level of the peak years around 2000 (Heggoy & Øien 2013). However, numbers of calling males in many countries in continental Western Europe have tended to decline again, after the population high around 2000 (albeit coming with large annual variation). Also evidence that lower numbers recorded recently are linked to lower abundance in the core breeding populations in Eastern Europe is absent, as high-quality monitoring data is scarce among the countries with highest numbers. At least in the Baltic States, increases were still reported for the period 1995–2014 (Table 3).

Given the ongoing changes in land-use, including grassland abandonment as well as agricultural intensification in countries that have accessed the EU in the past decade, it is not clear if Corncrake populations are secure on the long term (see also Fourcade *et al.* 2016). In most countries, the species still heavily depends on agricultural practise. Monitoring of these developments is therefore important, but not carried out on a sufficiently large scale in several important range states. Therefore, we strongly recommend coordinated and reinforced survey effort, at least prior to the next overall population assessment, in order to avoid the use of outdated data (cf. BirdLife International 2015). Moreover, research on breeding biology, population demography and dispersal is strongly biased towards breeding birds in Britain and Ireland (Green *et al.* 1997), which obviously behave differently from breeding populations elsewhere. Hence, there is also a need for such work on the European continent, in order to understand population dynamics, e. g. in relation to conservation effort.

Acknowledgements: We are indebted to all folk who provides us with data or other sources of information, or connected us to colleagues in their country: Mika Asikainen, Jochen Bellebaum, Leo van den Bergh, Edouard Beslot, Sandor Boldogh, Bernard Deceuninck, Miro Demko, Anita Donaghy, Jaanus Elts, Fabrizio Florit, Knud Fredsøe, Rhys Green, Peter Haase, Bernd Hälterlein, David Hora, Hubertus Illner, Eva Inderwildi, Kjell Isaksen, Ralf Joest, Bernd Koop, Alexander Mischenko, Renno Nellis, Franck Noël, Ingar Jostein Øien, Richard Ottvall, Petri Parkko, Mark Pedersen, Jiri Pykal, Gianluca Rassati, Torsten Ryslavy, Jan Schoppers, Ole Thorup, Silvio Stucki and Dominique Verbelen. Jeroen Nienhuis & Erik van Winden (Sovon) took part in the data processing. Jochen Bellebaum, Ruud Foppen, Ralf Joest, Jean Secondi, Chris van Turnhout and especially Rhys Green are all thanked for their input in earlier versions of this paper. Part of the study was funded by the Royal Society for the Protection of Birds (RSPB).

5. Zusammenfassung

Koffijberg, K., C. Hallmann, O. Keišs & N. Schäffer 2016: Aktueller Status und Bestandstrends von Wachtelkönigen *Crex crex* in Europe. Vogelwelt 136: 75 – 87.

In vielen, vor allem westeuropäischen Ländern sind Bestände und Verbreitung von Wachtelkönigen im letzten Jahrhundert stark zurückgegangen. Daten von BirdLife International belegen jedoch, dass es um 1995 in sämtlichen Ländern Osteuropas große Brutvorkommen gab. Sowohl auf globalem Niveau als auch in Europa wird die Art deshalb mittlerweile nicht mehr als gefährdet eingestuft. Es wird allgemein angenommen, dass Wachtelkönige in Osteuropa in den 1990er Jahren vom Kollaps der kollektiven Landwirtschaft profitierten. Von dieser Entwicklung sind vermutlich auch die viel kleineren Brutpopulationen in anderen europäischen Ländern beeinflusst worden. Nur am West- und Südrand des europäischen Brutareals sind aktuell immer noch Abnahmen zu verzeichnen. Eine Ausnahme bilden dort die schottischen Wachtelkönige, die sich nach Beginn umfangreicher Schutzmaßnahmen erholten und aktuell eine stabile Population bilden.

Eine genauere Analyse von nationalen Bestandsdaten aus 15 europäischen Ländern sowie drei Bundesländern in Deutschland zeigt, dass die Anzahl rufendender Wachtelkönigmännchen in den meisten Ländern erheblichen jährlichen Schwankungen unterliegt, mit überwiegend zunehmenden oder fluktuierenden Beständen seit 1995. Zudem gibt es immer wieder starke Einflugjahre (z. B. 1998, 2000, 2002, 2003, 2007), die u. a. in Ländern wie Dänemark, den Niederlanden, der Schweiz und in einigen deutschen Bundesländern synchron auftraten. Dies deutet darauf hin, dass die Brutbestände in weiten Teilen Mitteleuropas von Bedingungen auf europäischer Ebene beeinflusst werden. Nur in Irland, Schottland und Frankreich sind die Schwankungen in den Beständen signifikant geringer als in den anderen Ländern und es fehlen synchrone Fluktuationen. Vermutlich stehen die Bestände in den drei Ländern vor allem unter Einfluss von lokalen Brutbedingungen, wie z. B. in Schottland bei auffälligen Bestandsrückgängen in kalten Frühlingen beobachtet wurde. Diese unterschiedlichen Trendmuster lassen vermuten, dass die Bestände in vielen anderen westeuropäischen Ländern im hohen Maß von Immigration aus den viel größeren osteuropäischen Brutpopulationen abhängig sind, eventuell auch von (oder in Kombination mit) Schwankungen im Reproduktionserfolg.

Beringungsdaten sowie aktuelle Daten aus der Satellitentelemetrie zeigen beispielhaft, dass zumindest Wachtelkönigmännchen auf dem europäischen Kontinent größere Strecken (bis zu 1.500 km) innerhalb einer Brutsaison zurücklegen können. Solche Wanderungen werden teilweise auf Störungen durch Mahd zurückgeführt. Sie könnten aber auch der Suche nach geeigneten Standorten für eine Zweitbrut dienen. Genauere Gründe für die offensichtlich in manchen Jahren starken Bestandsfluktuationen sind schwer zu ermitteln. Im Gegensatz dazu zeigten Beringungsdaten aus Schottland und Irland, dass Wachtelkönigmännchen in einer Saison maximal nur 45 km aus ihren Brutgebieten abwanderten, und somit viel ortstreuer sind. Auch zwischen den Jahren wurden nur geringe Abwanderungen beobachtet. Dies erklärt auch, dass typische Bestandsfluktuationen in Ländern wie Deutschland auf den Britischen Inseln und in Frankreich fehlen. Die stärkere Ortstreue der schottischen Wachtelkönige zeigt sich auch in dem Verbreitungsmuster in ganz Großbritannien: trotz einer Bestandserholung auf den schottischen Inseln hat die Art ehemalige Brutgebiete auf dem schottischen und englischen Festland (noch) nicht wiederbesiedelt.

Die beobachteten Unterschiede in Bestandstrends und Bestandsschwankungen zwischen den Britischen Inseln und Frankreich einerseits und andere Ländern auf dem europäischen Kontinent andererseits passen gut zu den Ergebnissen von anderen Studien, die belegen oder darauf hinweisen, dass

die Vögel sich auch in ihren Zugmustern, Zugwegen, Morphologie und ihrer genetischen Struktur unterscheiden. Im Vergleich zu den Britischen Inseln und Frankreich bedeutet dies auch, dass es bei Wachtelkönigen in z. B. Deutschland durchaus ein Wiederansiedlungspotenzial gibt, wenn geeignete Schutzmaßnahmen getroffen werden.

Ob die Wachtelkönigbestände in Europa langfristig gesichert sind, ist unklar. Die Art bleibt sehr abhängig von Entwicklungen in der Agrarlandschaft und geeigneten Schutzmaßnahmen, vor allem in Osteuropa auch von großräumigen Änderungen in der Landnutzung. Ein Problem ist zudem, dass von den großen Beständen in Osteuropa kaum zuverlässige Zahlen über deren Größe und Trend vorliegen, und wir nur dort über gute Populationsdaten verfügen, wo die Populationen recht klein sind und nur einen geringen Anteil der Gesamtpopulation darstellen. Das macht Aussagen über den Erhaltungsstatus sowohl aus kurz- als auch langfristig problematisch.

6. References

Bairlein, F., J. Dierschke, V. Dierschke, V. Salewski, O. Geiter, K. Hüppop, U. Köppen & W. Fiedler 2014: Atlas des Vogelzuges. Ringfunde deutscher Brut- und Gastvögel. Aula-Verlag, Wiebelsheim.

Beaumont, D. J & B. J. England 2016: The Corncrake population in Scotland from 1993 to 2015 with an overview of conservation measures taken during this period. Vogelwelt 136: 153-161.

Bellebaum, J., C. Grüneberg & J. Karthäuser 2016: Status and population trend of Corncrakes *Crex crex* in Germany. Vogelwelt 136: 113-119.

BirdLife International 2004: Birds in Europe 2: population estimates, trends and conservation status. BirdLife International, Wageningen.

BirdLife International 2015: European Red List of Birds. Office for Official Publications of the European Communities.

Boele , A., J. van Bruggen, F. Hustings, K. Koffijberg, J. W. Vergeer & T. van der Meij 2016: Broedvogels in Nederland in 2014: Sovon-rapport 2016/04. Sovon Vogelonderzoek Nederland, Nijmegen.

Boldogh, S., Z. Szegedi, Z. Szentgyörgi & Z. Petrovics 2009: Verbreitung, Bestand und Schutzstatus des Wachtelkönigs *Crex crex* in Nordost-Ungarn 1997-2006. Vogelwelt 130: 153-158.

Broyer, J. 1985: Le Râle de genêts en France. Rapport SRETIE/UNAO/CORA/LPO, Paris.

Broyer, J. 1994: La régression du Râle de genêts *Crex crex* en France et la gestion des milieux prairiaux. Alauda 62 (1): 1-7.

Broyer, J., G. Rocamora, B. Lang & M. Metais 1994: Enquête nationale Rale des gênets 1991-1992. Synthese Nationale. LPO, Paris.

Bürger, P., J. Pykal & J. Hora 1997: Der Wachtelkönig *Crex crex* L. in der Tschechischen Republik. Vogelwelt 118: 209-213.

Cadbury, C. J. 1980: The status and habitats of the Corncrake in Britain 1978/79. Bird Study 27: 203-218.

Casey, C. 1998: Distribution and conservation of the Corncrake in Ireland. Irish Birds 6: 159-176.

Cepák, J. & P. Klvaňa 2014: Zpráva Kroužkovací stanice Národního muzea za rok 2013. Kroužkovatel 18: 1-22.

Cepák, J., P. Klvaňa, J. Škopek, L. Schröpfer, M. Jelínek, D. Hořák, J. Formánek & J. Zárybnický 2008: Atlas migrace ptáků České a Slovenské republiky. Aventinum, Praha.

Deceuninck, B. 2010: Coordination et mise en oeuvre du plan de restauration du Râle des genêts: enquête nationale de dénombrements des nicheurs. LPO, Paris.

Delov, V. & P. Iankov 1999: National survey of the Corncrake *Crex crex* in Bulgaria in 1995. Vogelwelt 118: 239-241.

Elts, J. 1997: Studies of the Corncrake in Estonia in 1995. Vogelwelt 118: 236-238.

Flade, M. 1991: Die Habitate des Wachtelkönigs während der Brutsaison in drei europäischen Stromtälern (Aller, Save, Biebrza). Vogelwelt 112: 16-40.

Flade, M. 1997: Wo lebte der Wachtelkönig in der Urlandschaft? Vogelwelt 118: 141-146.

Fourcade, Y., D. S. Richardson, O. Keišs, M. Budka, R. E. Green, S. Fokin & J. Secondi 2016: Range dynamics at the continental scale: testing the central-marginal hypothesis in the Corncrake, a species with a complex conservation status. Biol. Conserv. 198: 210-219.

Green, R. E. 1996: Factors affecting the population density of the Corncrake *Crex crex* in Britain and Ireland. J. Appl. Ecol. 33: 237-248.

Green, R. E. 1999: Survival and dispersal of male Corncrakes *Crex crex* in a threatened population. Bird Study Supplement 46: 218-229.

Green, R. E. 2004: A new method for estimating the adult survival rate of the Corncrake *Crex crex* and comparison with estimates from ring-recovery and ring-recapture data. Ibis 146: 501-508.

Green, R. E. 2008: Demographic mechanism of a historical bird population collapse reconstructed using museum specimens. Proc. R. Soc. B 275: 2381–2387.

Green, R. E. 2013: Tracking Scotland's Corncrakes. Birdwatch 250: 26-28.

Green, R. E. & T. J. Stowe 1993: The decline of the corncrake *Crex crex* in Britain and Ireland in relation to habitat change. J. Appl. Ecol. 30: 689-695.

Green, R. E. & M. D. Rayment 1996: Geographical variation in the abundance of the Corncrake *Crex crex* in Europe in relation to the intensity of agriculture. Bird Conservation International 6: 201-212.

Green, R. E. & D. W. Gibbons 2000: The status of the Corncrake *Crex crex* in Britain in 1998. Bird Study 47: 129-137.

Green, R. E., G. Rocamora & N. Schäffer 1997: Populations, ecology and threats to the Corncrake *Crex crex* in Europe. Vogelwelt 118: 117-134.

Heer, L., L. Maumary, J. Laesser & W. Müller 2000: Artenschutzprogramm Wachtelkönig in der Schweiz. BirdLife Schweiz, Zürich.

Heggøy, O. & I. J. Øien 2014: Kartlegging og overvåking av åkerrikse i 2013. NOF-notat 2014-11, Norsk Ornitologisk Forening, Trondheim.

Hennique, S., B. Dekeuninck, G. Mourgaud & C. Chanson 2013: Deuxième plan national d'actions en faveur du Râle des genêts (*Crex crex*) 2013-2018. LPO, LPO Anjou, Ministère de l'Écologie, du Développement Durable et de l'Énergie, DREAL des Pays de la Loire.

Hoffmann, M. 1997: Rufplatzwahl des Wachtelkönigs *Crex crex* und Verbleib von Individuen nach Verlust des Bruthabitats in Nordostpolen. MsC Thesis, University of Freiburg, Freiburg.

Hudson, A. V., T. J. Stowe & S. J. Aspinall 1990: Status and distribution of Corncrakes in Britain in 1988. British Birds 83: 173-187.

Inderwildi, E. & W. Müller 2015: Effects of a long-term recovery project for Corncrake *Crex crex* in Switzerland. Ornithol. Beob. 112: 23-40.

Isaksen, K. 2006: Åkerrikse i Norge: Kunnskapsstatus og forslag til nasjonal handlingsplan. Norsk Ornitologisk Forening, Trondheim.

Keišs, O. 1997: Results of a randomised Corncrake *Crex crex* survey in Latvia 1996: population estimate and habitat selection. Vogelwelt 118: 231-235.

Keišs, O. 2003: Recent increases in numbers and the future of Corncrake *Crex crex* in Latvia. Ornis Hungarica 12-13: 151-156.

Keišs, O. 2004: Results of a survey of Corncrake *Crex crex* in Latvia, 1989-1995. In: Anselin A. (ed.) Bird Numbers 1995. Proceedings of the International Conference and 13th Meeting of the European Bird Census Council, Pärnu, Estonia. Bird Census News 13: 73-76.

Keišs, O. 2005: Impact of changes in agricultural land use on the Corncrake *Crex crex* population in Latvia. Acta Universitatis Latviensis, Vol. 691: 93-109.

Keišs, O., J. Granats. & A. Mednis 2004. Use of biometrical data to study Corncrake *Crex crex* in Latvia. Acta Universitatis Latviensis, Biology, 2004, Vol. 676: 119-126.

Klein Tank, A. M. G. *et al.*: Daily dataset of 20th-century surface air temperature and precipitation series for the European Climate Assessment. Int. J. of Climatol. 22: 1441-1453.

Koch, J. C. 1932: Kwartelkoningen en maaimachines. De Levende Natuur 36: 323-325.

Koffijberg, K. & A. J. van Dijk 2001: Influx van Kwartelkoningen *Crex crex* in Nederland in 1998. Limosa 74: 147-159.

Koffijberg, K & N. Schäffer 2006: International Single Species Action Plan for the conservation of the Corncrake *Crex crex*. CMS Technical Series No. 14 & AEWA Technical Series No. 9. Bonn, Germany.

Koffijberg. K. & J. Schoppers 2009: De Kwartelkoning in Nederland in 2008 en evaluatie van het Beschermingsplan Kwartelkoning. Sovon-informatierapport 2009/02. Sovon Vogelonderzoek Nederland, Beek-Ubbergen.

Mayes, E. & T. Stowe 1989: The status and distribution of the Corncrake in Ireland, 1988. Irish Birds 4: 1-12.

Mischenko, A. L. 2016: Corncrake *Crex crex* in European Russia: habitat characteristics, status and trends. Vogelwelt 136: 139-144.

Mischenko. A. L., O. V. Sukhanova, V. T. Butjev, A. A. Mosalov & A. P. Mezhnev 1997: Ergebnisse der Wachtelkönig-Erfassung im europäischen Teil Russlands 1995. Vogelwelt 118: 215-222.

Mischenko, A. L. & O. V. Sukhanova 1999: Corncrake *Crex crex* in European Russia: methods and results of a large-scale census. Vogelwelt 120 (supplement): 323-327.

Mischenko, A. & O. Sukhanova 2006: Corncrake monitoring in European Russia. Bird Census News 19: 63-68.

Müller, A. & H. Illner 2001: Erfassung des Wachtelkönigs in Nordrhein-Westfalen 1998-2000. Bestand und langfristige Bestandsentwicklung einer vom Aussterben bedrohten Brutvogelart. LÖBF-Mitteilungen 2/01: 36-51.

Norris, C. A. 1947: Report on the distribution and status of the Corncrake. Brit. Birds 40: 226-244.

Nyegaard, T., H. Meltofte, J. Tofft & M. Borch-Grell 2014: Truede og sjældne ynglefugle i Danmark 1998-2012. Dansk Orn. Foren. Tidsskrift 108: 1-144.

O'Brien, M., R. E. Green & J. Wilson 2006: Partial recovery of the population of Corncrakes *Crex crex* in Britain, 1993-2004. Bird Study 53, 213-224.

O'Meara, M. 1979: Distribution and numbers of Corncrakes in Ireland in 1978. Irish Birds 1: 381-405.

Ottosson, U., R. Ottvall, J. Elmberg, M. Green, R. Gustafsson, F. Haas, N. Holmqvist, Å. Lindström, L. Nilsson, M. Svensson, S. Svensson & M. Tjernberg 2012. Fåglarna I Sverige – antal och förekomst. SOF, Halmstad.

Ottvall, R. & J. Petterson 1998: Is there a viable population of Corncrakes Crex crex on Öland, southeastern Sweden? Habitat preference in relation to haymowing activities. Ornis Svecica 8: 151-166.

Pedrini, P., F. Florit, G. Martignago, F. Mezzavilla, G. Rassati, G. Silveri & M. Brambilla 2016: Corncrake *Crex crex* population trend in Italy. Vogelwelt 136: 127-130.

Peške, L. & J. Vlček 2015: Satellite telemetry of Corncrakes. Poster presented on the International Corncrake Conference, Pilsen.

Petterson J. 1992: Kornknarren – en av fågelväreldens doldisar. Calidris 21: 55-58.

Pykal, J. & J. Flousek 2016: Numbers and population trends of the Corncrake (*Crex crex*) in the Czech Republic: results of a 20-year monitoring study. Vogelwelt 136: 89-92.

R Development Core Team 2015: R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

Ranke, P. S. & I. J. Øien 2011: Kartlegging og overvåkning av åkerrikse i 2010. Norsk Ornitologisk Forening Rapport 2-2011, NOF, Trondheim.

Ranke, P. S., T. Aarvak & I. J. Øien 2013: Kartlegging og overvåking av åkerrikse i 2012. NOF-notat 2013-12, NOF Trondheim.

Ryslavy, T. 2009: Zur Bestandssituation ausgewählter Vogelarten in Brandenburg - Jahresbericht 1998. Naturschutz Landschaftspfl. Brandenburg 18: 128-136.

RSPB 1995: Habitat management for Corncrakes. RSPB, Edinburgh.

Schäffer, N. 1994: Methoden zum Nachweis von Bruten des Wachtelkönigs. Vogelwelt 115: 69-73.

Schäffer, N. 1999: Habitatwahl und Partnerschaftssystem von Tüpfelralle *Porzana porzana* und Wachtelkönig *Crex crex*. PhD Thesis. Ökol. Vögel (Ecol. Birds) 21: 1-267.

Schäffer, N. & R. E. Green 2001: The global status of the Corncrake. RSPB Conservation Review 13: 18-24.

Schäffer, N. & K. Koffijberg 2004: *Crex crex* Corncrake. BWP Update Vol. 6: 55-76. Oxford University Press, London.

Schmid, H. & L. Maumary 1996: Die Situation des Wachtelkönigs *Crex crex* in der Schweiz und im Fürstentum Liechtenstein 1970-1994. Ornithol. Beob. 93: 169-175.

Schröder, K., T. Schikore, W. Eikhorst, K. Koffijberg & M. Richter 2007: Verbreitung, Bestand und Habitatwahl des Wachtelkönigs (*Crex crex*) in Niedersachsen und Bremen – Ergebnisse einer landesweiten Erfassung im Jahr 2004 sowie Aufarbeitung und Analyse der Bestandsentwicklung und Schutzsituation. Vogelkdl. Ber. Niedersachs. 39: 1-38.

Sheppard, R. & R. E. Green 1994: Status of the Corncrake in Ireland in 1993. Irish Birds 5: 125-138.

Soldaat, L., H. Visser, M. van Roomen & A. van Strien 2007: Smoothing and trend detection in waterbird monitoring data using structural time-series analysis and the Kalman filter. J. Ornithol. 148 (Suppl. 2): 351–357.

Stowe, T. J., A. V. Newton, R. E. Green & E. Mayes 1993: The decline of the corncrake *Crex crex* in Britain and Ireland in relation to habitat. J. Appl. Ecol. 30: 53-62.

Thorup, O. 1999: Engsnarrens *Crex crex* yngleforhold I kulturlandskabet, og artens fortid, nutid og eventuelle fremtid I Denmark. Dansk. Orn. Foren. Tidsskr. 93: 71-81.

Van den Bergh, L. M. J. 1991: Status, distribution and research on Corncrakes in the Netherlands. Vogelwelt 112: 78-82.

Verbelen, D., M. Herremans, A. Derouaux & J.-Y. Paquet 2016: Corncrake *Crex crex* in Belgium: holding on to the verge of extinction. Vogelwelt 136: 135-138.

Walther, B. 2008: Ringing recoveries of the Corncrake *Crex crex* in Africa and Sinai. Vogelwelt 129: 103-108.

Wernham, C. V., M. P. Toms, J. H. Marchant, J. A. Clarck, G. M. Siriwardena & S. R. Baillie 2002: The Migration Atlas: movements of the birds of Britain and Ireland. T. &A. D. Poyser, London.

Wettstein, W., R. Husi & B. Schmid 2003a: Population structure and dispersal of Corncrakes (*Crex crex*) in Europe revealed by microsatellite markers. In: Wettstein, W. (ed.): Conservation biology of *Crex crex* L. PhD thesis, Berichte aus dem Institut für Umweltwissenschaften der Universität Zürich 6, pp. 53-72.

Wettstein, W., K. Hobson & B. Schmid 2003b. Tracing a vagabond: potential and limitations of indirect methods to estimate philopatry and migratory connectivity of Corncrakes *Crex crex*. In: Wettstein, W. (ed.): Conservation biology of *Crex crex* L. PhD thesis, Berichte aus dem Institut für Umweltwissenschaften der Universität Zürich 6, pp. 87-105.

Wotton, S. R., M. Eaton, S. R. Ewing & R. E. Green 2015: The increase in the Corncrake *Crex crex* population of the United Kingdom has slowed. Bird Study 62: 486-497.

Kees Koffijberg, Sovon Vogelonderzoek Nederland, P. O. Box 6521, NL-6503 GA Nijmegen, The Netherlands; E-Mail: kees.koffijberg@sovon.nl

Caspar Hallmann, Sovon Vogelonderzoek Nederland & Experimental Plant Ecology Group, Radboud Universiteit Nijmegen, Institute for Water and Wetland Research, P. O. Box 9010 (mail box 31), NL-6500 GL Nijmegen, The Netherlands; E-Mail: C.Hallmann@science.ru.nl

Oskars Keišs, Laboratory of Ornithology, Institute of Biology, University of Latvia, LV-2169 Salaspils, Latvia; E-Mail: grieze@lanet.lv

Norbert Schäffer, Landesbund für Vogelschutz in Bayern e. V., LBV e. V. Landesgeschäftsstelle, Eisvogelweg 1, D-91161 Hilpoltstein; E-Mail: n-schaeffer@lbv.de