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VERTEBRATE PESTS UNIT
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The breeding performance of Barn Owl populations in five regions of the United Kingdom – 2016 Data Set.

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1. Introduction

1.1 General

The Barn Owl Monitoring Scheme (BOMS) is one of the surveillance projects being carried out, within the UK Rodenticide Stewardship Regime, by the Campaign for Responsible Rodenticide Use (CRRU) UK.

The barn owl (*Tyto alba*) is a charismatic and iconic species of Britain's agricultural landscape that typically hunts across open farmland, meadows, rough grassland and woodland-edge habitat, where there are high densities of their small mammal prey (Toms, 2014). The most frequently taken prey items in the UK are field vole (*Microtus agrestis*), bank vole (*Myodes glareolus*), wood mouse (*Apodemus sylvaticus*), common shrew (*Sorex araneus*) and pygmy shrew (*Sorex minutus*), although both UK commensal species, Norway rat (*Rattus norvegicus*) and house mouse (*Mus musculus*), are occasionally taken (Love et al., 2000; Martin, 2008).

1.2 A Fluctuating UK Barn Owl population

In the 18th century, barn owls were regarded as the most common species of owl over much of the country; where traditional low intensity agricultural practice, together with high reliance on livestock, provided a habitat rich in their prey items (Shawyer, 1987). However, a decline in numbers was evident by the early 1900's following advances in agricultural practice (Blaker, 1933; Toms, 2014).

Over recent years there have been a number of organised national surveys on the barn owl breeding population conducted across the UK, although advances in survey technique have meant that the methodologies adopted have not been consistent over time. In addition, estimates of the national breeding population have been made by expert groups and organisations, derived from their extensive experience in the field (Table 1).

Two extreme years for barn owls were the breeding seasons of 2013 and 2014. Although the winter of 2012/13 was less severe than the preceding years, the month of March 2013 was the coldest reported since 1962 and, during that month, numbers of dead barn owls reported to the BTO's ringing scheme were about three times above normal. With nest occupancy estimated to be below 72% of the 'all-years' average, 2013 was considered to be one of the worst barn owl breeding seasons since1958 (Shawyer; 2015[b]).

The mild winter of 2013-14 was followed by an early spring and one of the warmest summers on record. Subsequently 2014 became a peak year for small mammals, and in spite of the higher than average barn owl mortality in the winter of 2013, and low breeding productivity during the summer of 2013, 2014 became a highly productive year for barn owls in many areas (Shawyer, 2015[a]; Barn Owl Trust, 2016). The estimated 9,000 pairs that attempted to breed in 2014, with most nests sites occupied by breeding birds, has provided a reliable and up-to-date UK population estimate for the species (Shawyer, 2014).

Table 1. Barn owl population estimates derived from National Surveys, and from expert groups and organisations.

Year(s)	Population estimate	Location	Survey	Reference
1932	12,000 pairs	England and Wales	First National Survey	Blaker, 1933
1976	4,500 to 9,000 pairs	Britain and Ireland	BTO First Breeding Bird Atlas	Sharrock, 1976
1982	3,778 pairs 640 pairs	Britain and Ireland	Barn Owl Survey The Hawk Trust	Shawyer, 1987
1988 to 1991	43% decline in occupied 10km^2 grid squares compared with the First BTO Survey Britain and Ireland		* BTO Second Breeding Bird Atlas	Gibbons et al., 1993
1995 to 1997	4,000 pairs	Britain	Project Barn Owl	Toms et al., 2001
2007 to 2011	67% increase in occupied 10km^2 grid squares compared with the Second BTO Survey Britain and Ireland		* BTO Third Breeding and Wintering Bird Atlas	Balmer et al., 2013
2009	> 6,000 pairs	UK breeding population		Shawyer, 2009
2011	9,000 pairs	UK breeding population		Shawyer, 2015[a]
2014	9,000 pairs	UK breeding population		Shawyer, 2014
1995 to 2014	225% increase	UK breeding population		Hayhow et al., 2017

* The second BTO Survey (1988 to 1991), and the third BTO Survey (2007 to 2011) only provided a measure of the decrease or increase in occupancy of the number of 10km^2 squares surveyed when compared with the previous BTO Survey, and provided no population estimate for comparison with the other surveys.

With such marked annual fluctuations in the barn owl breeding population, nest occupancy and productivity, data in any one year are unlikely to provide an accurate reflection of the actual barn owl breeding population. More recent surveys are now using a standardised methodology conducted over several consecutive years, with the most productive years used for population estimations.

Overall 2015 was a poor breeding season for barn owls in the UK, although not as bad as that of 2013 (Shawyer, 2015[b]); while 2016 was a better breeding season, primarily as a result of repeat and second nesting attempts, following a highly productive June and July (Shawyer, 2017).

The increase in the barn owl population over recent years has been acknowledged by 'The state of the UK's birds 2016' Report, by downgrading it from the 'Amber List' in 2015 to the 'Green List' in 2016 (Hayhow et al., 2017). This Report considers the status of UK breeding and non-breeding birds in the UK, taking into consideration the results from annual, periodic and one-off surveys and monitoring studies.

Examination of the breeding range of the barn owl shows that, in the UK, the species is at the northernmost limit of its geographical distribution (Hagemeijer and Blair, 1997). Indeed, even within the UK, differences have been reported in their abundance from the lowland south to the highlands of the north (Balmer et al., 2013). It is therefore unsurprising that, together with prey abundance, and probably historical persecution, weather conditions, in particular climatic extremes, can exert a significant effect on the breeding performance of barn owls in the UK (Shawyer, 1987; Toms, 2014).

1.3 The Barn Owl as a sentinel species

Like many other species of vertebrate wildlife in the UK, the barn owl is exposed to second-generation anticoagulant rodenticides (SGARs) (Shore et al. 2014). The barn owl has been identified by the Health and Safety Executive (HSE) as a sentinel species for other species that are generalist predators of small mammals in rural areas and are also exposed to SGARs (HSE, 2017). The barn owl is an ideal species for monitoring breeding performance, being one of the most frequently monitored species by the British Trust for Ornithology's Nest Record Scheme. In 2014, 2,766 barn owl nest records were submitted to the BTO, a number only exceeded by blue tit and great tit. In 2015 and 2016 there were 1,807 and 2,406 barn owl nest records submitted to the BTO respectively, numbers only exceeded by blue tit, great tit, swallow and tree sparrow. Since the mid 1990's, and following major improvements in habitat quality, barn owl nest site availability would appear to have become an important limiting factor for the species and their willingness to occupy man made nest-boxes has increased the number of birds monitored by the Nest Record Scheme (Shawyer, pers.comm.). In addition, these artificial nest sites appear to be having a positive effect on the national population and by 2006 were believed to contribute more than 70% of all known breeding sites for this species in the UK (Shawyer 2006).

1.4 Objectives of the study

One of the important CRRU monitoring projects for rodenticide stewardship, conducted by the Centre for Ecology & Hydrology (CEH), is the monitoring of SGAR residues in the livers of 100 barn owls each year, in an attempt to quantify exposure in free-living birds. However, reports of these data provide no contextual information on the status and breeding success of the UK barn owl population that carries them. Therefore, it is the purpose of the CRRU UK Barn Owl Monitoring Study (BOMS) to bridge this gap by monitoring various breeding parameters in a representative sample of barn owl populations across the UK. To this end, a CRRU commissioned the Wildlife Conservation Partnership (WCP) to conduct this work. The output from the WCP is an "Annual Data Set", giving barn owl nest monitoring data for the preceding season.

The BOMS provides annual data on key breeding parameters for selected barn owl populations. CRRU has received the annual BOMS data sets for 2015 and 2016, together with similar available data from the same nest sites, from 2011 to 2014. This report comprises an analysis of the 2016 breeding data and a comparison with equivalent data from five previous breeding seasons. In addition, the BOMS field operators will monitor the fledgling birds for any unusual growth characteristics that could potentially be attributed to the anticoagulant residue levels.

2. Methodology Overview

The main aim of the BOMS is to examine a substantial core sample of barn owl nests and broods across five regions of the UK, in order to investigate various breeding performance parameters year on year. The same set of core sites is being monitored annually throughout the course of this project, which is initially of three years duration. The examination of breeding adults, eggs and chicks undertaken during nest monitoring, will also provide information on possible sub-lethal effects of low-level SGAR liver residue levels on chick development and barn owl breeding that might be visible on external examination (e.g. see Toms, 2014; pg 236).

Data collection at each nest site was based largely on that successfully developed and validated for the BTO's 10-year Barn Owl Monitoring Programme (Crick et al., 2001). The field research for the BTO project involved inspection of nests by Wildlife Conservation Partnership (WCP), BTO and Barn Owl Conservation Network (BOCN) nest recorders, under Natural England Disturbance Licences, primarily to determine nest occupancy levels, clutch size and brood size. For the purpose of the BTO project and that of the BOMS, brood size at ringing is considered equivalent to fledging success.

For the BOMS, brood size was recorded at successful nests and where nests were not visited at the egg stage, clutch size was estimated from the number of chicks and the age intervals between them. Chick ages were determined by wing development, either by wing cord for chicks under 13 days of age or the length of the developing 7th primary feather for older chicks (Shawyer 1998). The hatch date was derived from the age of the oldest chick and the first successful egg date determined by adding the 30 day incubation period.

The biometric measurements of young birds caught at the nest included sexing, measurement of wing development (to age and determine first egg date) and body weight (to establish body condition and growth patterns). Adult birds were treated in a similar way but were aged from their wing moult pattern, or from the length of moulted primary and secondary wing feathers found at nests (Shawyer 1998), or for those owls which were already ringed, the year in which ringing had occurred. Both young and new adult birds were ringed.

All birds handled, and eggs found in the nest, were screened for any unusual growth characteristics and physiological deformities that were externally visible. The main factors screened were, for eggs; size, structural integrity and the smoothness of the shell surface; and for the barn owls, feather structure and the occurrence of unusual growths; although it is acknowledged that any of these abnormalities are rarely observed.

Each nest under observation was visited on at least one occasion, and in order to collect the necessary nest data for BOMS, the visit was optimally timed to occur when chicks were between 3 and 9 weeks of age. In this study no attempt was made to record second broods which can occasionally occur, typically in years when field vole abundance is particularly high and first clutches are laid earlier than usual (Jackson, 2017).

For nests that were unsuccessful at producing fledged birds, it was not always possible to distinguish between nest sites where a barn owl breeding attempt had failed, and nest sites that had not been used by barn owls in that season.

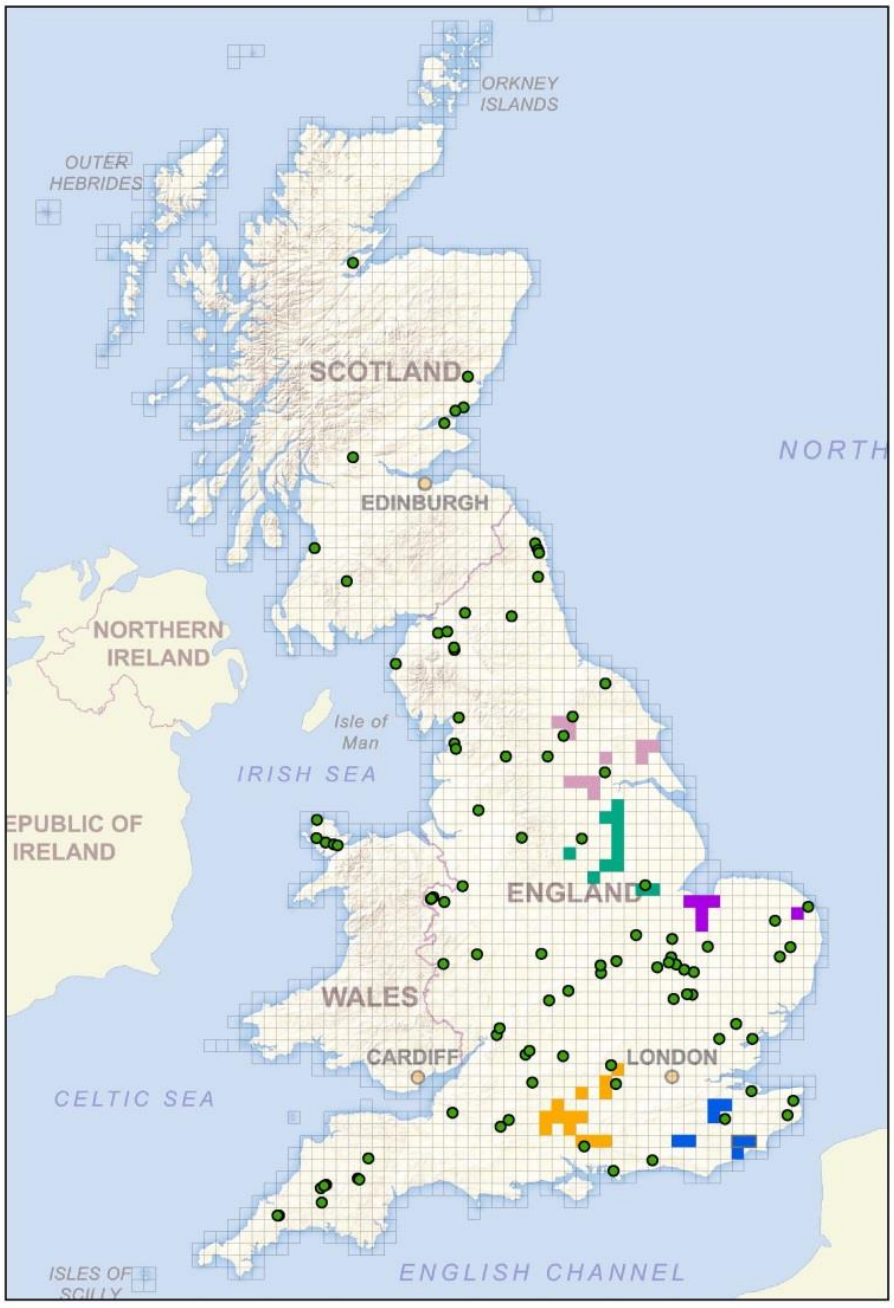
Key Performance Indicators for each of the proposed survey areas of the BOMS are:

- Nest occupancy data
- Nest Productivity (mean number of chicks fledged) for successful nests
- Individual records of any chicks and eggs which show abnormal development

The survey area for the BOMS comprises the following five areas, surveying a total of approximately 130 nests (Figure 1):

Region 1 – (N) SE Yorkshire, Mid/West Yorkshire and SW Yorkshire (25 nests)
Region 2 – (E) East and West Norfolk (25 nests)
Region 3 – (C) Berkshire, South Hampshire, North Hampshire, South Wiltshire and North Wiltshire (25 nests)
Region 4 – (SE) Kent (25 nests)
Region 5 – (Midlands) Nottinghamshire, South Lincolnshire and Cambridgeshire (30 nests).

Figure 1. A map of England showing the locations of the 10 kilometre squares in each of the five Regions containing the barn owl nest sites surveyed in 2016. The location of the barn owls obtained by CEH for the CRRU liver residue analysis survey in the same year are also presented (green circles).



[Region1 (N) = pink; Region 2 (E) = purple; Region 3 (C) = yellow; Region 4 (SE) = blue; Region 5 (Midlands) = green]

3. Results

3.1 The 2016 Data Set

Of the 130 barn owl nests monitored in 2016, a total of 154 young birds fledged from 61 nests. In addition there was evidence of 12 barn owl pairs that had produced eggs and then subsequently failed, 3 pairs where breeding had not been attempted and a further 8 nests where adult singletons were present. The overall mean productivity for the successful nests was 2.52 fledged birds (Table 2), with mean productivities for the five Regions ranging between 2.27 and 2.83.

Table 2 Barn owl nest occupancy in 2016, indicating the number of nests monitored and the number of young birds that fledged.

2016	Region 1 (N)	Region 2 (E)	Region 3 (C)	Region 4 (SE)	Region 5 (Midlands)	Total
Total number of nests monitored	25	25	25	25	30	130
Nest site occupancy by adult pairs	12	11	15	17	22	77
Nests that produced fledgling birds	7	9	11	16	18	61
Total number of birds fledged	18	21	25	39	51	154
Mean productivity per successful nest	**2.57**	**2.33**	**2.27**	**2.44**	**2.83**	**2.52**

Region 5 (Midlands) and Region 4 (SE) produced the largest number of fledglings, with 51 and 39 fledged chicks from 18 and 16 nest sites respectively (Table 2).

3.2 Comparison of the 2016 data with available data from 2011 to 2015

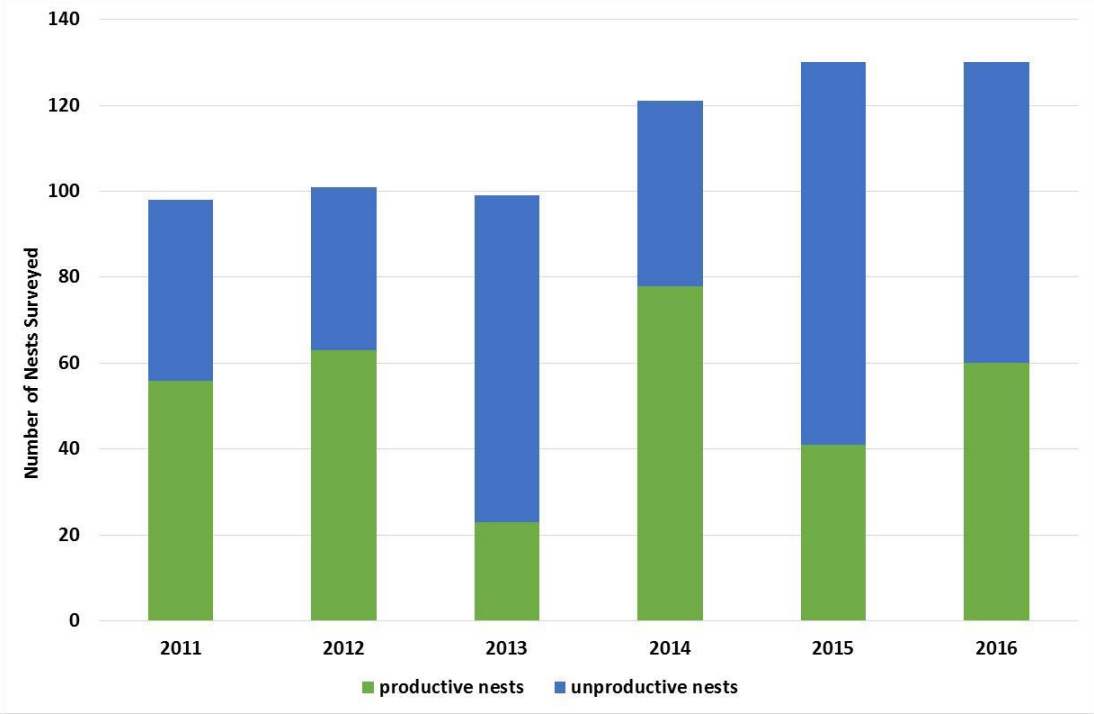
Of the 130 barn owl nest sites surveyed in 2016, all sites had been monitored by WCP in 2015, and between 98 and 121 of these sites had been monitored by WCP each year between 2011 and 2014 (Table 3; Figure 2). The proportion of nests that was productive and produced fledged young was highest in 2014 (where 64.5% of nests produced a total of 336 fledged birds) and lowest in 2013 (where 23.2% of nests produced a total of 83 fledged birds), which corresponds well with the barn owl productivity assessments of the BOCN (Shawyer, 2015[a]; Shawyer, 2015[b]). The average date for the first successful egg to be laid across the five regions was respectively on the 23rd, 10th and 14th April in 2011, 2012 and 2014, and on the 18th, 12th and 2nd May in 2013, 2015 and 2016.

Table 3 Barn owl nest productivity between 2011 and 2016; indicating total numbers of nests monitored, average date of first egg laid, numbers of nests that produced fledged birds, numbers of fledged birds produced, and the mean productivity per successful nest.

	2011	**2012**	**2013**	**2014**	**2015**	**2016**
Total number of nests monitored	98	101	99	121	130	130
Average date of first egg (number of nests)	23/04/11 (46)	10/04/12 (53)	18/05/13 (22)	14/04/14 (64)	12/05/15 (43)	02/05/17 (59)
Nests that produced fledgling birds	56	63	23	78	41	61
Total number of birds fledged	**186**	**153**	**83**	**336**	**103**	**154**
Nest surveyed that were productive	**57.1%**	**62.4%**	**23.2%**	**64.5%**	**31.5%**	**46.9%**
Mean productivity per successful nest	3.32	2.43	3.61	4.31	2.51	2.52
Total number of Barn Owl chicks ringed in Britain and Ireland*	***8534***	***7326***	***3042***	***14466***	***4934***	***7554***

** Data from the BTO on number of Barn Owl chicks ringed in Britain and Ireland.*

Figure 2. Barn owl nests surveyed each year, indicating the proportion of productive nests that produced fledged young.

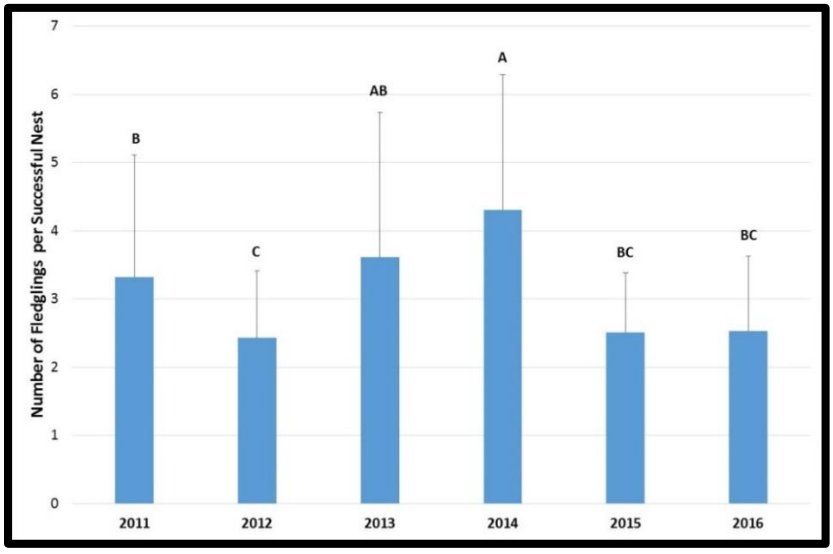


The numbers of birds fledged per successful nest site from each of the five regions between 2011 and 2016 (Table 3) were compared using a General Linear Model, and were found to differ significantly between years ($F = 15.91$; $p < 0.001$), but not to differ significantly between regions ($F = 2.10$; $p = 0.080$). GLM Tukey Pairwise Comparisons of the six years of barn owl productivity data indicate no significant difference between the 2014 and 2013 data, no significant difference between the 2013, 2010, 2015 and 2016 data, and no significant difference between the 2015, 2016 and 2012 data (Figure 3).

Table 4. Mean barn owl nest productivity for each of the five Regions between 2011 and 2016 for the nests that successfully produced fledged birds (summary data derived from Annex 1). Some nests were not visited in the 'South-east' Region in 2013 and those that were visited (16/25) produced no chicks.

	Year						
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**Mean**
Region 1 (N)	3.00	2.33	3.00	3.33	2.60	**2.57**	**2.90**
Region 2 (E)	2.33	3.00	3.50	4.52	2.50	**2.33**	**3.30**
Region 3 (C)	3.33	2.17	2.00	4.93	2.38	**2.27**	**3.06**
Region 4 (SE)	3.60	2.42	no breeding recorded	3.27	2.58	**2.47**	**2.82**
Region 5 (Midlands)	4.00	2.21	4.00	5.06	2.57	**2.83**	**3.46**
Mean	**3.32**	**2.43**	**3.61**	**4.31**	**2.51**	**2.53**	

Figure 3. Mean number of fledgling barn owls produced per successful nests (with standard deviations) for all nests monitored between 2011 and 2016. Letters denote post hoc groups from a General Linear Model (using Tukey Pairwise Comparisons).



3.3 Unusual Growth Characteristics

Among the eggs and barn owls (both young and adult) studied during 2016, none was found to have any unusual growth characteristics or physical deformities, such as abnormal feather development and pattern of moult, that might suggest any sub-lethal effects of exposure to anticoagulant rodenticides.

3.4 Rodenticide Residues in UK Barn Owls

A long-term study has been conducted by the Centre for Ecology and Hydrology (CEH) to investigate the exposure of UK barn owls to anticoagulants. The study reported that the number of UK barn owl individuals found to carry residues of one or more SGAR's ranges from 94% [of 100 birds analysed in 2015] to 78% [of 100 birds analysed in 2016] (Shore et al., 2017).

Generally, the residues levels found were low, and are considered unlikely to have caused harm to the birds, their deaths having been caused by a range of other factors such as collisions with road traffic, starvation and disease (Shawyer, 1987; Toms, 2014; Smith and Shore, 2015). The barn owl liver residue results obtained for 2016, the year of collection of breeding data presented in this report, showed that of the 78% (n=100) of the 2016 birds with liver residue levels, 69 birds contained liver residues less than 100 ng/g wet wt. (Shore et al., 2017). The geographical distribution of the birds sampled in 2016 is shown in Figure 1; and it can be seen that there is some concurrence in the locations of those birds and the locations of the nests studied in the present investigation of barn owl breeding performance. The present study can therefore be considered as a monitoring procedure, providing information about barn owl breeding performance in the presence of the SGAR residues detected by the CEH investigation.

4. Discussion

From 2011 to 2016 between 98 and 130 barn owl nest sites were surveyed each year across five regions of the UK, and during this time, between 23 and 78 of these nest sites were successful, producing between 83 and 336 fledgling birds each year. The number of fledged birds produced from each successful nest has been used to assess nest productivity as a measure of barn owl breeding success. Across the five regions surveyed between 2011 and 2016, the overall mean nest productivity for the successful nests ranged between 2.0 and 5.06, with a mean of 3.15 (n = 322). Nest productivity was used in this study as a measure of barn owl breeding success to enable comparisons to be made with numerous other studies that generate similar data (see Henderson et al., 1993; Toms et al., 2001; Shawyer, 2010).

An advantage of the present study is that nest occupancy is being been assessed in 130 specific barn owl nest sites on an annual basis, so that for any particular year, the proportion of nest sites that successfully produce fledged birds can be used as another measure of barn owl breeding success alongside the nest productivity data. However, there would appear to be very few published studies that present monitoring data year on year for barn owl nests sites, irrespective of their occupancy and productivity. The analysis in the present study is therefore able to consider the nest productivity data in the light of the nest occupancy data.

It is important to recognise that barn owl nest occupancy and breeding success can vary considerably from year to year for a very wide variety of reasons, including population numbers, prey availability and weather conditions (Toms, 2014). For this reason, both the 1982-1985 Barn Owl Survey of Britain and Ireland (Shawyer 1987) and the 1995-97 BTO/Hawk and Owl Trust 'Project Barn Owl' survey (Toms et al., 2001) provided annual UK population estimates over their three or four year study periods, thus embracing a more complete cycle of field vole abundance.

For example, in years when vole numbers are particularly low (such as 2013), many barn owls will remain at their winter roosts and will make little attempt to occupy their breeding sites. In such years many barn owls will simply go unrecorded. Where population estimates are based on these years alone, rather than peak years like 2014, they are likely to prove inaccurate.

The average date for the first egg laid in the nests monitored across the five regions was the 18th May and the 14th April in 2013 and 2014 respectively (Table 3), indicating that the few barn owls which were able to breed in 2013 had delayed their breeding activity on average by 34 days when compared with 2014. This, in combination with the high mean 2013 nest productivity would suggest that food availability was a limiting factor for the barn owls at the onset of breeding, but not as the season progressed.

Shawyer (2017) reported a poor start to the 2016 barn owl breeding season; at a time when vole abundance appeared to be relatively high. The inclement weather of mid- to late-April was considered to be the primary cause for their low productivity. However, in the latter half of the season, increased vole abundance combined with the unusually warm and dry weather of August, September and October, increased their productivity, with second clutches in early July producing seven, eight, and on one occasion nine fledglings (Shawyer, 2017).

In the 2016 BOMS data set, of the 5 non-breeding females that were found occupying nest sites, all weighed less than 340g, below the threshold body weight for breeding of 360g (Shawyer, 1994). In comparison, of the 28 breeding females which were weighed, 18 weighed 360g or above.

The number of fledged barn owls that have been recorded in this survey represents between 2.0% and 2.7% of the total number of barn owl chicks ringed by the BTO in Britain and Ireland each year (Table 3). Analysis of the six years of available data indicates a very high correlation between the two data sets (Pearson Correlation $R=0.990$; $p<0.001$). Assuming that numbers of barn owl chicks ringed across the UK each season is a reflection of the national productivity of the species, the BOMS survey would appear to provide a useful indication of barn owl productivity across the UK.

In 2011, 2012 and 2014, when the average date for the first egg laid in the nests monitored across the five regions was between the 10th and 23rd April, the number of birds fledged each year ranged from 153 to 336. In contrast, for 2013, 2015 and 2016, the average date for the first egg laid in the nests monitored across the five regions was between the 2nd May and the 18th May, and the number of birds fledged each year ranged from 83 to 154 (Table 3). The ability of the birds to lay eggs early in the season would appear to be an important factor influencing the total number of fledged birds produced each year.

Between 1982 and 1986, Shawyer (1987) estimated barn owl mean productivities of 3.35 (n=155) for England and Wales, and 2.84 (n=135) for Scotland, and presented annual productivity values for the British Isles ranging from 2.77 to 3.36, with a mean value of 3.00 (n=290).

In a BTO Research Report (Henderson et al., 1993), barn owl annual mean productivity was presented for six specified regions of England and Wales between 1988 and 1990, and ranged between 2.6 and 4.2 (n=246). Similarly an internal report to the Environment Agency (Shawyer, 2010) reported an annual mean productivity between 2000 and 2009 ranging between 2.6 and 3.5 (n=581). These values are comparable with earlier data presented by Shawyer (1987) and with that presented in this report.

According to Shawyer 1987, the marked fluctuations in barn owl breeding productivity year on year are primarily a result of annual changes in small mammal abundance and extreme weather events at critical times during the barn owl's annual cycle (see Shawyer, 1987; Shawyer, 1998; Toms 2014).

Barn owl exposure to SGAR's in the UK would be expected to be greatest across agricultural areas, because of the association between modern agricultural practice and Norway rat infestations, particularly around livestock-rearing and grain storage facilities. In addition, the high incidence of physiological resistance to anticoagulant rodenticides in Southern England might be expected to cause an increase in the use of anticoagulant rodenticides in this area, as the effectiveness of these rodenticides is reduced. Such areas would include Region 3 (C), Region 4 (SE) and Region 2 (E). Furthermore, the use of SGARs in these Regions would be expected to be relatively consistent from year to year, to address the consistent problem of resistant Norway rats in this area (Buckle and Prescott, 2012).

It is difficult to see how the annual fluctuations in barn owl nest occupancy and breeding productivity observed in the data of the BOMS between 2011 and 2016 can be associated with the approved use of rodenticides across the agricultural landscape, particularly in Southern England. If this were the

case, the resulting declines would be expected to be relatively consistent year on year, to reflect the consistent use of these products, which clearly it is not. The BOMS observed peaks in barn owl productivity, particularly in the productive year of 2014, occurred primarily in Region 2 (E), Region 5 (Midlands) and Region 3 (C), which encompass the major agricultural areas of Southern England, where physiological resistance to the anticoagulant rodenticides in Norway rats is most extensive.

In conclusion, the number of breeding pairs of barn owl in any given year is determined by factors which include the level of overwintering mortality of breeding adults, the survival of first year birds and the successful recruitment of these birds into the breeding population. Data presented from various reported studies in Britain between 1988 and 2015 indicate that the productivity of barn owls has not changed markedly over this 28-year period. Breeding success is influenced by prey availability and survival, which in turn is shaped by numerous other factors such as climate, habitat quality and population density (Toms, 2014). Barn owls clearly are widely exposed to SGARs, but the impact of this on the productivity of the UK population is difficult to quantify directly. The BOMS data obtained to date suggest that the magnitude of this impact, if any occurs, is low. The study will continue in the forthcoming years to assemble more information on this important aspect of the biology of UK barn owls, the chosen sentinel species for SGAR contamination.

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Annex 1 Barn owl breeding data for 2011 to 2016.

Year	Parameter	Region 1 (N)	Region 2 (E)	Region 3 (C)	Region 4 (SE)	Region 5 (Midlands)	All Regions
2011	**Total number of nests**	16	20	16	22	24	98
	Nests that produced fledgling birds	6	12	12	10	16	56
	Total number of birds fledged	18	28	40	36	64	186
	Mean productivity per successful nest	**3.00**	**2.33**	**3.33**	**3.60**	**4.00**	**3.32**
2012	**Total number of nests**	16	19	17	21	28	101
	Nests that produced fledgling birds	6	14	12	12	19	63
	Total number of birds fledged	14	42	26	29	42	153
	Mean productivity per successful nest	**2.33**	**3.00**	**2.17**	**2.42**	**2.21**	**2.43**
2013	**Total number of nests**	14	20	18	16	30	98
	Nests that produced fledgling birds	2	10	1	0	10	23
	Total number of birds fledged	6	35	2	0	40	83
	Mean productivity per successful nest	**3.00**	**3.50**	**2.00**	**-**	**4.00**	**3.61**
2014	**Total number of nests**	25	25	22	21	28	121
	Nests that produced fledgling birds	15	21	14	11	17	78
	Total number of birds fledged	50	95	69	36	86	336
	Mean productivity per successful nest	**3.33**	**4.52**	**4.93**	**3.27**	**5.06**	**4.31**
2015	**Total number of nests**	25	25	25	25	30	130
	Nests that produced fledgling birds	5	4	13	12	7	41
	Total number of birds fledged	13	10	31	31	18	103
	Mean productivity per successful nest	**2.60**	**2.50**	**2.38**	**2.58**	**2.57**	**2.51**
2016	**Total number of nests**	25	25	25	25	30	130
	Nests that produced fledgling birds	56	63	23	78	41	61
	Total number of birds fledged	186	153	83	336	103	154
	Mean productivity per successful nest	**3.32**	**2.43**	**3.61**	**4.31**	**2.51**	**2.52**