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The BTO Barn Owl Monitoring Programme: Final Report 2000-2009

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OVERVIEW OF THE BARN OWL MONITORING PROGRAMME 2000-2009

The Barn Owl Monitoring Programme (BOMP), funded by the Sheepdrove Trust, was initiated in 2000. The main aim of the project was to provide a mechanism for monitoring annual changes in size of the Birds of Conservation Concern (BoCC) Amber-listed Barn Owl population in the UK. As existing transect-based diurnal surveys such as the BTO/JNCC/RSPB Breeding Bird Survey (BBS) provided poor coverage of the species, BOMP methodology involved the regular visitation of an established network of nest sites to assess occupancy. This approach also permitted the collection of data on breeding success and, through the ringing that occurred at the majority of sites, on survival and dispersal of young and adult birds.

In the first two years of the project, Colin Shawyer of the Wildlife Conservation Partnership (WCP) monitored 159 and 170 sites respectively, submitting the data to the BTO for analysis. From 2002 onwards, WCP monitored 200 sites per annum and the dataset was boosted by the addition BOMP Network sites covered by BTO volunteers, collecting data at a further 365 sites in the first year and an incredible 593 by 2009. One of the major successes of BOMP is the impact it has had on recruiting new surveyors, and Figure A shows the four-fold increase in Barn Owl nest records that were submitted to the BTO's Nest Record Scheme (which includes data from BOMP sites) following the programme's initiation.

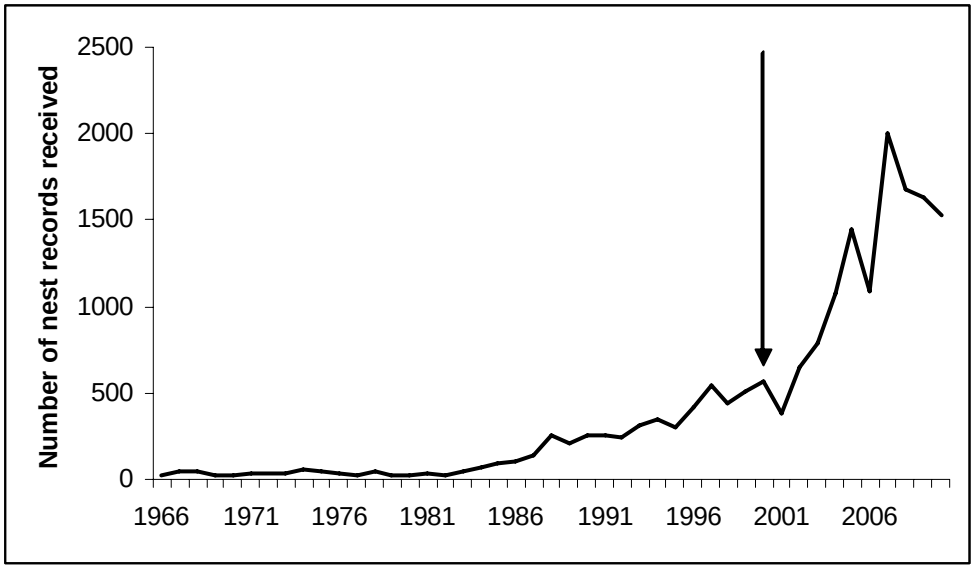


Figure A. Submission of nest records (including information from BOMP) to the BTO's Nest Record Scheme. Black arrow indicated the year in which BOMP was initiated (2000).

Analysis of the data on occupancy rates showed a significant decline over the duration of BOMP. Concurrent trends in BBS results and preliminary data from the BTO Bird Atlas 2007-2011 suggest that the UK population has actually increased in size over the last decade. The decline in occupancy rates recorded by BOMP may therefore reflect an increase in the provision of artificial nesting sites at a national scale, providing breeding birds with a greater number of alternative sites to move to between years.

However, the information collected has been incredibly useful in investigating spatial and temporal variation in occupancy rates and breeding success. A paper by Leech *et al*. (2009) published in the journal *Ardea* used BOMP data to demonstrate that occupancy rates were higher and brood sizes larger in areas of rough grassland habitat relative to those inhabiting areas of either pastoral or arable land, indicating that the availability of suitable foraging habitat can limit breeding success. Further analyses of BOMP data have identified the very significant role that winter weather can play in

determining breeding success the following season, and these results are currently being prepared for publication. Other practical benefits include the experience gained by WCP under BOMP, allowing them to further develop their monitoring techniques and provide advice to other fieldworkers monitoring the species.

Thanks to the generosity of the Sheepdrove Trust, the BOMP project has been incredibly successful in raising the profile, and consequently the recording effort, of this threatened species, to the extent that it is now one of the most intensively monitored birds in the UK. BOMP leaves a legacy of over 100 volunteer fieldworkers who will continue to submit their data to BTO, allowing us to assess the progress of the species for many years to come.

1. EXECUTIVE SUMMARY

1.1 The Barn Owl is a scarce breeding species that has undergone a substantial population decline in the UK during the 20th century. It is listed as being of Amber conservation concern in the UK, but has been poorly covered by the national, long-running population monitoring schemes operated by the BTO. The BTO Barn Owl Monitoring Programme (BOMP) was set up in 2000 with the aim of:

Monitoring Barn Owl populations through standardised recording of nest occupancy rates, breeding performance and survival at a set of Barn Owl nest sites broadly representative of the distribution of the Barn Owl in Britain.

1.2 Fieldwork involves repeat visits to registered sites, particularly to paired nest boxes, over the Barn Owl nesting season between April and October, to assess occupancy, gather breeding statistics, and ring adults and chicks. The Wildlife Conservation Partnership (WCP) has undertaken the development of BOMP methodology and has carried out fieldwork since 2000 at a set of '*core*' sites, distributed across five regions of England. In 2002, a network of volunteer ornithologists began gathering additional information at '*BOMP Network'* sites over a wider geographical area.

1.3 This report reviews data collected over the ten years of the survey period (2000-2009). Rates of occupancy are investigated, along with breeding statistics, in relation to year, geographical location, main habitat type and weather conditions.

1.4 In 2009, WCP monitored 194 sites and the BOMP Network monitored 593. WCP sites are located across the whole of England, although as a consequence of sampling methodology they tend to be concentrated in the southern, eastern and northern regions. BOMP Network sites are more widely distributed within the UK, including sites in Scotland and Wales.

1.5 The proportion of sites at which Barn Owls were recorded as present (whether breeding or not) has declined over the ten years of the study, as has the proportion of occupied sites at which Barn Owls bred. This may indicate a decline in Barn Owl populations over this period but, given the 464% increase in population size in the period 1995-2008 indicated by the Breeding Bird Survey results, this is likely to be an artefact of increasing nest site availability over time rather than a reflection of a true population trend.

1.6 Weather conditions have previously been reported to affect both Barn Owl abundance and the proportion of pairs that are in sufficient condition to breed, with cold, wet weather during the winter reducing the availability of small mammal prey and the ability of Barn Owl to hunt successfully. Analyses using national temperature (Central England Temperature) and rainfall (England & Wales Precipitation) datasets suggest that the proportion of sites at which owls were present was reduced following cold, wet winters and that the proportion of occupied sites at which the birds attempted to breed was also lower. These results suggest that a reduction in body condition during inclement winters, results in the suspension of breeding during the following breeding season and possibly to an increased mortality rate.

1.7 Weather conditions also had a significant effect on Barn Owl productivity, with females laying earlier and producing larger clutches and broods after warmer winters. Such a relationship is expected if inclement weather increases thermoregulatory costs, reduces hunting efficiency or opportunity or reduces the abundance of prey species, thereby negatively influencing body condition. Female weights at WCP sites were lower following colder winters, and adults in poorer condition may reduce their investment in reproduction during the following season. Alternatively, harsh winters may reduce the size of prey populations the following spring, reducing food availability during the breeding season.

1.8 Site occupancy rates were significantly higher and brood sizes were significantly larger at BOMP sites in areas of natural grassland, relative to sites in arable and pastoral areas. These results are likely to reflect inter-habitat variation in the density of prey species, particularly Field Voles (*Microtus agrestris*).

1.9 Occupancy rates were also influenced by geographic location. Sites towards the north of the UK were more likely to record Barn Owls. This may be due to lower densities of nest sites in these regions (Toms *et al.* 2000), although climate and habitat quality may also vary with longitude, thus influencing population sizes.

1.10 The proportion of sites occupied by breeding pairs of Jackdaws was higher towards the north of the UK, and the species showed preference for sites not occupied by Barn Owls. The proportion of sites occupied by breeding pairs of Kestrels was higher in the south-east of the UK. Both species preferred pole-boxes, which have an additional chamber.

1.11 Analysis of the data on occupancy rates showed a significant decline over the duration of BOMP. Concurrent trends in BBS results and preliminary data from the BTO Bird Atlas 2007-2011 suggest that the UK population has actually increased in size over the last decade. The decline in occupancy rates recorded by BOMP may therefore reflect an increase in the provision of artificial nesting sites at a national scale, providing breeding birds with a greater number of alternative sites to move to between years.

1.12 It would be highly desirable within the next decade to conduct a repeat survey using Project Barn Owl methodology, to assess Barn Owl population trends using a randomised sample of study sites. This would help to validate the annual monitoring approach taken by BOMP and help to put the results in context.

2. INTRODUCTION

The Barn Owl Monitoring Programme (BOMP) was set up in 2000 as a means of monitoring Barn Owl populations in the UK. This species can be difficult to monitor because it is largely nocturnal, is not vocal and occurs at low densities. To overcome these problems, BOMP methodology asks participants to visit known nest sites on an annual basis to determine whether Barn Owls are breeding and to collect information on breeding success. These data are collated at the BTO each year and analysed, with the aim of producing annual trends in occupancy rates and breeding parameters. The value of BOMP is shown by the inclusion of its results in the annual publication *The State of the UK's Birds* (e.g. Eaton *et al*. 2009a). This report presents an analysis of the ten years of BOMP data (2000-2009).

2.1 History of Barn Owl population surveys in the UK

The Barn Owl *Tyto alba* is one of the world's most widely distributed land birds, being found on all continents except Antarctica. It is a moderately widespread bird throughout the UK, found especially on farmland, although generally absent from upland and heavily urbanised areas and from the far north and northwest of Scotland, including Shetland, Orkney and the Hebrides (Gibbons *et al*. 1993). Its pale plumage, partly diurnal or crepuscular hunting behaviour, and habit of nesting in buildings and more recently in nestboxes, make it more noticeable than some other owls and many local people know of it as a characteristic part of the countryside. Where small mammals are perceived as pests, Barn Owls that feed on them may typically be viewed as actively beneficial to man. Where Barn Owls occur, therefore, their presence in an area (as distinct from actual breeding place) is often known and appreciated.

Throughout the 18th and early 19th centuries, the Barn Owl was regarded as our most common species of owl (Latham 1781, Rivière 1830, Macgillivray 1840, Holloway 1996). Since about the middle of the 19th century, however, factors such as increasing persecution and collection of specimens for taxidermy are said to have contributed to a population decline. This perceived decline prompted one of the earliest national surveys of the breeding population of any wild bird (Blaker 1933, 1934). Blaker's evidence, collected through a request for information he circulated throughout England & Wales, suggested a population estimate of about 12,000 breeding pairs in these countries in 1932, and indicated that a substantial decline had indeed occurred over the previous 30–40 years. The decline appears to have continued through the 1950s and 1960s (Prestt 1965, Parslow 1973) and was suggested to have stemmed from the increased use of toxic chemicals (especially organochlorine seed dressings), loss of hunting habitat, increased disturbance and the hard winters of 1946/47 and 1962/63 (Dobinson & Richards 1964). During the surveys for the 'Atlas of Breeding Birds in Britain and Ireland 1968–72', the population was estimated to number between 4,500 and 9,000 pairs (Sharrock 1976). The second atlas, the 'New Atlas of Breeding Birds in Britain and Ireland 1988-1991' estimated a decline of 37% in Britain alone (Gibbons *et al*. 1993). The new Atlas 2007-11 will provide an up-to-date result of the distribution of this raptor (provisional results can be found on http://www.bto.org/volunteer-surveys/birdatlas), and the latest results from the Breeding Bird Survey showed that the long-term population trend was up by 464% in the period 1995-2008 (Risely *et al*., 2010).

During 1982–85, the Hawk and Owl Trust (known then as the Hawk Trust) undertook a four-year census of Barn Owls in Britain, Ireland and the Channel Islands. They estimated the size of the breeding population at 3,778 pairs in England & Wales, 640 pairs in Scotland, 39 pairs in the Channel Islands and 4,457 pairs in Britain as a whole (Shawyer 1987). These figures represented a decline of about 70% in England & Wales since Blaker's 1932 survey, although differences in methods between the surveys meant that the precision of this figure is unknown (Toms *et al.* 2001).

The most recent nationwide survey was *Project Barn Owl*, undertaken jointly by BTO and Hawk and Owl Trust in the UK, Isle of Man and Channel Islands during 1995–97 (Toms 1997, Toms *et al.* 2000, 2001). This project established a random sample of survey sites, which were 2x2-km tetrads of the

national grid, and devised new survey methods that could be repeated at intervals in the future to produce directly comparable results. This survey produced a population estimate of about 4,000 pairs for the whole area of study (Toms *et al.* 2001), a slightly lower figure than produced by the Hawk Trust survey for Britain alone twelve years earlier. Because the confidence intervals around the Project Barn Owl figure included the previous Hawk Trust estimate and as the methodologies were not identical, it was not clear whether or not a further decline had occurred between these two surveys. It is important to note that these two surveys were specifically designed to be carried out over a 3-4 year period: the difficulty of assessing trends between annual surveys having been emphasised by the finding that, in southwest Scotland, numbers of Barn Owl pairs which breed can more than double across a single three- to four-year cycle of vole abundance (Taylor *et al.* 1988).

2.2 Conservation status of the Barn Owl

Although the UK Barn Owl population may have declined slightly or remained essentially stable in recent decades, there is evidence that a substantial decline took place during the 20th century as a whole. Less comprehensive data from other parts of the world range suggest that similar declines have been widespread across Europe and elsewhere (Colvin 1985, Shawyer 1987, Tucker & Heath 1994, BirdLife International 2004). The Barn Owl has qualified under international criteria, through its 'moderate decline' in Europe as a whole, as a species of European conservation concern (SPEC category 3; Tucker & Heath 1994).

In the UK, Barn Owl was included in Schedule 1 of the Wildlife and Countryside Act 1981, affording it protection by special penalties at all times. In 2002 it was included on the Amber List of Birds of Conservation Concern (Eaton *et al*. 2009b) due both to its decline in breeding range of between 25-49% and because it is listed as a species with unfavourable conservation status in Europe. A UK conservation action plan for the species has been developed (RSPB Species Action Plan 0735), as well as over 40 local Biodiversity Action Plans under Local Agenda 21 of the International Convention on Biodiversity.

Much conservation work has focused on the Barn Owl over the last 25 years when a long-term conservation and research plan was put in place for the UK (Brazil and Shawyer 1988). The Barn Owl Conservation Network (BOCN) as a project of the Hawk Trust, was established at this time to provide the means by which this plan could be carried out. The BOCN, along with the Barn Owl Trust and other specialist groups has subsequently led to the fostering of a more widespread recognition of the species' conservation importance. Attention has been directed towards the creation and management of areas of suitable feeding habitat, increasing the availability of prey, providing habitat corridors to promote dispersal and provide connectivity of habitat, coupled with the provision of nest boxes on these habitat corridors and elsewhere in areas where a shortage of nest and roost sites was considered to be a limiting factor. Over the same period, attention has also been focused on other factors that may have played a part in the Barn Owl's decline, in particular 'second-generation' rodenticides (Shawyer 1985) and mortality due to collisions with road traffic (Bourquin 1983, Massemin & Zorn 1998, Shawyer & Dixon 1999). The second-generation rodenticides difenacoum, bromadiolone, brodifacoum and flocoumafen are used to control Brown Rats *Rattus norvegicus* in and around agricultural premises, particularly in areas where resistance to warfarin is high (Shawyer 1987, Harrison 1990). Barn Owls are potentially vulnerable to secondary poisoning from ingesting poisoned rodents. Chemical residue monitoring by the Centre for Ecology and Hydrology has found that a small proportion of Barn Owl corpses contain potentially lethal doses of rodenticide (Newton *et al.* 1991; Newton & Wyllie 1992).

Attempts to increase the population have, in the past, included large-scale programmes for releasing captive-bred birds (e.g. Ramsden & Ramsden 1989, Warburton 1992). Concerns that some releases may have been against the birds' and the species' best interests led in 1992 to Barn Owl being added to Schedule 9 of the Wildlife and Countryside Act, of species of animals that may not be released or allowed to escape into the wild without a licence, and to the Government setting up the 'Captive Barn Owl Release Scheme', to prevent indiscriminate releases by inappropriate methods. This scheme,

which had prompted a very low take-up rate and was felt by the Government to have shown limited benefits, was discontinued in 2002.

The lack of an ongoing, annual monitoring scheme for Barn Owl has hampered the assessment of national population trends and, consequently, of the success or otherwise of local conservation measures. Annual monitoring of this species is particularly important given its inclusion on the UK Government's Farmland Bird Index of Sustainable Development and the Government's Publics Service Agreement target to reverse the decline in the index by 2020. This PSA target was abandoned by the UK's Coalition Government in 2010, along with a raft of similar targets, but the farmland bird indicator and the intention to reverse declines in farmland bird populations remain. Furthermore, concerns about the use of newer types of rodenticide as well as other pesticides require the ability to detect, at the earliest opportunity, any widespread detrimental impact of poisoning through annual monitoring of Barn Owl populations, their breeding performance and survival. In addition, a carefully designed monitoring programme can help identify whether any changes in abundance are driven by changes in breeding performance or survival, and link these demographic processes to likely causal factors in the environment, such as habitat or climatic change.

2.3 Potential impacts of weather conditions and climate change

The effects of weather, in particular climatic extremes (prolonged snow cover, persistent rainfall and drought), on Barn Owl survival and productivity have been reported previously (Shawyer 1987). The duration of winter snow cover, strong winds and heavy rain can impede hunting directly, by reducing visibility, auditory capabilities and manoeuvrability, and indirectly, by reducing the activity levels of rodent prey. Such inclement conditions, when persistent, can also lead to increased thermoregulatory costs and declines in prey abundance. The increased costs associated with such conditions may either result in lower rates of adult or chick survival or lead to a reduction in adult body condition causing a reduced investment in reproduction or, in some cases, the suspension of breeding. Conditions, particularly cold winter or spring weather, can reduce vegetation growth that may, in turn, have implications for the abundance and/or the availability of small mammal species.

The latest scientific evidence suggests that there are a range of possible climate outcomes for given emissions trajectories (Murphy *et al*. 2009). These ranges are wide and may change in future as the science develops further. The latest UK Climate Projections (UKCP09) make this explicit by providing a range of projections of the future climate with associated probabilities, based on the strength of evidence provided by current knowledge, climate modelling capability and using expert judgement. These projections suggest that the UK is likely to experience an increase in seasonal temperatures, more so in summer than in winter. For example, the projections give a range of summer average temperature increases for the south-east of England of between 2 and 6.4ºC by the 2080s (2070-2099) under a medium emissions scenario. In contrast, increases in winter mean temperature are given as +3 (1.6-4.7) ºC (Murphy *et al.* 2009). As well as rising temperatures, climate change is likely to lead to changes in the number of extreme events: specifically, increases in hot days (nationwide and particularly in south east England) and decreases in frost days (greatest where frost days are currently more frequent).

Such changes in weather conditions may have important consequences for the UK Barn Owl population. One of the first steps in attempting to predict the impact of such climatic changes is to investigate the current relationships between weather parameters and population processes. The BOMP dataset provides an excellent opportunity to explore such associations and the results of analyses of both BOMP and Nest Record Scheme (NRS) data with respect to weather conditions are contained within this report.

2.4 Aims and work plan of the Barn Owl Monitoring Programme

The Barn Owl Monitoring Programme (BOMP) was set up in 2000 to address the needs of conservationists to be better informed about this important and vulnerable species. BOMP's overall aim and strategy were:

> *To monitor Barn Owl populations – through standardised recording of nesting rates, breeding performance and survival at a set of Barn Owl nest sites that broadly representative of the distribution of the Barn Owl in Britain.*

The key activities of BOMP were as follows:

- *To establish a set of Barn Owl sites, which could be monitored on an annually basis.*
- *To assess change in the number of breeding attempts, using site occupancy rates.*
- *To monitor breeding productivity of Barn Owls, using standardised nest recording methods.*
- *To monitor survival rates and dispersal of Barn Owls, through the ringing of chicks and adults.*
- *To examine breeding performance and site occupancy in relation to environmental variables, in particular broad-scale habitat surrounding each site.*
- *To provide an annual report of each year's results and to provide analyses and interpretation to assist conservation action and research.*

Fieldwork was undertaken by a combination of professionals and volunteers. The Wildlife Conservation Partnership (WCP) undertook fieldwork, to monitor a set of '*core sites*' in England, and methodological development. BOMP coverage was greatly swelled in 2002 by opening up the scheme to volunteers and developing 'BOMP Network' sites. Even if unable to contribute formally to BOMP, fieldworkers had been encouraged to submit extra records to the national Barn Owl databases held by BTO's Nest Record and Ringing Schemes.

Throughout the project, opportunities were taken to publicise BOMP, to recruit more volunteers, to provide feedback, and to raise public awareness about the ecology of the Barn Owl. We produced an annual newsletter that acts as a forum for the exchange of ideas and information between volunteers, in addition to providing feedback. The BTO worked with other organisations concerned with the conservation of Barn Owls, thereby ensuring that the monitoring results provided effective guidance for conservation action. BTO staff worked closely with the Barn Owl Conservation Network (www.bocn.org), producing articles for the BOCN Newsletter and speaking at BOCN symposia. The Barn Owl Bulletin, the annual newsletter produced by the BTO for BOMP participants, also included features about other relevant organisations, including BOCN.

This report presents the results of the full whole Barn Owl Monitoring Project that was undertaken between 2000 and 2009.

3. METHODS

3.1 Overall strategy of BOMP

Barn Owl biology and behaviour means that this species is most easily surveyed by monitoring potential nest sites during the breeding season (Bunn *et al*. 1982, Shawyer *et al*. 1987, Bibby *et al*. 1992). Nest visits also allow measures of productivity to be recorded and for adult and young Barn Owls to be ringed, enabling the study of survival rates and dispersal.

A key feature of BOMP has therefore been the establishment of a set of nesting sites at which occupancy and breeding parameters are monitored every year. Many of the sites have been selected and surveyed by BTO volunteers, some of whom are ringers and are licensed to handle and ring young and adult Barn Owls at the nest. Volunteers were asked to guarantee to monitor at least one Barn Owl nest site for a minimum of three consecutive years. A further substantial sample of sites in five English regions is monitored by The Wildlife Conservation Partnership (WCP). Additional studies carried out at WCP sites have contributed to the methodological development of the scheme.

It should be noted that nest site occupancy provides a minimum estimate of Barn Owl abundance in a specified area, because they only include those individuals attempting to breed in monitored sites and do not record the presence of unpaired individuals, pairs not attempting to breed, or any pairs breeding in unmonitored nest sites.

BOMP's collection of detailed breeding performance and survival information complements that that gathered nationally by the BTO Nest Record and Ringing Schemes. These schemes, unlike BOMP, do not impose any requirement on volunteers for consistent recording; thus the potential exists for changes in recording effort and methods to influence results, as the set of sites monitored by volunteers changes over time. By using a set of sites that are monitored every year, BOMP more precisely indicates the effects of changes in the environment surrounding Barn Owl sites.

All BOMP participants, and other BTO volunteers collecting similar data, need a valid Schedule 1 Licence before approaching any Barn Owl nest site. It is important to note that Barn Owls tend not to be easily disturbed by careful fieldwork (Percival 1990, Taylor 1991). Several long-term studies of the breeding biology of Barn Owls indicate that monitoring active nest sites is unlikely to bring about desertion (Lenton 1984, Wilson *et al*. 1987, de Bruijn 1994, Taylor 1994). Taylor (1991) examined the effect of nest inspections and radio tagging on breeding success of Barn Owls in southwest Scotland. He found that the various measures of productivity did not differ significantly between those nests that were only visited during late chick stage and those that received multiple visits. Taylor also noted that site fidelity was high, with only 0.9% of males and 5.6% of females changing nest sites between consecutive breeding seasons. We are confident, therefore, that nest site inspections did not compromise the welfare of Barn Owls, nor the integrity of the data gathered, provided that they were carried out following the protocols described in BOMP's Barn Owl Fieldwork Guidance Notes. These guidelines, which have been given to all BOMP participants, build upon those in the *Nest Record Scheme Handbook*, which themselves have been followed successfully for many years by nest recorders (Crick *et al*. 1999), and also draw upon 25 years of WCP field experience. The guidelines appeared as an Appendix in a previous annual report (Leech *et al.* 2005).

3.2 Study sites

Each BOMP study site is an actual or potential nest site for a single pair of Barn Owls. Where two or more sites are in close proximity, and likely to be used by the same pair of owls, they are registered separately but their linkage, or pairing, is also recorded. Barn Owl nest boxes are often positioned in pairs, and in some instances paired boxes are occupied simultaneously by the same pair of owls, either roosting apart or with one containing old young from the first brood and the other eggs from a second brood.

As there is a relatively high turnover of 'natural' sites, due for example to the felling of hollow trees for reasons of human safety, to barn conversions, to the shifting location of bale-stacks and waterlogging of natural sites, and because accurate recording of eggs and young is often difficult at natural sites where nests are located within deep cavities, observers are encouraged to target nest-box sites. As a result of this and the fact that natural sites are becoming increasingly uncommon in the UK, almost all of the sites that have been registered for BOMP are nestboxes. The widespread distribution of nestboxes clearly highlights the extent of the public's interest in Barn Owls (Project Barn Owl estimated that there were some 25,000 boxes in the UK; Toms *et al*. (2000) and Shawyer (2008) now estimates that about 75% of Barn Owls in the UK now breed in nestboxes. Their occupation indicates the benefit that conservation measures targeted at restoring foraging habitat, coupled with the provision of artificial nest sites, have had for the species. Many individuals who install nestboxes generally inspect them too. BOMP provides a framework for collating such observations, ensuring that the data are recorded according to a recognised standard thereby maximising the benefit derived.

Observers register their sites by sending details of their location to BTO HQ. For nest boxes, information is recorded on floor area, the positioning of the entrance hole (at top or bottom of box), and how the box is sited (for example mounted on a pole, in a barn, or in a tree). Grid references are held in confidence by the BTO in the light of the species' protection under Schedule 1 of the Wildlife and Countryside Act 1981.

Prior to the 2000 pilot survey, 125 sites were selected by WCP to be visited every year. These 'core' sites were chosen on the criteria outlined in the 2000 BOMP Report (Crick *et al.* 2001). WCP sites comprise two nest-box designs ('pole-box' or 'A-frame' in trees, Dewar & Shawyer 1996), the proportions of which are identical in four of the five study regions. Boxes in the fifth region, the southwest, are a hybrid of the two designs, being similar to pole-boxes but mounted in trees. WCP also monitors a further 75 supplementary ('extra') sites that have been included in the programme since 2002 and are now regarded as part of the WCP 'core' sample.

Because of the regional nature of WCP activities, and because most BTO volunteers have registered several sites within their home areas, there is substantial geographical clumping of sites. Although BOMP is intended to be a national programme within the UK, no sites have yet been registered in Northern Ireland, probably a consequence of the Barn Owls scarcity there (Scott *pers. com.).*

BOMP's concentration of effort into nest-box sites should not affect the analysis of differences between years, regions or habitats, although overall breeding performance may be somewhat enhanced compared to natural sites. Nesting in boxes may improve Barn Owl breeding success, as the nesting environment has been specially designed for this purpose. Nest recorders may remove old nest debris from boxes at the end of the breeding season (legally this is permitted only between 1 August and 31 January of the following year, but for Barn Owls considerably later than 1 August is usually more appropriate), maintaining sufficient space for successful nesting and potentially reducing parasite loads in the box. However, to counter these positive effects, nest boxes may be more obvious to competing species or predators.

3.3 Fieldwork methods

Monitoring at BOMP Network sites is carried out at two possible levels of commitment, described to potential contributors as Option 1 and Option 2. Full details of these are given in the Guidance Notes (Leech *et al.* 2005, Appendix 1).

At the first level, key information can be gathered with minimal disturbance to Barn Owls. Option 1 involves checking the registered nest sites at least twice, and preferably more regularly, for signs of occupancy, assessing fledging success, and checking for signs of re-nesting and second broods (see Table 3.3.1).

Requirements for Option 1:

- *Site occupancy*: a visit to the site in late April or early May usually reveals whether the site is occupied by Barn Owls (or has been during the current calendar year). A series of brief monthly visits from April to October is ideal. Evidence of usage, including pellet remains, moulted feathers and prey items is recorded, as is the identity and reproductive status of any other species occupying the box.
- *Second broods*: these are important in determining the overall productivity of a pair. Instances of double brooding can be identified more reliably where nest boxes are placed in closely adjacent pairs, as second clutches are often laid at different sites to the first.
- *Habitat / land-use of surrounding area*: the habitat surrounding the site is recorded using the standard BTO habitat codes (Crick 1992), which incorporates information concerning broad habitat types as well as more detailed information concerning crop types and livestock. 'Micro-habitat' features near the nest (for example ditch banks within a landscape of large arable fields) are potentially the most important factors in terms of attracting Barn Owls to breed at many sites, and are also recorded. Staff at BTO HQ have access to additional information concerning land-use at a wider scale, such as the Centre for Ecology & Hydrology's satellite-derived Land Cover data (Haines-Young *et al*. 2000).

The second level of monitoring, demanding greater experience and commitment, involves visiting nests to record additional information regarding the nest contents. Nest recorders choosing Option 2 are invited to record clutch size, brood size, age of young, losses of young, the presence of other species nesting at the site, and details of species, number and weight of any prey animals stored there.

Requirements for Option 2:

- *Clutch size*: the number of eggs present – recorded during a visit in late April or early May. For the most part, second broods are detected on the visits made in July or August, when the female is sitting on eggs, sometimes in an adjacent (paired) nest box, while the male is still feeding young from the first brood (as well as his mate).
- *Hatching success*: counts of unhatched eggs or eggshells.
- *Brood size*: the number of young present, preferably at early and late nestling stages.
- *Age of young*: as judged from the development of down, or estimated from feather length (7^{th} primary) or wing cord length.
- *Losses of young*: any dead or missing young are noted.
- *Prey stored at nest*: presence, species composition, number (and, if possible, weight) of prey stored at nests.
- *Dates of laying, hatching and fledging*: these are recorded when visits coincide with these events, but hatching, and hence laying dates, can also be deduced from the age of the nestlings.
- *Fledging success*: the number of young fledged from a site. This must include zeros (total failures) to give an accurate indication of the breeding performance of Barn Owls each year. In practice, this is likely to be measured as the number of young in the nest at 5-8 weeks old, at ringing age, because most chick losses have usually occurred by this time. A late visit to the nest site is useful to record the presence of any remains or rings of chicks that died prior to fledging. The fledging success of any second broods is assessed through a final site visit in October.

Under Option 2, suitably licensed ringers are encouraged to ring the adults and young, record chick measurements and, for adults, note their age, sex, and state of brood patch and moult (Table 3.3.1).

- *Ringing young*: this is important for measuring survival rates and dispersal, when breeding adults are recaptured in subsequent years and when dead birds are found and reported under the BTO Ringing Scheme; 10-15% of ringed Barn Owls are subsequently reported to the BTO's Ringing Office.
- *Measurements of young*: on each visit, ringers are asked to measure wing length (maximum chord) and weight of chicks. Nestling age from 12 days to fledging can be estimated by taking the length of the unfurled section of the 7th primary feather, and prior to this, by the total length of pin, and by consulting one of two separate (pin and feather) growth curves (Shawyer 1998). A further growth curve for the 11 days following hatching has also been developed using the length of the relaxed wing chord (Shawyer *pers comm.*).
- *Sexing of young*: the degree of speckling on the underside of the body and wings can be used to determine a nestling's sex after the fourth week of age (Shawyer 1998). Chick weight may provide a useful measure of condition and sex; the value of this technique is being assessed.
- *Measurement of dead chicks (length of 7th primary, pin or unfurled)*: primary feathers are generally very resilient and therefore can be useful in estimating the age at which any dead chicks died.
- *Ringing adults*: only ringers who have experience of catching birds at a nest site are permitted to ring adults and take biometric measurements. Guidelines have been provided as part of the fieldwork Guidance Notes and we encourage the sharing of information between ringers. Ringing of adult birds is necessary for the robust estimation of survival rates, and allows assessments of dispersal and movements by breeding individuals. Typically the ratio of chicks ringed to adults ringed is approximately 12:1. Ringers are therefore urged to catch more adults.
- *Measurements of adults*: the age, sex, weight, moult and brood patch condition of adult birds is recorded using standard techniques.

Visit period	***Information sought, ringing activity***
Late April to mid May	Site occupancy Count eggs and any chicks just hatched Catch and ring adults *Identify moulted feathers*
Mid July to early August	Count chicks at 6-8 weeks old Ring chicks Identify whether second broods begun *Collect / identify moulted feathers*
October	Count second broods at 6-8 weeks old *Ring chicks*

Table 3.3.1 Visiting schedule adopted as standard for the BOMP Network sites, designed to document the key events in the Barn Owl's breeding cycle.

Work by WCP has been carried out at the full Option 2 level, which also includes the development and testing of new methods.

- When combined with egg weight, measurements of length and breadth of eggs can be used to assess egg density, which declines predictably through incubation due to respiration by the developing embryo (Rahn & Ar 1974). A portable electronic pan balance is needed for accurate weighing. Egg measurements may prove useful for determining a relatively precise laying date and can also be used by ringers to assess when to revisit the nest in order to

optimise data gathering and to ring the chicks. The period between egg measurement and hatching can be estimated by referring to a standard curve (Percival 1990, Shawyer 1998).

- A method of estimating post-ringing chick mortality is being investigated by WCP. This involves visiting a sample of sites six to eight weeks after ringing, and making thorough searches of pellet debris at boxes where young have been ringed for a number of years.
- WCP is assessing whether the presence of shredded pellets, and of incubating females in July or August are effective indicators of second breeding attempts.
- Variation in the presence of moulted wing feathers from the female at the first breeding attempt, usually between late April and early June, is being investigated to assess whether it can be used as positive indicator that a second brood will not be attempted.
- The length of moulted primary and secondary wing feathers found at the nest during the early stages of breeding provide a means of aging the adults up to their fifth calendar year. A calibration curve has been produced that enables individual feathers to be identified, inferring moult pattern and therefore permitting age to be determined (Shawyer *pers comm.*)

The standard equation used to derive egg density from egg measurements comes from a study by Hoyt (1979), and is drawn from information for 115 species. This equation is applicable to all species, except a few that have relatively pointed eggs. Percival (1990) used a slightly different equation that was based on a smaller number of species, as reported by Hoyt (1979) and Furness & Furness (1981), and created a curve that relates egg density to hatching date, based on Barn Owl egg measurements. Shawyer (see above) has adapted this further as part of BOMP.

3.4 Data collation

WCP data were recorded on standard paper forms developed during the first year of BOMP (Leech *et al*. 2005, Appendix 2). BOMP Network data have been recorded on an equivalent form on which all the information for Option 1 and Option 2 could be entered (Leech *et al*. 2005, Appendix 3).

3.4.1 Incorporation of BOMP sites into the NRS

Whilst the data collected by BOMP participants and NRS volunteers are largely the same, the format is not identical and as a consequence they have been loaded into two distinct databases. To ensure that BOMP and NRS productivity data for Barn Owl could be pooled easily each year, it was decided in 2007 that BOMP nest contents data should be submitted on Nest Record Cards or ideally electronically via software designed for this purpose, known as Integrated Population Monitoring Reporter (IPMR). These data are then loaded into the NRS Oracle database each year along with any standard nest records submitted (see Leech et al. 2005, Appendix 5 for example of a Nest Record Card and a NRS Coding Card). For this each BOMP participant was registered as a nest recorder and supplied with a NRS Starter Pack (see http://www.bto.org/volunteer-surveys/nrs for more details). The BOMP Site Code was noted for each record together with a letter indicating the number of the brood (A = first brood, B = second brood, etc.). By doing this, it allows the records to be linked with information on the BOMP forms that are not submitted on standard nest records, e.g. details of prey items, specific habitat features and other species present.

A further advantage of this approach is that it allows BOMP records to be checked easily for inconsistencies using standard data checking programs that used to check nest record data. Laying dates, clutch sizes, brood sizes and failure rates can also be calculated using standard NRS programs (Crick et al. 2003).

3.5 Calculating breeding parameters

3.5.1 Site occupancy

A site was classed as 'used for nesting' if a breeding attempt had been made, as signified by the presence of one or more eggs or chicks on at least one visit made during the season. If a Barn Owl(s) was encountered or if fresh pellets were present, but no eggs or chicks were recorded during the season, the site was classed as 'used for roosting'. Sites that were not visited and those at which Barn Owls may have been prevented from nesting, e.g. by the presence of other species, were excluded from all analyses.

Barn Owls may start to lay a repeat clutch before all of the chicks of the first brood have fledged. At some sites paired boxes were erected with the intention of providing a potential site for repeat nesting attempts. These boxes are usually placed very close together and are thus very unlikely to be used simultaneously by two different pairs. For analytical purposes, the pair of boxes was therefore treated as a single site and if a breeding attempt was initiated in either box then the site was classed as 'Used for nesting'. However, in a few cases, two pairs did nest in paired boxes. If this occurred during any season, the paired boxes are treated as two separate sites in all years as there is the potential for simultaneous breeding sometimes involving polygyny (Shawyer *pers comm.*).

From the 2004 season onwards, BOMP Network participants were able to record the identity of registered sites that were located within 500m of each other. If these sites were not occupied simultaneously by breeding Barn Owls at any point during the study period, these were treated as paired sites for the purpose of analyses.

3.5.2 Laying date

Very few nests are found sufficiently early for the laying date of the first egg (FED) to be known with certainty. For the most part, back-calculation is required, based on information on clutch size and the age or stage of the nest contents on each visit. Given the visit date and the stage of development of the contents, as recorded by the observer, and information about the typical length of the egg-laying interval, incubation and nestling periods and whether or not the eggs hatch synchronously, it is possible to calculate the earliest and latest possible first egg dates for each nest (Crick *et al.* 2003).

An acceptable level of uncertainty used in the analysis of laying dates will vary according to species and study, but for the purpose of these analyses the midpoints between earliest and latest possible FEDs were used to provide a measure of laying date uncertainty to within ± 5 days. If the range of possible FEDs exceeded 10 days, the record was excluded from the analysis. This methodology was used to determine laying dates for both BOMP and NRS data.

Unfortunately, visits to sites during the laying and incubation periods are relatively infrequent and the range of possible FEDs for the majority of nesting attempts is greater than the 10-day cut-off point, resulting in greatly reduced sample sizes for the analyses. However, additional measurements of chicks at WCP sites permit egg-laying dates to be estimated to +- 1 day using standard growth curves relating the length of the wing or the seventh primary to the age of the chick (Crick *et al*. 2001). The hatching date of the oldest chick was therefore back calculated and the FED was estimated by assuming a mean incubation period of 31 days.

3.5.3 Clutch and brood size

For determining clutch size, it is important to know whether egg-laying has finished or not. Thus records were omitted from these analyses if nests were only visited once, if they only visited when the eggs were cold (suggesting the nest had failed before the first visit), if laying may still have been in progress on the last visit or if the maximum recorded brood size exceeded the maximum number of recorded eggs (Crick

et al. 2003). Clutch sizes of a single egg were included from the analyses as these are highly likely to represent incomplete clutches. Records were excluded from the analysis of brood size if no visit was made while any of the young were alive. This methodology was used to calculate clutch and brood sizes for BOMP.

3.5.4 Data for repeat broods

Because second broods are likely to be unrecorded by BOMP and that productivity may vary between first and second broods, any breeding attempts identified as repeats by observers were removed from the BOMP dataset prior to analysis of laying date, clutch size, brood size or failure rate. As NRS participants do not necessarily distinguish between first broods and repeat attempts, all nests at which the estimated FED occurred after 4th July were removed from the dataset prior to analysis. This cut-off date was selected because Joys & Crick (2004) identified it as the upper 95% quartile in their analysis of first egg dates in the NRS dataset.

3.6 Assigning habitat categories

A primary habitat code is associated with all WCP sites. Each record was assigned to a broad habitat category on the basis of the first two levels of the primary habitat code (Crick 1992) as indicated in Table 3.6.1.

BTO Habitat Code	**Description**	**Habitat Category**
B1-B7	Scrubland	GRASS
C1-C9	Semi-natural grassland and marsh	GRASS
D1-D6	Heathland and bogs	GRASS
E1, E2, E5, E6	Farmland	PASTORAL
E3, E4	Farmland	ARABLE
A1-A6	Woodland	Excluded from analyses due to small sample sizes
F1-F3	Human sites	
G1-G10	Water bodies (freshwater)	
H1-H4	Coastal	
I1-I7	Inland rock	
J	Miscellaneous	

Table 3.6.1 Broad habitat categories used in the analyses of BOMP data.

For BOMP Network sites, participants are asked to record the proportion of each of the major BTO habitat categories (Levels 1 and 2 – Crick 1992) within the 1km square in which the nest site is centred. For the purposes of this analysis, each site was allocated the habitat code of the most prevalent habitat type. The records were then allocated to broad habitat categories as indicated in Table 3.6.1.

3.7 Weather data

The two climatic parameters used in these analyses were the Central England Temperature (CET) index (Manley 1974, Parker *et al*. 1992) and the England and Wales Precipitation (EWP) index (Wigley *et al*. 1984, Jones & Conway 1997). These data were used because the area of Britain from which they are collected is broadly comparable with the distribution of BOMP sites. Mean monthly values for these variables were obtained from the Hadley Centre for Climate Prediction and Research (http://hadobs.metoffice.com/hadcet/data/download.html) for the years 2000-2009 (BOMP data).

For the analyses of occupancy rates here, mean annual values of CET and EWP over the period November-March were included in the models to investigate the influence of winter weather on nest box occupancy during the following spring. For analyses of laying date and clutch size, mean annual values of CET and EWP included in the analyses were calculated over the period Mar-June. This range of months was selected because the central 80% of first egg dates for Barn Owl that can be calculated with an accuracy of ± 5 days from the NRS dataset 1990-2009 fall between the beginning of April and the end of June, and the weather in the month immediately preceding the laying season may also influence characteristics of the clutch. For analyses of brood size, means of CET and EWP over the period May-Aug were included in the model as the average incubation period is approximately one month and chicks take approximately 50 days to fledge.

3.8 Statistical models

All statistical models were built using SAS 9.2 (SAS Institute, 2008).

3.8.1 Barn Owl nest box occupancy

Factors influencing both the proportion of sites at which Barn Owls were present, whether breeding or non-breeding, and the proportion of occupied sites at which Barn Owls were actually breeding were investigated. As the dataset included information from the same nest sites in several different years, a repeated measures GENMOD procedure was used, with a site identifier as the repeated variable and specifying an autoregressive correlation function. Barn Owls are a relatively long-lived species (mean life-expectancy = 3 years, maximum = 13 years, Robinson 2005), and using a repeated-measures approach therefore allows us to control for the fact that the same pair might be breeding at a specific site in successive years. In all models of occupancy rates, a binomial error distribution was assumed and a logit link function was specified.

WCP and BOMP Network data were analysed together, with the categorical variable 'Site type' (either 'WCP' or 'BOMP Network') included as an independent variable. Northing, Easting, year, primary habitat type, winter temperature and winter precipitation were also included as independent variables in all models.

3.8.2 Barn Owl laying date and productivity – BOMP dataset

Models used to investigate factors influencing the various measures of productivity were identical to those described in Section 3.9.1 above, except:

- For all analyses of laying date information, a normal distribution was assumed and an identity link function was specified, and for all analyses of clutch and brood size data, a Poisson error distribution was assumed and a log link function was specified.
- Temperature and rainfall terms were included as separate independent variables in the same model as there was no significant correlation between the two parameters either during winter ($R<0.1$, $P=0.917$) or during the breeding season ($R<0.1$, $P=0.994$). Temperatures during the breeding season were strongly and significantly correlated with those during the winter ($R=0.64$, $P=0.030$), although the same was not true of the rainfall parameters ($R=0.35$, $P=0.426$). All initial models therefore contained winter weather parameters only.

3.8.3 Barn Owl productivity – NRS dataset

Whilst the NRS dataset does undoubtedly contain data for the same sites in different years, such replication is more difficult to detect than it is in the BOMP dataset, as sites are not identified by unique codes. While observers usually provide grid references, this is not always the case and the reference given may vary slightly between years, making the automated identification of repeated

sites impossible. In addition, due to the much longer span of NRS data, it is much more likely that there may be some turnover of pairs at individual sites. NRS data were therefore analysed using standard GENMOD procedures and not by using repeated-measures GENMOD.

As with the BOMP dataset, temperature and precipitation showed no significant correlation over the period 1980-2008, either during winter (R^2<0.01, P=0.801) or during the breeding season (R^2=0.05, P=0.099), and both weather variables could therefore be included as independent variables in the same model. Temperatures during the breeding season were significantly correlated with those during the winter (R^2=0.28, P<0.001), and the same was true of winter and spring precipitation parameters, although the relationship was weak (R^2=0.075, P=0.028). All initial models therefore contained winter weather parameters only, although the effects of including spring weather parameters were investigated in some cases, with appropriate caveats concerning interpretation included in the text.

3.8.4 Female weight

Factors influencing the weight of female Barn Owls were investigated using repeated measures, assigned according to site location, GENMOD models similar to those described in Section 3.9.1, with a normal distribution assumed and an identity link function specified, and Northing, Easting, year and primary habitat type included as independent variables in all models. As female weight varies at different stages of the reproductive cycle (Shawyer *pers comm.*), an additional categorical term specifying the stage of the cycle was also included in the models. This term had four different categories, representing 'Roosting', 'Clutch', 'Mixed' (eggs and chicks) and 'Brood'.

3.8.5 Nest occupancy by other species

Factors influencing the proportion of BOMP sites at which other species were recorded as breeding were also investigated using species-specific models similar to those used for Barn Owl occupancy. Prior to 2004, the recording of other species at BOMP Network sites was not standardised and may not have been consistent between observers. Analysis was therefore restricted to WCP sites.

As with analysis of Barn Owl occupancy rates, year, Northings, Eastings and primary habitat type were included as independent variables in all models. The effects of winter temperature and precipitation were analysed separately due to the significant correlation between the two variables (see Section 3.9.1). The models contained two additional variables:

- Box type – the number of potential breeding cavities, and therefore the probability of occupancy, varies between the three Barn Owl nestbox designs (Polebox, A-frame and Square).
- Paired box – again, the presence of a paired nestbox provides additional cavities in which other species could potentially nest.

4. RESULTS

4.1 BOMP coverage

The 2009 season was the tenth year of data collection at WCP sites and the eighth year of data collection at BOMP Network sites. The number of both core and supplementary sites monitored by WCP has remained approximately constant since the 2002 breeding season, while the number of sites covered by BOMP Network participants increased during the course of the study (**Table 4.1.1**).

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
WCP	159	170	203	205	204	202	197	190	191	194
BOMP Network	-	-	365	395	338	368	453	475	572	593
TOTAL	159	170	568	600	542	570	650	665	763	787

Table 4.1.1 Total number of BOMP sites surveyed annually 2000-2009

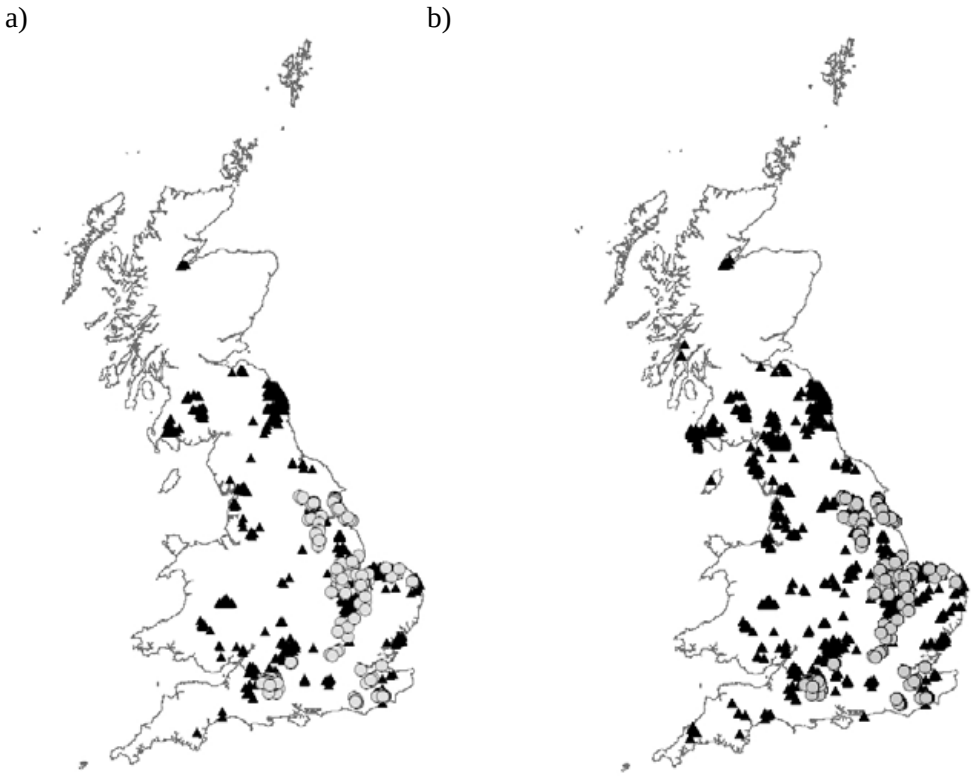


Figure 4.1.1 Distribution of WCP (grey circle) and BOMP Network (black triangle) sites monitored in a) 2009 and b) 2000-2009.

It is encouraging to note that the number of sites monitored in 2009 was the highest in any year of the survey, thanks to both the recruitment of new volunteers and to existing volunteers expanding their coverage. **Figure 4.1.1** shows the distribution of all BOMP sites monitored in 2009. As in previous years, coverage was generally good in the South, East and North of England. Although coverage is still poorer in western England and the majority of Scotland, many of the sites new to the project in 2009 were located in these areas, reflecting the targeted promotional effort. Coverage in Wales remained poor even though Barn Owls breed throughout much of the country (Gibbons *et al*., 1993; http://www.bto.org/volunteer-surveys/birdatlas).

4.2 Barn Owl occupancy rates

Factors influencing Barn Owl occupancy rates were investigated using a pooled dataset containing information from both WCP and BOMP Network sites. In total, over the ten study years, Barn Owls were present in 3771 of the 5466 sites visited (69.8%) and were found to be breeding at 2939 (53.7%) sites.

The results presented in **Table 4.2.1** indicate that the occupancy rate of boxes decreased over the ten-year study, and that this relationship holds even when the first two years of data, that reflected WCP only, are omitted from the analyses (**Table 4.2.1b)**. The proportion of birds that went on to breed also show a negative trend with the progression of the study when the full dataset is considered, but this relationship ceases to hold when the first two years are excluded (**Table 4.2.1b**). When site type was included in the model, occupancy rate was higher at WCP sites than BOMP Network sites (p=0.007), but only when the first two years of the study are omitted, while when the full dataset is considered, the relationship no longer receives statistical support. In contrast, the proportion of Barn Owls breeding was higher at BOMP sites than at WCP sites (p=0.001) when site type was included in the model, and the relationship holds when either dataset is considered. The number of boxes at each site had no effect on the likelihood of occupancy or of breeding initiation, regardless of whether site type was included or not in the model.

There was weak evidence that site occupancy varied geographically. A higher proportion of sites was occupied towards the North of the UK, but there was no evidence of differences between the East and West of the country. Habitat type correlated significantly with site occupancy. Site occupancy was greater in rough grassland sites then in those consisting of arable land, and it was the lowest in pastoral areas, but the proportion of breeding pairs did not significantly correlate with habitat type. Temperatures over the winter period (Nov-Mar) were strongly correlated with site occupancy and the proportion of pairs that bred, with warmer winters associated with higher occupancy and higher proportion of breeding pairs. Precipitation over the winter period had a negative association with occupancy and breeding, with site occupancy and proportion of breeding pairs decreasing following wetter winters. These results did not change when site type (BOMP or WCP) was included in the model.

a)

	DF	X^2	P	Direction
Site occupancy (N =5045)				
Year	1	69.76	<0.001	-
Northing	1	4.26	0.038	+
Easting	1	1.11	0.292	
Primary habitat	2	10.47	0.053	G > A > P
Number of boxes at site	1	0.02	0.88	
Over-winter temperature	1	29.24	<0.001	+
Over-winter precipitation	1	102.74	<0.001	-
Proportion breeding (N =3528)				
Year	1	4.88	0.027	-
Northing	1	3.55	0.06	
Easting	1	0.01	0.92	
Primary habitat	2	0.61	0.738	
Number of boxes at site	1	0.57	0.44	
Over-winter temperature	1	72.72	<0.001	+
Over-winter precipitation	1	15.11	<0.001	-

b)

	DF	X^2	P	Direction
Site occupancy (N =4731)				
Year	1	42.43	<0.001	-
Northing	1	1.96	0.16	
Easting	1	0.62	0.42	
Primary habitat	2	15.41	0.0005	G > A > P
Number of boxes at site	1	0.92	0.33	
Over-winter temperature	1	42.77	<0.001	+
Over-winter precipitation	1	23.82	<0.001	-
Proportion breeding (N =3249)				
Year	1	0.27	0.60	
Northing	1	5.43	0.019	+
Easting	1	0.16	0.069	
Primary habitat	2	0.20	0.90	
Number of boxes at site	1	0.16	0.68	
Over-winter temperature	1	63.49	<0.0001	+
Over-winter precipitation	1	15.02	0.0001	-

Table 4.2.1 Factors influencing site occupancy and the proportion of pairs breeding a) over the period 2000-2009 and b) over the period 2002-2009. In the 'Primary Habitat' row, 'G' indicates rough grassland, 'A' indicates arable land and 'P' indicates pastoral land.

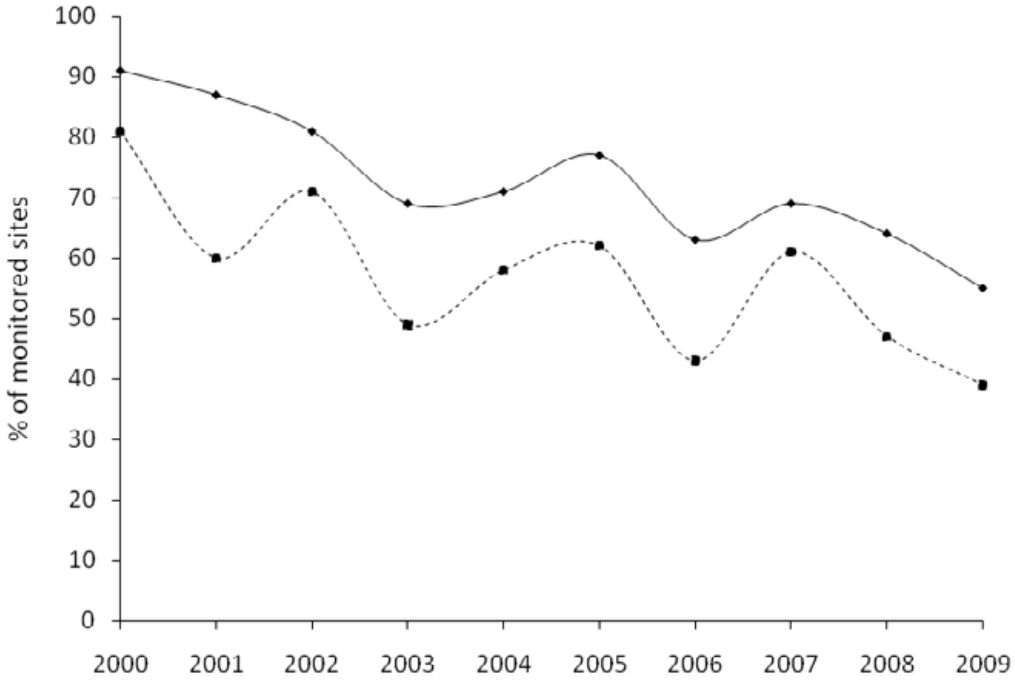
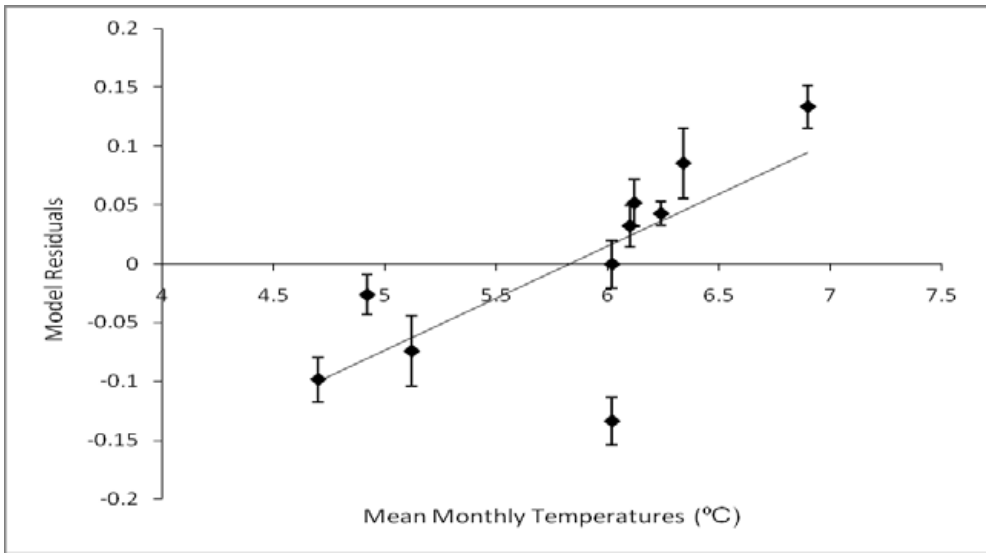


Figure 4.2.1 Annual variation in the proportion of BOMP sites at which Barn Owls were recorded as present (solid line) and the proportion of sites at which the birds were recorded as breeding (dashed line).

a)



b)

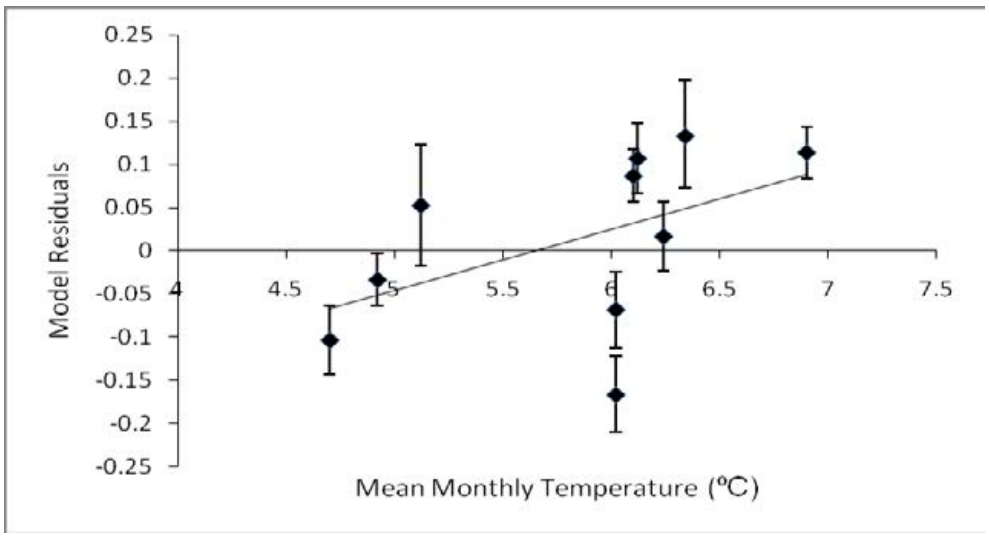
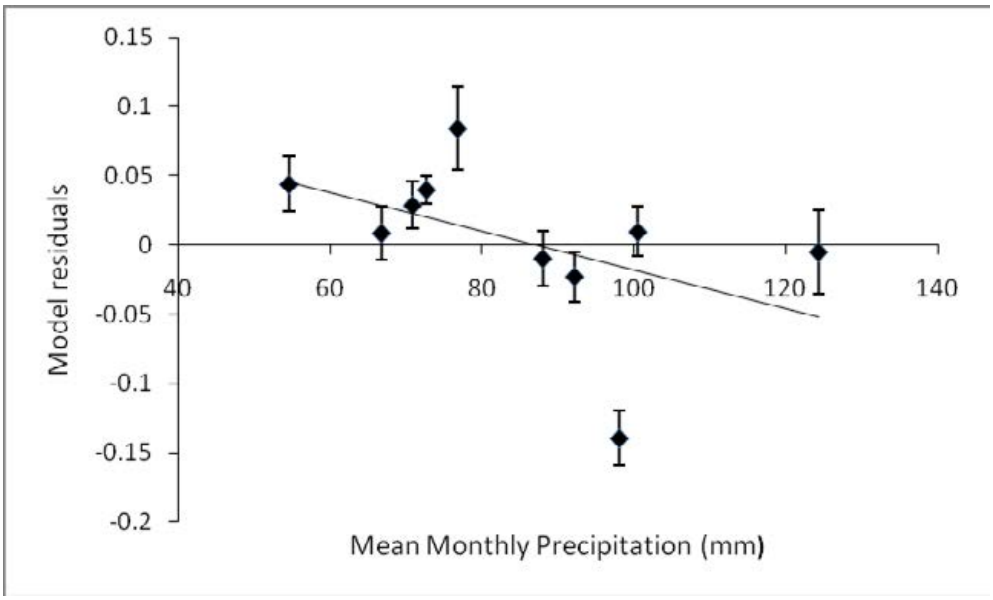


Figure 4.2.2 Relationship between mean winter (Nov-Mar) temperatures and a) the proportion of sites occupied by Barn Owls and b) the proportion of Barn Owls occupying BOMP sites that attempted to breed. The residuals here were generated using the GENMOD procedure, with all terms included in the model except temperature. Error bars signify ± 1 S.E.

a)



b)

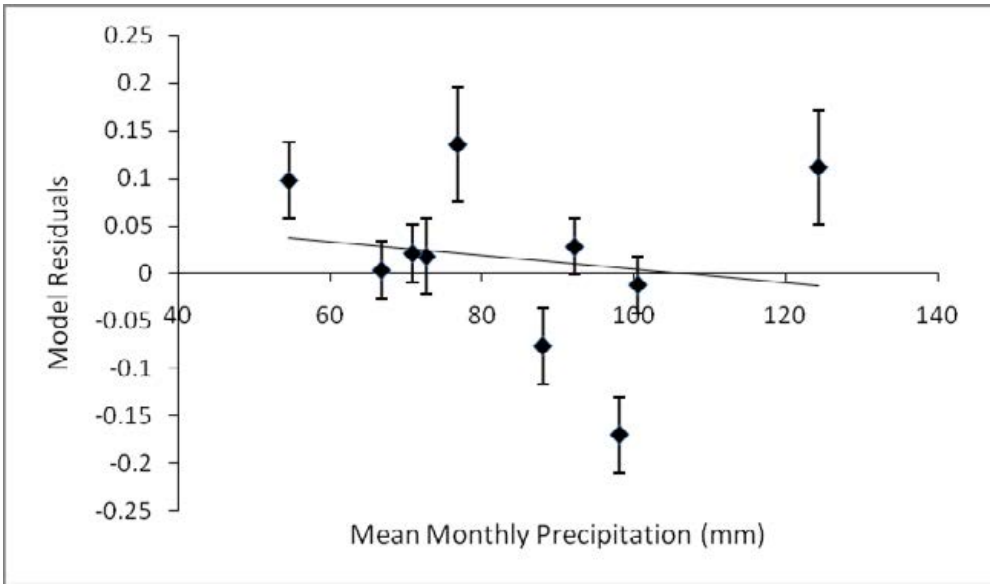


Figure 4.2.3 Relationship between mean winter (Nov-Mar) precipitation and a) the proportion of sites occupied by Barn Owls and b) the proportion of Barn Owls occupying BOMP sites that attempted to breed. The residuals were generated using the GENMOD procedure, with all terms included in the model except precipitation. Error bars signify ± 1 S.E.

4.3 Female weight at laying

Over the period 2001-2009, 718 females were weighed at 161 different nest sites. The results in **Table 4.3.1** show that mean weight did not change over the study period, and that it increased with latitude and from West to East of the UK. The mean weight of females also correlated with the nesting cycle, in particular non-breeding females had lower body weight than breeding ones, and those incubating were heavier than females that were at the brooding stage or that had a combination of chicks and eggs in the nest. body weight of the females. Weather conditions over the winter months (Nov-Mar)

were correlated with differences in body weight: females were heavier after mild, dry winters and lighter in colder and wetter ones.

	DF	X^2	P	Direction
Year	1	0.48	0.223	
Northing	1	6.05	0.013	+
Easting	1	4.81	0.028	+
Primary habitat	2	4.52	0.104	
Nest stage	3	67.75	<0.001	C > M > B > R
Over-winter temperature	1	7.29	0.006	+
Over-winter precipitation	1	4.65	0.031	-

Table 4.3.1 Factors influencing mass of females caught at the nest. In the 'Nest stage' row, 'B' signifies brooding, 'M' signifies a mixture of eggs and chicks, 'C' signifies clutch and 'R' signifies a bird that was roosting with no contents in the nest.

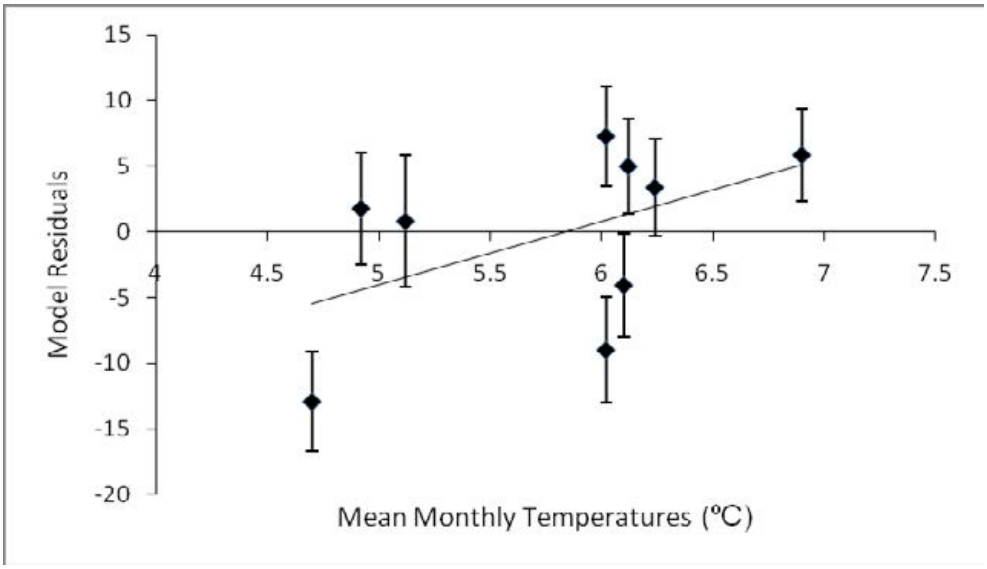


Figure 4.3.1 Relationship between mean winter (Nov-Mar) temperature and female body mass. The residuals were generated using the GENMOD procedure, with all terms listed in Table 4.3.1 included in the model except temperature. Error bars signify ± 1 S.E.

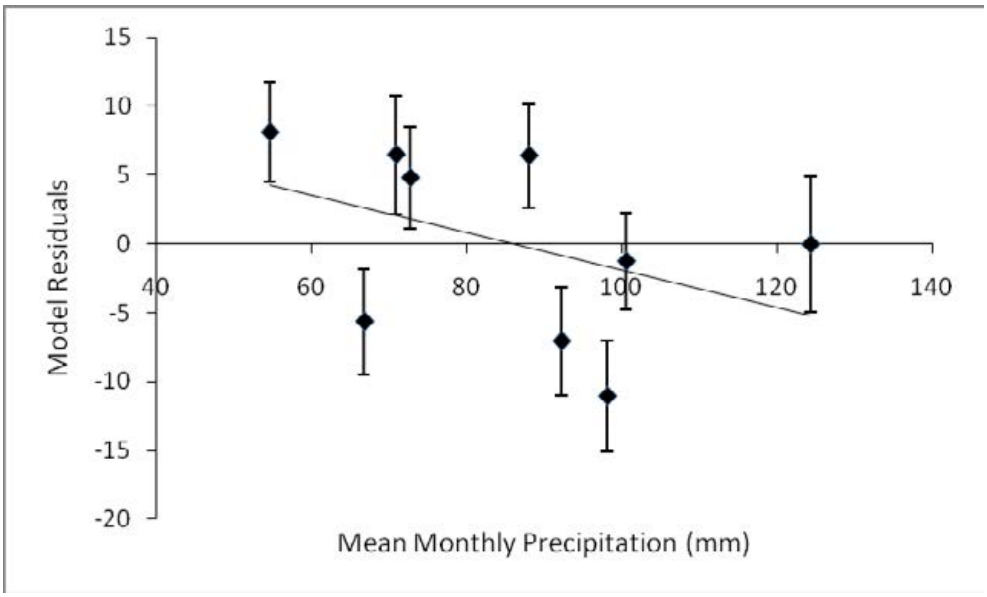


Figure 4.3.2 Relationship between mean winter (Nov-Mar) precipitation and female body mass. The residuals were generated using the GENMOD procedure, with all terms listed in Table 4.3.1 included in the model except temperature. Error bars signify ± 1 S.E.

4.4 Barn Owl productivity

Laying date of the first egg in the clutch, clutch size and brood size were all analysed with respect to year, longitude, latitude, habitat type and weather condition of the preceding winter (**Table 4.4.1**). Whole nest **(**Mayfield) failure rates could not be modelled as complete clutch and brood failures were too infrequent.

The mean first egg date occurred increasingly earlier over the ten-year period. Clutch size and brood size both appeared to increase during the same time period, but these relationships were not statistically significant. None of the three productivity parameters varied with longitude or latitude, and only brood size was correlated with habitat type, with larger broods produced in areas of rough grassland than in agricultural sites.

All three productivity parameters were correlated with over-winter weather. The date of the first egg laid was earlier after milder winters and later following wetter ones. Clutch and brood sizes were larger after warmer winters, and brood sizes were smaller after wet winters. High spring temperatures resulted in earlier laying and larger broods, while spring rainfall was also positively correlated with brood size (**Table 4.4.2)**.

As winter and spring temperatures were significantly positively correlated (R^2 = 1.012, P = 0.035) it is difficult to determine which period is most important for determining timing of laying, but it is interesting to note that when terms for spring temperature and rainfall are included in the model, neither is significantly correlated with laying date while both winter weather variables remain so.

	DF	X^2	P	Direction
First egg date (N = 782)				
Year	1	9.69	0.0019	-
Northing	1	1.04	0.307	
Easting	1	0.00	0.96	
Primary habitat	2	3.79	0.15	
Over-winter temperature	1	53.33	<0.0001	-
Over-winter precipitation	1	23.43	<0.001	+
Clutch size (N = 263)				
Year	1	0.39	0.56	
Northing	1	1.01	0.31	
Easting	1	0.00	0.97	
Primary habitat	2	0.10	0.94	
Over-winter temperature	1	7.28	0.007	+
Over-winter precipitation	1	1.35	0.244	
Brood size (N = 1724)				
Year	1	0.04	0.842	
Northing	1	0.00	0.945	
Easting	1	0.67	0.414	
Primary habitat	2	15.48	0.0003	G>P>A
Over-winter temperature	1	24.45	<0.0001	+
Over-winter precipitation	1	3.62	0.057	-

Table 4.4.1 Factors influencing productivity of Barn Owls breeding at BOMP sites 2000-2009. Directions of significant linear relationships are given in the right-hand column. In the 'Primary habitat' row, P = Pastoral, A = Arable and G = Grassland (natural).

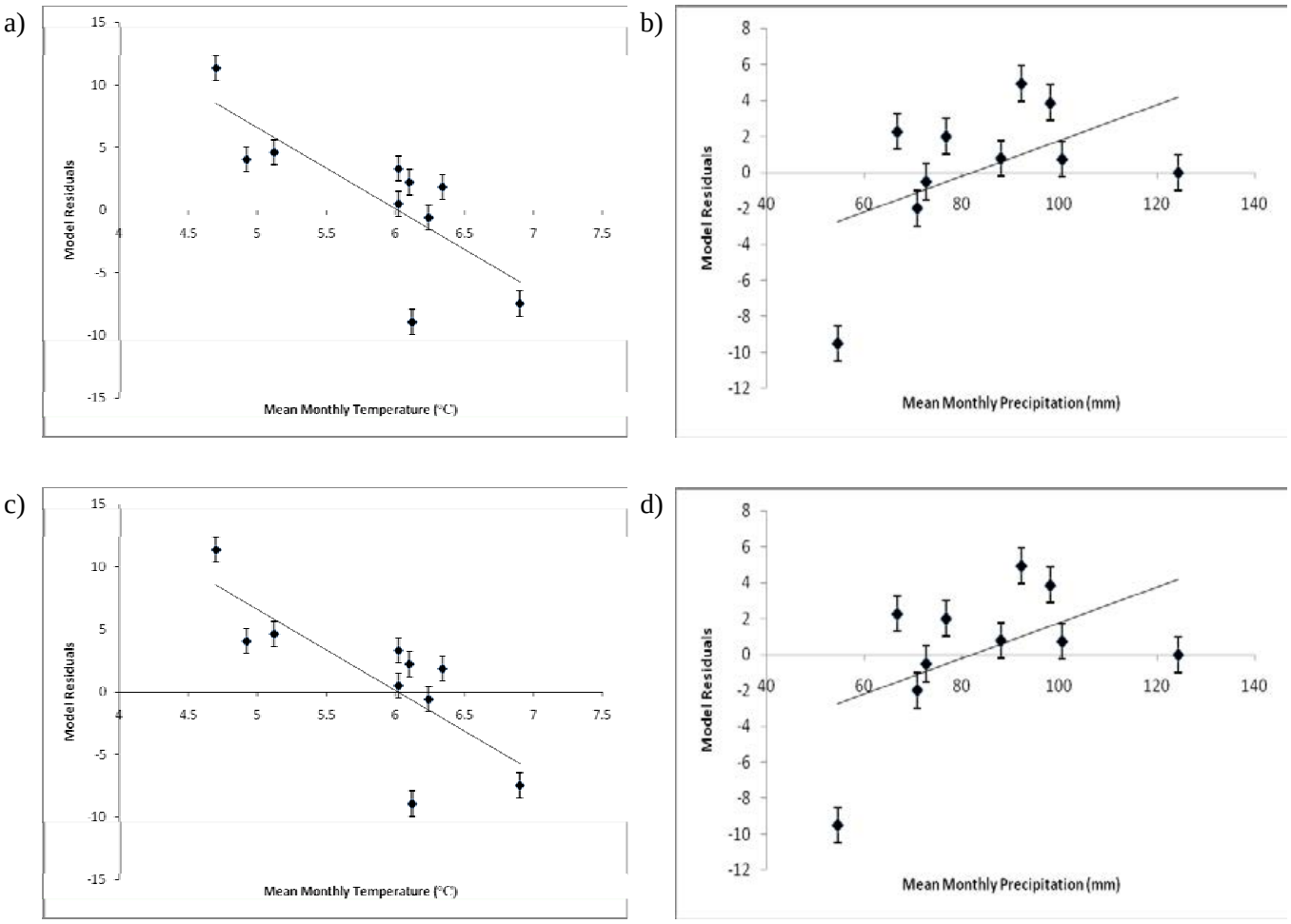


Figure 4.4.1 Relationship between a) laying date and winter temperature, b) laying date and winter rainfall, c) clutch size and winter temperature and d) brood size and winter temperature for the period 2000-2009. The residuals were generated using here GENMOD procedure, with all terms listed in Table 4.4.1 included in the model except that plotted along the X axis. Error bars signify ± 1 S.E.

	DF	X^2	P	Direction
First egg date (N = 782)				
Year	1	0.00	0.95	
Northing	1	0.76	0.38	
Easting	1	0.06	0.81	
Primary habitat	2	2.82	0.244	
Spring temperature	1	9.65	0.0019	-
Spring precipitation	1	2.38	0.123	
Clutch size (N = 263)				
Year	1	0.05	0.826	
Northing	1	1.10	0.295	
Easting	1	0.02	0.896	
Primary habitat	2	0.10	0.951	
Spring temperature	1	3.26	0.07	
Spring precipitation	1	0.68	0.409	
Brood size (N = 1724)				
Year	1	2.79	0.095	
Northing	1	0.00	0.955	
Easting	1	0.44	0.5	
Primary habitat	2	15.99	0.0003	P>G>A
Spring temperature	1	10.97	0.0009	+
Spring precipitation	1	6.34	0.012	+

Table 4.4.2 Factors influencing productivity of Barn Owls breeding at BOMP sites 2000-2009 using spring mean temperature and precipitation. Directions of significant linear relationships are given in the right-hand column. In the 'Primary habitat' row, P = Pastoral, A = Arable and G = Grassland (natural).

Results from the long-term Barn Owl productivity dataset collected by Nest Record Scheme participants between 1980 and 2009 (**Table 4.4.3**) were largely consistent with those from the BOMP analysis, identifying a significant positive relationship between winter temperatures and both clutch and brood sizes. Brood size was also correlated with habitat type - in accordance with BOMP data, arable land had the lowest brood size and grassland areas had larger brood size than habitats predominated by pasture land. A noteworthy difference between the BOMP and the longer Nest Record Scheme dataset, was that brood size decreased over the years within the long-term data. No latitudinal, habitat- or weather-related variation in productivity was identifiable if the data run was restricted to the pre-BOMP period (1980-1999), suggesting that these results are driven primarily by the relationships observed during the BOMP period, when sample sizes are on average 4-7 times greater per annum.

	DF	X^2	P	Direction
First egg date (N = 1025)				
Year	1	1.62	0.203	
Northing	1	1.05	0.305	
Easting	1	0.16	0.691	
Primary habitat	2	2.65	0.265	
Over-winter temperature	1	54.15	<0.0001	-
Over-winter precipitation	1	21.13	<0.0001	+
Clutch size (N = 882)				
Year	1	0.03	0.856	
Northing	1	0.60	0.440	
Easting	1	0.13	0.723	
Primary habitat	2	2.88	0.237	
Over-winter temperature	1	5.91	0.015	+
Over-winter precipitation	1	0.04	0.851	
Brood size (N = 7467)				
Year	1	14.38	<0.0001	-
Northing	1	0.01	0.912	
Easting	1	0.40	0.526	
Primary habitat	2	16.47	0.0003	G > P > A
Over-winter temperature	1	65.58	<0.0001	+
Over-winter precipitation	1	6.11	0.0134	-

Table 4.4.3 Factors influencing productivity of Barn Owls as recorded by Nest Record Scheme (NRS) 1980-2009. Directions of significant linear relationships are given in the right-hand column.

	DF	X^2	P	Direction
First egg date (N = 1025)				
Year	1	0.00	0.960	
Northing	1	0.53	0.467	
Easting	1	0.13	0.713	
Primary habitat	2	3.49	0.174	
Over-winter temperature	1	15.43	<0.0001	-
Over-winter precipitation	1	0.40	0.529	
Clutch size (N = 882)				
Year	1	0.08	0.770	
Northing	1	0.63	0.429	
Easting	1	0.12	0.724	
Primary habitat	2	3.04	0.218	
Over-winter temperature	1	2.11	0.146	
Over-winter precipitation	1	1.55	0.213	
Brood size (N = 7467)				
Year	1	39.72	<0.0001	-
Northing	1	0.02	0.897	
Easting	1	0.24	0.625	
Primary habitat	2	17.41	0.0002	G > P > A
Over-winter temperature	1	74.03	<0.0001	+
Over-winter precipitation	1	9.65	0.0019	+

Table 4.4.4 Factors influencing productivity of Barn Owls as recorded by Nest Record Scheme (NRS) participants 1980-2009 using spring mean temperature and precipitation. Directions of significant linear relationships are given in the right-hand column. In the 'Primary habitat' row, P = Pastoral, A = Arable and G = Grassland (natural).

4.5 Occupancy rates of other species

Data from BOMP sites can also be used to investigate variation in the occupancy rates of three additional species that frequently utilise Barn Owl nest sites - Stock Dove (*Columba oenas*), Jackdaw (*Corvus monedula*) and Kestrel (*Falco tinnunculus*). However, the results must be interpreted conservatively, as there is some evidence to suggest that these additional species, or their absence, are not always routinely noted down by all recorders. In addition, the design of the nest box may influence the presence of other species. For these reasons, analyses on occupancy rates of nest boxes by these additional species were conducted conservatively, using data from a subset of Core sites at which either Pole-box or A-frame boxes are present over the period 2002-2009 (**Table 4.5.1**).

	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Stock Dove	23%	28%	19%	17%	20%	16%	17%	28%
Jackdaw	29%	32%	26%	25%	28%	21%	33%	33%
Kestrel	20%	15%	17%	17%	16%	16%	21%	17%
TOTAL BOXES	**162**	**163**	**166**	**166**	**166**	**160**	**159**	**159**

Table 4.5.1 Frequency of use of Core sites containing either Pole-box or A-frame boxes by different species.

Analyses showed that occupancy rates of Stock Dove increased following dry winters (**Table 4.5.2**) but over winter temperatures, habitat type, box type, number of boxes or any other variable considered were not correlated with the occupancy rate of this species. Jackdaw occupancy rates were highest in pole boxes at northern sites and positively correlated with the number of nest boxes present. Presence of Jackdaw was also negatively correlated with occupancy of the nest box by Barn Owl, and occupancy was higher after dry winter than after wet ones. Kestrel occupancy rates were highest in pole boxes in the south and east, but did not vary with the number of boxes present. Presence of Kestrels in the nest box did not correlate with presence of Barn Owls, habitat type, nor with over winter temperatures or precipitation.

	DF	X^2	P	Direction
Stock Dove				
Year	1	0.82	0.364	
Northing	1	2.06	0.151	
Easting	1	0.41	0.524	
Primary habitat	2	0.94	0.626	
Box type	1	0.05	0.819	
Number of boxes at site	1	0.32	0.572	
Presence of Barn Owl	1	0.26	0.608	
Over-winter temperature	1	1.13	0.286	
Over-winter precipitation	1	5.74	0.016	-
Jackdaw				
Year	1	1.29	0.256	
Northing	1	11.05	0.0009	+
Easting	1	0.87	0.349	
Primary habitat	2	1.39	0.499	
Box type	1	19.43	<0.0001	P>A
Number of boxes at site	1	14.69	0.0001	+
Presence of Barn Owl	1	22.97	<0.001	-
Over-winter temperature	1	0.22	0.636	
Over-winter precipitation	1	4.89	0.027	-
Kestrel				
Year	1	0.15	0.698	
Northing	1	7.08	0.007	-
Easting	1	4.16	0.041	+
Primary habitat	2	1.67	0.434	
Box type	1	37.06	<0.0001	P>A
Number of boxes at site	1	0.02	0.899	
Presence of Barn Owl	1	0.38	0.537	
Over-winter temperature	1	0.46	0.496	
Over-winter precipitation	1	0.12	0.726	

Table 4.5.2 Factors influencing proportion of WCP sites occupied by breeding Stock Dove, Jackdaw and Kestrel 2002-2009. Directions of significant linear relationships are given in the right-hand column. In the 'Box type' row, 'P' = Polebox design and 'A' = A-frame box design.

5. DISCUSSION

BOMP has successfully established a protocol for data collection that enables breeding statistics to be calculated and is already providing valuable data for the conservation of the species. Fieldwork is inevitably concentrated in areas where the Barn Owl is relatively abundant and, by monitoring such populations, BOMP is monitoring a key component of the Barn Owl's national population. Furthermore, the scale of the monitoring effort within BOMP, amounting to *c.* 15% of the national population of Barn Owls and with a good geographical spread, gives the results added importance. Although BOMP concentrates on nestbox sites, these are increasingly used by the species in the UK: 38% of nesting attempts recorded under Project Barn Owl in the mid-1990s were in boxes (Toms *et al.* 2000) and Shawyer (2008) has estimated that this has now increased considerably to about 75%. While the non-random nature of the sample may influence the resulting trends to some degree, we are able to control for factors such as geographical location and habitat.

5.1 Temporal trends in occupancy and phenology

There has been a decline in the proportion of sites at which Barn Owls were recorded as present and the proportion of occupied sites at which Barn Owls were recorded as breeding since the Programme began in 2000. While the population size of Barn Owls in the UK has not been estimated since Project Barn Owl finished in 1997, a study which takes account of the conservation work undertaken in the eastern half of England, primarily to provide foraging habitat, artificial nest sites and re-create habitat connectivity, suggests that the population has doubled in this part of Britain since 2000 (Shawyer 2008). This result is consistent with the Breeding Bird Survey results that show an increase in the population of Barn Owls by over 400% in the period 1995-2008 (Risely *et al*. 2010). The observed declines in occupancy since the initiation of BOMP may therefore be an artefact of the non-random selection of monitoring sites; if BOMP Network participants were more likely to select sites at which Barn Owls were known to be present or breeding in previous years, then initial occupancy rates may have been artificially inflated and a subsequent decrease might be predicted until a more 'natural' level is reached. Alternatively, this may be a consequence of the increased number of nest boxes which are believed to have been installed in the vicinity of the core and network sites since the project began. This has provided Barn Owls with alternative nest sites not monitored for BOMP, potentially accounting for the apparent decline in occupancy.

BOMP data indicate that laying dates have advanced significantly over the laying period. Similar trends have been observed for many other bird species in response to a rise in early spring temperatures driven by anthropogenic climatic change (Crick *et al*. 1997, Crick & Sparks 1999), which may enable birds to reach breeding condition earlier than in colder years

5.2 Spatial variation in occupancy and productivity

Barn Owls were present at slightly higher proportion of sites further North in the UK. This is likely to be the result of an expansion of breeding Barn Owl into more northerly latitudes and into areas of higher altitude since 1985, when only 12% bred at altitudes above 150 m (Shawyer 1987). By 2007, Barn Owls breeding above 150 m was estimated to have increased to 30%, although the number of pairs breeding above this altitude is thought, once again, to have fallen back following the severe winters of 2008/2009 and 2010/2011 (Shawyer *in press*). This northerly bias may also be due to a higher density of nest boxes in these regions or the lower availability of other nest sites (Toms et al 2000), or alternatively this relationship may reflect latitudinal differences in climate and habitat quality. The proportion of birds that elected to breed also increased with latitude but, as expected, first egg date was later in those regions. In the North of the UK, clutch size was greater than in the south (as predicted by theory, supported by evidence in several species, which postulates that clutch size increases with latitude (Lack, 1947)), but brood size was smaller in the North, possibly reflecting weather conditions and prey availability. BOMP Network sites had a higher proportion of pairs attempting to breed than WCP sites. This difference may be due to an initial bias in the selection of

the BOMP Network sites towards boxes in more northerly latitudes of the UK or at sites where ~~which~~ pairs were already known to be present and regularly breed.

Birds breeding in arable land laid the smallest clutches and therefore produced smaller broods. Grassland sites were associated with higher occupancy and proportion of breeding pairs, and females in grassland areas were heavier than in pasture or on arable land. These results are likely to reflect differences in the availability of small mammal prey, particularly Field Vole (*Microtus agrestris*), between habitats. Densities of prey
are likely to be higher in areas of rough grassland, the species' favoured habitat (Harris & Yalden 2008) than in agricultural land, where harvesting and grazing by livestock reduces those primary components of grassland, such as tussock structure, litter layer and length of sward, which are all necessary to provide Field Vole habitat (Shawyer 1998). Previous studies have shown that Field Vole population densities display a negative relationship with grazing intensity in meadows (Schmidt *et al*. 2005) and in agricultural areas, the species' distribution is generally limited to areas of set-aside or field margins, although management practices in these areas are not usually optimised to favour voles (Harris & Yalden 2008).

5.3 Influence of weather conditions on occupancy and productivity

This study indicates that weather conditions significantly influenced Barn Owl breeding phenology and productivity. Box occupancy was lower following colder and wetter winters, suggesting that the number of breeding pairs was lower following harsher winters. Studies of Barn Owl populations in England (Shawyer 1987), Scotland (Taylor 1992), Utah (Marti 1994) and Switzerland (Altwegg et al. 2005) have identified significant relationships between the number of breeding pairs of Barn Owls and the severity of weather conditions, primarily the extent of snow cover, during the previous winter. However, a further study by de Bruijn (1994) in Holland found no effect of snow cover, nor any correlation between the number of breeding pairs and an index of winter severity.

Snow cover and temperature have both been observed to influence Barn Owl survival rates, particularly those of juvenile birds, in Britain (Shawyer 1987) and on the Continent (Altwegg *et al*. 2003, 2005). Energetic costs associated with keeping a constant body temperature are higher at lower temperatures (Berry *et al*. 1969, Hornfeldt 1994). Prey availability may also decline with temperature, as rodent survival may be lower, activity rates may fall and snow cover may provide shelter from predators (Shawyer 1987, Pucek *et al*. 1993). Wet weather may also be problematic. Barn Owls use auditory cues to hunt and the feather structure has evolved to enable silent flight, but a trade-off of this adaptation is that the plumage is not waterproof and birds therefore cannot hunt in heavy rain.

The proportion of birds occupying boxes that initiated breeding attempts was also lower in seasons following colder, wetter winters, during which female Barn Owls were lighter, suggesting that they were in poor condition. Shawyer (*pers comm*.) has observed that females below a threshold weight (approximately 345g) are unlikely to produce eggs even if they have already occupied a nest site and that a minimum body weight of 360g is normally necessary before full clutches and successful hatching can be achieved.

Birds that did elect to breed after inclement winters experienced reduced breeding success. First egg date was later following colder and wetter years, suggesting that female Barn Owls may take longer to reach breeding condition following harsh winters. Clutch size and brood size were also smaller following colder and wetter winters, which may be due to the relatively poor body condition of breeding birds, or alternatively to lower prey abundance during the breeding season as a result of winter conditions (Altwegg *et al*. 2005). In the absence of vole population monitoring at a national scale, it is difficult to determine which of these two mechanisms is responsible for the observed patterns of productivity.

The UKCIP09 report (Murphy *et al*. 2009) presents a series of potential climate change scenarios over a series of time scales (2020, 2050 and 2080), based on the level of emissions of greenhouse gases

over this period. Under medium emissions scenarios, temperatures in the UK will rise by an average of 1.6-4.7 °C by 2080, with temperatures in summer and autumn likely to increase by more than those in winter and spring. Based on the results of these analyses, warmer winters are likely to positively impact on Barn Owls, leading to an increase in both the number of birds breeding and the mean reproductive output per pair. However, it is possible that any benefit may be offset by increasing precipitation during the winter months, with intense periods of rainfall becoming more frequent.

5.4 Occupancy rates of other species

The proportion of WCP sites occupied by breeding pairs of Stock Doves did not vary significantly over the period 2002-2009, but the presence of this species was higher in years following drier winters. Occupancy of sites by Jackdaws was higher in the North of Britain, while Kestrels occupy more boxes in the South and East of the country. While BTO Bird Atlas data (Gibbons *et al.*, 1993) suggest that these results might reflect actual variation in distribution of the former, this is not the case for Jackdaw. It is possible, however, that regional variation in the availability of alternative nest sites could result in the observed relationships.

Box type significantly influenced the probability of Kestrel and Jackdaw breeding at WCP sites, with both species exhibiting a preference for the polebox design that contains an additional nesting chamber. Jackdaw occupancy rate at WCP site was negatively correlated to that of the Barn Owl, indicating that the former prefers to nest where the latter is absent to avoid competition. However, an alternative possibility is that Jackdaws exclude Barn Owls from boxes by blocking the entrances with their nests rather than vice versa. While sites at which this was thought to have happened were removed from the analysis (see Section 3.5.1), it may be difficult to ascertain in the field.

5.5 Recommendations for future analyses and data collection

Second broods. An important parameter influencing overall Barn Owl productivity may be the number and outcome of second broods, currently one the biggest gaps in our knowledge. During the last ten years WCP, through the use of a sub-set of 80 sites, has been investigating the frequency of double-brooding and the relationship between female moult and first egg dates. Early laying dates and the suspension of wing moult have, in combination, been shown to provide valuable indicators of double brooding in Barn Owls. These indicators can alert fieldworkers to those sites which are worth re-visiting later in the season, specifically in July to record second clutches and October/November to record brood size and fledging success. An additional practical recommendation would be to try and encourage BOMP network contributors further to continue to monitor Barn Owl boxes late into the season, and to record whether or not they do so.

Nest survival and partial clutch / brood losses. In past analyses, an estimate of nest survival, i.e. the probability of fledging one or more young, has been estimated using the Mayfield method (Mayfield 1961, 1975). However, complete nest failure in the Barn Owl is rare, and it would be more useful to consider this question in terms of partial clutch and brood losses. These analyses are not straightforward, because of the need to account for non-independence of individual eggs / chicks within nests. Some work would be needed to evaluate the options for such an analysis in relation to nest record / BOMP data.

Use of weather data. Previous analyses of BOMP data has made use of monthly Central England Temperature (CET) and England and Wales Precipitation(EWP) index data. These data have a temporal, but not a spatial component, so it is assumed that the weather is the same at all sites. More ideal would be use spatially explicit weather data, such as UKCIP09 which provides weather data at a 5-km square resolution, where appropriate weather values are matched at the individual site level. However, development to make use of these data is not trivial and currently a limitation of UKCIP09 as a data source is that these data are only publically available up to 2006.

Estimates of annual survival. For year-round demographic modelling of the Barn Owl population, BOMP requires estimates of the annual survival rates of birds in their first and later years of life. The

first annual report of BOMP presented the information available on Barn Owl movements and dispersal (Crick *et al.* 2001). The additional ringing activity generated by the introduction of BOMP will make more detailed analyses possible in the longer term and sufficient data may now have accumulated for a preliminary analysis of these data. Such an analysis, in relation to weather, would also be useful when considering how climate change might affect the population dynamics of the species.

Repeat census of UK Barn Owl population. It would be highly desirable within the next decade to conduct a repeat survey using Project Barn Owl methodology, to assess Barn Owl population trends using a randomised sample of study sites. This would help to validate the annual monitoring approach taken by BOMP and help to put the results in context. The population status of Barn Owls in Britain and Ireland will be covered by the Atlas of Breeding Birds of Britain and Ireland 2007-11, which will provide results on abundance and distribution and population change since the previous atlas (1988-1991). The species is also monitored by the Breeding Bird Survey, which shows an increase in Barn Owl population by 464% in the period 1995-2009 (Risely *et al*., 2010).

Use of Barn Owl boxes by other species. With the exception of those in southern England, BOMP sites appear to have provided nesting sites for a wide variety of species other than Barn Owls and WCP has installed large numbers of nestboxes specifically designed for Kestrels but not Barn Owls, throughout the BOMP study areas. This work which is currently being trialled in England by WCP, has currently involved (in 2010) 75 occupied Kestrel and 75 occupied Little Owl sites. In future years it would be worth considering whether a similar monitoring scheme to BOMP could be undertaken to cover these amber-listed species.

5.6 Key achievements of the Project

Analysis of the data on occupancy rates showed a significant decline over the duration of BOMP. Concurrent trends in BBS results and preliminary data from the BTO Bird Atlas 2007-2011 suggest that the UK population has actually increased in size over the last decade. The decline in occupancy rates recorded by BOMP may therefore reflect an increase in the provision of artificial nesting sites at a national scale, providing breeding birds with a greater number of alternative sites to move to between years.

However, the information collected has been incredibly useful in investigating spatial and temporal variation in occupancy rates and breeding success. A paper by Leech *et al*. (2009) published in the journal *Ardea* used BOMP data to demonstrate that occupancy rates were higher and brood sizes larger in areas of rough grassland habitat relative to those inhabiting areas of either pastoral or arable land, indicating that the availability of suitable foraging habitat can limit breeding success. Further analyses of BOMP data have identified the very significant role that winter weather can play in determining breeding success the following season, and these results are currently being prepared for publication. Other practical benefits include the experience gained by WCP under BOMP, allowing them to further develop their monitoring techniques and provide advice to other fieldworkers monitoring the species.

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Appendix 1 BOMP guidance notes supplied to participants on registering

The Barn Owl Monitoring Programme

The following is information about the BTO Barn Owl Monitoring Programme (BOMP). For more information about BOMP please visit our web pages at http://www.bto.org/survey/bomp/index.htm.

SITE REGISTRATION

You will find a Site Registration Form with this mailing. If you are interested in taking part, please fill in the details of the sites that you hope to be able to monitor over at least the next two to three years. One of the key aspects of the monitoring Programme is to try to define a core set of nesting sites that can be monitored *every* year.

When listing your sites, please consider whether you are likely to have access to these sites in future years. We would rather that you monitored a small number of sites well, than trying to cover a large number of sites and not be able to cover them adequately.

Please include a six-figure grid reference for the nest site (this will be kept confidential, see below). This will enable us to extract information from other sources, to complement the information that you provide e.g. from the Centre for Ecology and Hydrology's Landcover dataset or Countryside 2000 dataset.

You will also notice we are asking you to provide a 'Site Code' for each of your sites. This can be the code you already use to identify your site, and may be a combination of alphabetical and numerical figures. It is a good idea to incorporate part of the site name in the code.

For each site, please indicate whether you are likely to be able to monitor the site at the Option 1 or Option 2 level, as indicated below:

OPTION 1

Monitor at least one Barn Owl nest site, checking nest sites on two or more occasions for occupancy, assessing fledgling success and checking for signs of re-nesting and second broods. A series of brief visits at monthly intervals from April to October would be sufficient. This option involves minimal disturbance to Barn Owls, however fieldworkers will still require a nest disturbance licence to ensure full compliance with the Wildlife and Countryside Act 1981.

OPTION 2

As Option 1, but this involves recording additional information about eggs or young. The extra information you can record will depend on whether you are a licensed nest recorder or a ringer.

NEST RECORDERS and **RINGERS** can record the following information:
Clutch size;
Brood size;
Age of young and losses of young;
Presence of other species nesting in the box;
Presence, species composition, number and weight of prey stored in boxes.

RINGERS ONLY can record the following additional information:
Chick measurements;
Feather length, wing length and weight;
Age, sex, moult and brood patch stage of development of adults captured at the nest;
Information on dispersal and survival can be obtained by the ringing of adults and young;

Adult Barn Owls should only be caught by ringers who have experience of catching birds at the nest. Guidelines will be provided as part of the fieldwork manual, and we hope that ringers will share information with other ringers, perhaps as part of specialist ringing training courses.

Appendix 1 (continued)

CONFIDENTIALITY

We wish to assure you that the information you provide will be kept strictly confidential. The introduction of the 'Site Code' will mean that we do not have to refer to your sites by name or grid reference. Information gathered through the Programme will be analysed at the national or regional level. We will not publish information about the specific locations of any sites. All Site Registration Forms will be kept in a locked cabinet and any computerised datasets will be password protected.

FEEDBACK TO VOLUNTEERS

We hope to be able to produce an annual newsletter to keep recorders in touch with developments in the Programme. We would welcome any contributions from ringers and nest recorders in the form of short articles, tips or artwork.

COMMENTS OR QUERIES

If you have any questions or comments about the Barn Owl Monitoring Programme please don't hesitate to get in contact.

THE 2005 SEASON

We hope that you will be able to monitor your Barn Owl sites this season. Please complete and return the enclosed Site Registration Form to the BTO as soon as possible, so that we can return your fieldwork sheets and full instructions for the monitoring Programme. In the meantime, please record any information in your ringing notebook and/or Nest Record Cards and transfer it to the recording forms later on.

THANK YOU

Thank you for your interest in the Barn Owl Monitoring Programme. We are hoping that this survey will provide a useful 'benchmark' for Barn Owl productivity and show the species' population change on a national level.

Carl Barimore
Nest Records Officer
barnowls@bto.org

Appendix 1 (continued)

Barn Owl Monitoring Programme: Site Registration Form

Name:	Permit No.:	NRS Code:	Our Code:	Postcode:

Site Number	Site Name	Natural (N) or Box (B)?	Grid Reference (6 figure)	Year site first visited for monitoring	Your Code	Option 1 or 2
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						

Please return your completed form to: Carl Barimore, BOMP, BTO, The Nunnery, Thetford, Norfolk IP24 2PU

Appendix 1 (continued)

BOMP INSTRUCTION SHEET (May 2004)

(A) FILLING IN THE BOMP SHEET

Thank you for monitoring this BOMP site again this year. Please fill in and return your BOMP form for each site whether or not it has been used by nesting Barn Owls this year. We hope that the questions on the form are self-explanatory, but if you need to query anything, please do not hesitate to ask.

'ADDITIONAL INFORMATION' (Prey Items, Pellets, Moulted Feathers)

- Please record the date for this information on the back of the BOMP form, indicating whether the information recorded relates to the 'first' or 'second' brood ('A' or 'B'). Use 'U' if the brood number is unknown.
- If any pellets or moulted feathers are found at a non-breeding site, record the date but leave the 'Nesting Attempt' column blank.
- Please give the number of prey items found on each visit.
- For Barn Owl pellets use 'Y' (give number) or 'N'. If not checked, please leave blank.

OTHER SPECIES USING THE BOMP SITE

- Please note other species that are using the BOMP site. Indicate whether any of these interfere with the Barn Owls (eg Jackdaw filling entrance hole up with sticks).

NON-USE OF BOMP SITE THIS YEAR?

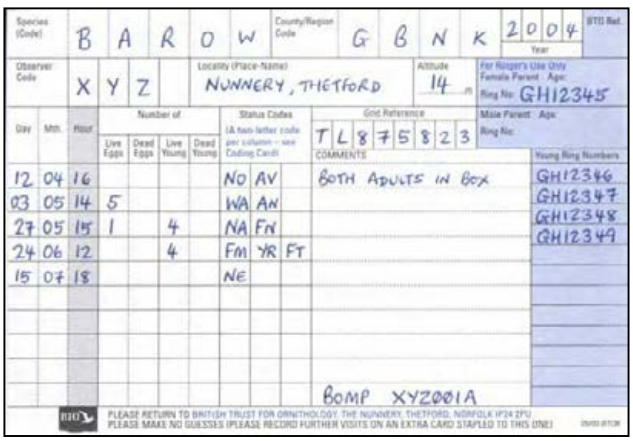
- It is not necessary to submit cards or an IPMR record if there has NOT been a nesting attempt at this BOMP site during the year.
- However please remember to tick the 'SITE NOT USED' box on the front of the BOMP form.
- 'Nil returns' ('Site Not Used') are as important as 'Site Used' ones (needed to calculate occupancy rates). Please remember to return forms at the end of the season whether or not the BOMP site has been used.

(B) RECORDING BARN OWL NESTS

If there has been a NESTING ATTEMPT at this BOMP site, please enter the VISIT DETAILS using one of the following two methods:

(1) A STANDARD BTO NEST RECORD CARD

- Please see NRS instruction sheet for details of how to fill in your record (Status Codes are the same as the ones used for BOMP forms previously).
- Please label each card with the BOMP Site Code. This code consists of 3 letters and 3 numbers, starting 001 for the first of your sites (shown at the top of each BOMP form).



Appendix 1 (continued)

- Please add an 'A' at the end of this code to indicate it is a 1st brood, 'B' for 2nd (use 'U' if the number of the brood is unknown). Examples: 'XYZ001A', 'XYZ001B' or 'XYZ001U'
- Use a separate card for each nesting attempt. Clip any 2nd brood cards (by the same pair) to the back of the first.
- If you have only been able to monitor the 2nd brood, please make a note of this on the nest record card (which will be labelled 'XYZ001B' – there won't be a card for 'XYZ001A').
- Please return both the nest record card AND the BOMP form for each site.

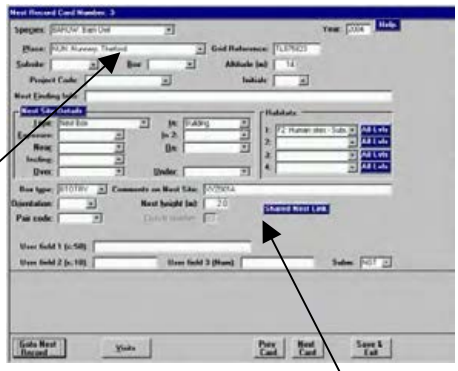
(2) IPMR (INTEGRATED POPULATION MONITORING REPORTER)

Box on back of each BOMP form:

SUBMITTED USING IPMR (*tick) ☐
(Please label as per Instruction Sheet)

IPMR submission file number:

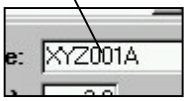
Record number(s) within this file:



Once you have started inputting your BOMP record within IPMR you may also find it useful to make a note of the nest record number in the box on the back of your BOMP form (see example above):

When you submit your nest records to the BTO please record the 'submission file' name in the box on the reverse side of the BOMP form.
(The submission file name will be your NRS Observer Code, a full stop, then 041)

Within the IPMR record, please also add the BOMP Site Code ('XYZ001A', 'XYZ001B' or 'XYZ001U') to the **'Comments on Nest Site'** field (see example to the right).



(C) RINGING BARN OWLS

RINGING INFORMATION (ADULTS)

- Please record BROOD PATCH (0-5), WING LENGTH and WEIGHT within IPMR (for submission to the Ringing Unit)

RINGING INFORMATION (CHICKS)

- Please record P7 LENGTH, WING LENGTH, HEAD+BILL and WEIGHT within IPMR (for submission to the Ringing Unit)

Please return completed BOMP forms, IPMR submissions and cards to the BTO as soon as possible (by 31 December at the very latest) **EVEN IF THE BOMP SITE HAS NOT BEEN USED BY BARN OWLS THIS YEAR.**

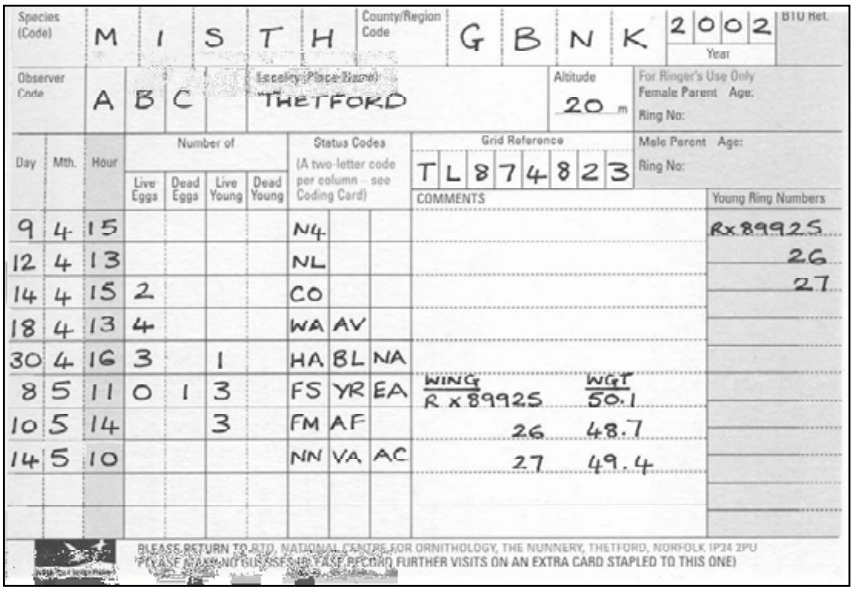
Barn Owl Monitoring Programme Coordinator
BTO
The Nunnery
THETFORD
Norfolk IP24 2PU
Tel: 01842 750050 Email: barnowls@bto.org

Appendix 1 (continued)

Completing BTO Nest Record Cards for BOMP

These instructions are based on the fuller Nest Record Scheme Handbook. If you'd like to record nests of other species for The Nest Record Scheme then please contact the Nest Records Officer (nest.records@bto.org, Tel. 01842 750050) who will send you a free copy of the Handbook.

- **Please use one card per nesting attempt. For successive attempts by the same pair of birds, cross-reference the cards and clip them together. Also, if you make more visits than can be fitted onto one card, please clip the cards together and mark them accordingly.**
- **Each row contains the information collected during a single visit to the nest (eight visits in total were therefore made to the nest in the example below, the first on the 9th of April and the last on the 14th May).**



Species (Code): MISTH | County/Region Code: GBNK | Year: 2002 | BTO Ref.

Observer Code: ABC | Locality (Place Name): THETFORD | Altitude: 20 m | For Ringer's Use Only: Female Parent Age: | Ring No:

Grid Reference: TL874823 | Male Parent Age: | Ring No:

Day	Mth.	Hour	Number of: Live Eggs	Dead Eggs	Live Young	Dead Young	Status Codes (A two-letter code per column – see Coding Card)			COMMENTS	Young Ring Numbers
9	4	15					N4				Rx89925
12	4	13					NL				26
14	4	15	2				CO				27
18	4	13	4				WA	AV			
30	4	16	3		1		HA	BL	NA		
8	5	11	0	1	3		FS	YR	EA	WING Rx89925 WGT 50.1	
10	5	14			3		FM	AF		26 48.7	
14	5	10					NN	VA	AC	27 49.4	

PLEASE RETURN TO BTO, NATIONAL CENTRE FOR ORNITHOLOGY, THE NUNNERY, THETFORD, NORFOLK IP24 2PU
PLEASE MARK NOT GUESSES IF FAILS RECORD FURTHER VISITS ON AN EXTRA CARD STAPLED TO THIS ONE)

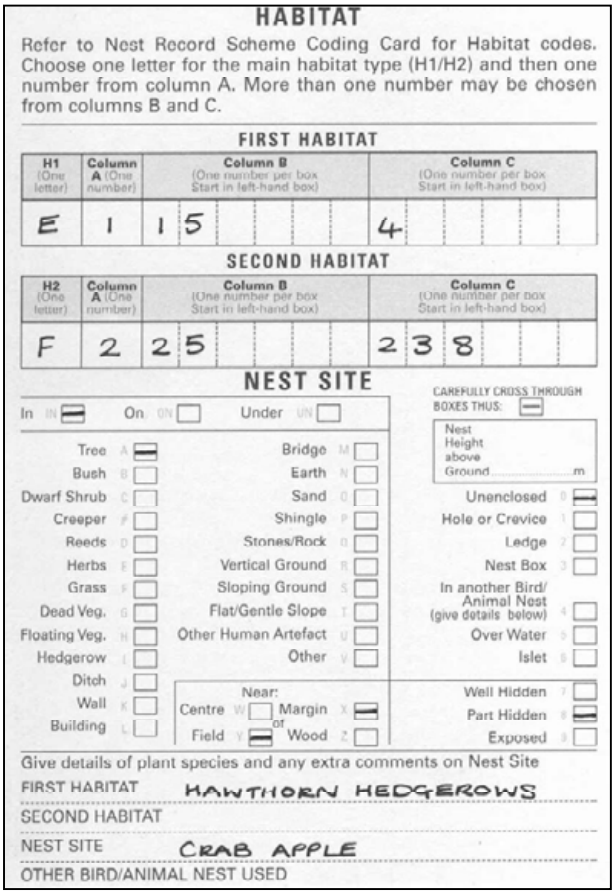
Front of Card

- **The front of the card is used to record the basic information about the geographical location of the nest, along with the details from each visit to the nest.**
- **Species Code –** Use the appropriate five-letter Species Code from the list
- below (e.g. "BAROW" for Barn Owl).

- **Year** – Please enter the year in full.
- **County/Region Code** – Use the County Code as given on the list below (e.g. "GBNK" for Norfolk).
- **Observer Code –** If you do not have a NRS Observer Code already, a code will be allocated to you when you have registered your sites for BOMP.
- **Locality –** Give the name of the nearest town, village, lake etc. that is closest to the nest.
- **Altitude –** Give the height above sea level in metres, which can be calculated using the contours on an Ordnance Survey map.
- **Grid Reference –** Use the six-figure National Grid reference as given on the maps, (e.g. TL825872).

Appendix 1 (continued)

- **Parent ages and ring numbers, young ring numbers –** Complete if known.
- **Date –** Give the day and month of each visit in figures, e.g. "22 06" for 22nd June.
- **Number of live eggs/young –** Count the number of live eggs/young in the nest. If the precise number cannot be ascertained, use one of the following:
- **?** When contents cannot be counted, e.g. if the female is sitting on the nest.
- **+** After the count if it is suspected that the number is an underestimate, e.g. 6+ means 'at least 6 eggs/young'.
- **( )** Place brackets around the count if it is approximate, e.g. (6) means 'between 5 to 7 eggs or young'
- **Number of dead eggs/young –** This figure must be a precise count.
- **Status codes** – These are listed on blue **Nest Record Scheme Coding Card**. These two-letter codes indicate the stage of development of the nest/eggs/young (left hand column on Coding Card), as well as describing the activity of the adults (left hand column on Coding Card) and the eventual outcome of the breeding attempt (central column on Coding Card). There is space to record 3 status codes for each visit. **Codes describing outcomes should only be used in the final visit of the card.**


HABITAT

Refer to Nest Record Scheme Coding Card for Habitat codes. Choose one letter for the main habitat type (H1/H2) and then one number from column A. More than one number may be chosen from columns B and C.

FIRST HABITAT

H1 (One letter)	Column A (One number)	Column B (One number per box Start in left-hand box)	Column C (One number per box Start in left-hand box)
E	1	1 5	4

SECOND HABITAT

H2 (One letter)	Column A (One number)	Column B (One number per box Start in left-hand box)	Column C (One number per box Start in left-hand box)
F	2	2 5	2 3 8

NEST SITE

In ☐ On ☐ Under ☐

CAREFULLY CROSS THROUGH BOXES THUS: ☒

Tree ☐ Bush ☐ Dwarf Shrub ☐ Creeper ☐ Reeds ☐ Herbs ☐ Grass ☐ Dead Veg. ☐ Floating Veg. ☐ Hedgerow ☐ Ditch ☐ Wall ☐ Building ☐

Bridge ☐ Earth ☐ Sand ☐ Shingle ☐ Stones/Rock ☐ Vertical Ground ☐ Sloping Ground ☐ Flat/Gentle Slope ☐ Other Human Artefact ☐ Other ☐

Near: Centre ☐ Margin ☒ or Field ☒ Wood ☐

Nest Height above Ground ..... m

Unenclosed ☒ Hole or Crevice ☐ Ledge ☐ Nest Box ☐ In another Bird/Animal Nest (give details below) ☐ Over Water ☐ Islet ☐

Well Hidden ☐ Part Hidden ☒ Exposed ☐

Give details of plant species and any extra comments on Nest Site

FIRST HABITAT HAWTHORN HEDGEROWS

SECOND HABITAT

NEST SITE CRAB APPLE

OTHER BIRD/ANIMAL NEST USED

Back of Card

- **First Habitat –** Record details of the dominant habitat type around the nest site using the Habitat Codes listed on the blue **Nest Record Scheme Coding Card**. In the example given (left) the nest is on farmland (Habitat 1 (H1) = E) in apparently improved grassland (Column A = 1). There are hedges with trees and groups of trees on the land (Column B = 1 and 5) and horses are present (Column C = 4).
- **Second Habitat** – If there is another habitat near to the nest that may influence the outcome of the breeding attempt, e.g. a coppice in the middle of an area of farmland, then details may be entered here.
- **Nest Position** - The feature(s) that the nest is positioned 'in', 'on' or 'under' can be recorded by checking the appropriate box. In the example above, the nest is in a tree. The relative location of the nest can be recorded in the same manner. In the example above, the nest is near the field margin.
- **Nest Site Type** - The details of the type of nest site can also be recorded. The nest in the example above was unenclosed but partially hidden. The height in metres should also be recorded.

Appendix 1 (continued)

Sending in your cards

Please send your completed cards together with your BOMP forms to Barn Owl Monitoring Programme, BTO, The Nunnery, THETFORD, Norfolk, UK, IP24 2EQ.

COUNTY CODES
Please use the following four letter County Codes for the Republic of Ireland (all prefixed with ER).

Carlow	ERCW	Kilkenn	ERKK	Offaly	EROF
Cavan	ERCV	Leitrim	ERLM	Roscommon	ERRO
Clare	ERCL	Leix	ERLX	Sligo	ERSL
Cork	ERCK	Limerick	ERLK	Tipperary	ERTP
Donegal	ERDO	Longford	ERLG	Waterford	ERWA
Dublin	ERDU	Louth	ERLU	Westmeath	ERWM
Galway	ERGA	Mayo	ERMA	Wexford	ERWX
Kerry	ERKE	Meath	ERME	Wicklow	ERWI
Kildare	ERKD	Monaghan	ERMO		

Please use the following four letter County Codes for Great Britain and Northern Ireland (all prefixed with GB except for the Channel Islands which uses CI).

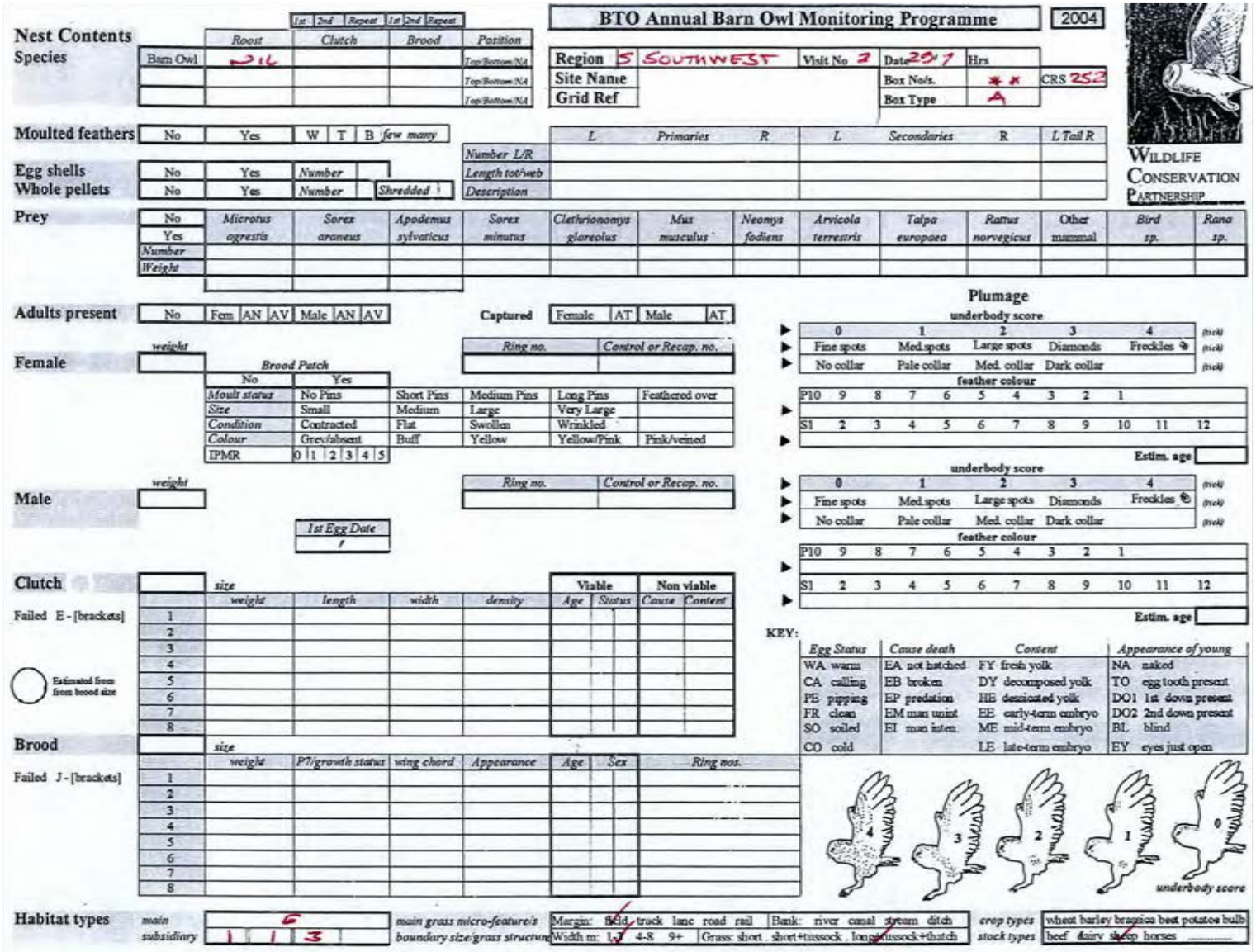
Anglesey	GBAN	Gwynedd	GBGD	Staffordshire	GBST
Avon	GBAV	Hampshire		Strathclyde Region	GBSC
Bedford	GBBD	(excl. I. of W.)	GBHA	Somerset	GBSO
Berkshire	GBBK	Hereford &Worcs.	GBHF	Suffolk	GBSK
Border Region	GBBR	Hertfordshire	GBHT	Surrey	GBSR
Buckingham	GBBC	Highland Region	GBHR	Sussex (West & East)	GBSX
Cambridge &		Humberside	GBHU	Tayside Region	GBTR
Huntingdon	GBCA	Isle of Man	GBIM	Tyne & Wear	GBTY
Central Region	GBCR	Isle of Wight	GBIW	Warwickshire	GBWK
Cheshire	GBCH	Kent	GBKE	Western Isles	GBWI
Cleveland	GBCV	Lancashire	GBLA	West Midlands	GBWM
Clwyd	GBCW	Leicester & Rutland	GBLE	West Yorks	GBWY
Cornwall	GBCO	Lincolnshire	GBLI	Wiltshire	GBWT
Cumbria	GBCU	Greater London	GBLO		
Derby	GBDB	Lothian Region	GBLR	**NORTHERN IRELAND**	
Devon	GBDV	Greater Manchester	GBMA	Antrim	GBUN
Dorset	GBDO	Merseyside	GBME	Armagh	GBUR
Dumfries &		Norfolk	GBNK	Down	GBUD
Galloway	GBDR	Northamptonshire	GBNH	Fermanagh	GBUF
Durham	GBDU	Northumberland	GBNL	Londonderry	GBUL
Dyfed	GBDY	North Yorkshire	GBNY	Tyrone	GBUT
Essex	GBES	Nottinghamshire	GBNT		
Fair Isle	GBFI	Orkney	GBOR	**CHANNEL ISLANDS**	
Fife Region	GBFR	Oxford	GBOX	Alderney	CIAL
Glamorgan		Powys	GBPO	Guernsey	CIGU
(W., Mid. & S.)	GBGM	Salop	GBSA	Herm	CIHE
Gloucester	GBGL	Scilly Isles	GBSI	Jersey	CIJE
Grampian Region	GBGR	Shetland	GBSH	Sark	CISA
Gwent	GBGT	South Yorks	GBSY		

Appendix 1 (continued)

BTO FIVE LETTER SPECIES CODES

Red-throated Diver	RETDI	Greenshank	GRESH	Grasshopper Warbler	GRAWA
Black-throated Diver	BLTDI	Common Sandpiper	COMSA	Sedge Warber	SEDWA
Little Grebe	LITGR	Arctic Skua	ARCSK	Marsh Warbler	MARWA
Great Crested Grebe	GRCGR	Great Skua	GRESK	Reed Warbler	REEWA
Slavonian Grebe	SLAGR	Black-headed Gull	BLHGU	Dartford Warbler	DARWA
Fulmar	FULMA	Common Gull	COMGU	Lesser Whitethroat	LESWH
Manx Shearwater	MANSH	L. Black-backed Gull	LBBGU	Whitethroat	WHITE
Storm Petrel	STOPE	Herring Gull	HERGU	Garden Warbler	GARWA
Gannet	GANNE	G. Black-backed Gull	GBBGU	Blackcap	BLACA
Cormorant	CORMO	Kittiwake	KITTI	Wood Warbler	WOOWA
Shag	SHAG	Sandwich Tern	SANTE	Chiffchaff	CHIFF
Grey Heron	GREHE	Roseate Tern	ROSTE	Willow Warbler	WILWA
Mute Swan	MUTSW	Common Tern	COMTE	Goldcrest	GOLDC
Greylag Goose	GREGO	Arctic Tern	ARCTE	Spotted Flycatcher	SPOFL
Canada Goose	CANGO	Little Tern	LITTE	Pied Flycatcher	PIEFL
Egyptian Goose	EGYGO	Guillemot	GUILL	Bearded Tit	BEATI
Shelduck	SHELD	Razorbill	RAZOR	Long-tailed Tit	LOTTI
Mandarin	MANDA	Black Guillemot	BLAGU	Marsh Tit	MARTI
Wigeon	WIGEO	Puffin	PUFFI	Willow Tit	WILTI
Gadwall	GADWA	Rock Dove	ROCDO	Crested Tit	CRETI
Teal	TEAL	Feral Pigeo	FERPI	Coal Tit	COATI
Mallard	MALLA	Stock Dove	STODO	Blue Tit	BLUTI
Shoveler	SHOVE	Woodpigeon	WOODP	Great Tit	GRETI
Pochard	POCHA	Collared Dove	COLDO	Nuthatch	NUTHA
Tufted Duck	TUFDU	Turtle Dove	TURDO	Treecreeper	TREEC
Eider	EIDER	Cuckoo	CUCKO	Golden Oriole	GOLOR
Goldeneye	GOLDE	Barn Owl	BAROW	Jay	JAY
R.-breast. Merganser	REBME	Little Owl	LITOW	Magpie	MAGPI
Goosander	GOOSA	Tawny Owl	TAWOW	Chough	CHOUG
Ruddy Duck	RUDDU	Long-eared Owl	LOEOW	Jackdaw	JACKD
Marsh Harrier	MARHA	Short-eared Owl	SHEOW	Rook	ROOK
Hen Harrier	HENHA	Nightjar	NIJAR	Carrion Crow	CROW
Goshawk	GOSHA	Swift	SWIFT	Hooded Crow	HOOCR
Sparrowhawk	SPARR	Kingfisher	KINGF	Raven	RAVEN
Buzzard	BUZZA	Green Woodpecker	GREWO	Starling	STARL
Golden Eagle	GOLEA	G. Spot. Woodpecker	GRSWO	House Sparrow	HOUSP
Kestrel	KESTR	L. Spot. Woodpecker	LESWO	Tree Sparrow	TRESP
Merlin	MERLI	Woodlark	WOODL	Chaffinch	CHAFF
Hobby	HOBBY	Skylark	SKYLA	Greenfinch	GREFI
Peregrine	PEREG	Sand Martin	SANMA	Goldfinch	GOLDF
Red Grouse	REDGR	Swallow	SWALL	Siskin	SISKI
Ptarmigan	PTARM	House Martin	HOUMA	Linnet	LINNE
Black Grouse	BLAGR	Tree Pipit	TREPI	Twite	TWITE
Red-legged Partridge	RELPA	Meadow Pipit	MEAPI	Redpoll	REDPO
Grey Partridge	GREPA	Rock Pipit	ROCPI	Common Crossbill	CROSS
Pheasant	PHEAS	Yellow Wagtail	YELWA	Bullfinch	BULLF
Water Rail	WATRA	Grey Wagtail	GREWA	Hawfinch	HAWFI
Moorhen	MOORH	Pied Wagtail	PIEWA	Yellowhammer	YELHA
Coot	COOT	Dipper	DIPPE	Cirl Bunting	CIRBU
Oystercatcher	OYSTE	Wren	WREN	Reed Bunting	REEBU
Avocet	AVOCE	Dunnock	DUNNO	Corn Bunting	CORBU
Stone Curlew	STOCU	Robin	ROBIN		
Little Ringed Plover	LIRPL	Nightingale	NIGAL		
Ringed Plover	RINPL	Black Redstart	BLARE		
Dotterel	DOTTE	Redstart	REDST		
Golden Plover	GOLPL	Whinchat	WHINC		
Lapwing	LAPWI	Stonechat	STOCH		
Dunlin	DUNLI	Wheatear	WHEAT		
Snipe	SNIPE	Ring Ouzel	RINOU		
Woodcock	WOODC	Blackbird	BLABI		
Whimbrel	WHIMB	Song Thrush	SONTH		
Curlew	CURLE	Redwing	REDWI		
Redshank	REDSH	Mistle Thrush	MISTH		

Appendix 2 BOMP recording form used at WCP sites 2000-present



BTO Annual Barn Owl Monitoring Programme 2004

Wildlife Conservation Partnership

Nest Contents — Species: Barn Owl 216

Region 5 SOUTHWEST Visit No 2 Date 29/7 Hrs

Site Name

Grid Ref

Box No/s. * * CRS 252

Box Type A

Moulted feathers: No / Yes / W T B / few many

Egg shells: No / Yes / Number

Whole pellets: No / Yes / Number / Shredded

	L Primaries R	L Secondaries R	L Tail R
Number L/R			
Length tot/web			
Description			

Prey

	Microtus agrestis	Sorex araneus	Apodemus sylvaticus	Sorex minutus	Clethrionomys glareolus	Mus musculus	Neomys fodiens	Arvicola terrestris	Talpa europaea	Rattus norvegicus	Other mammal	Bird sp.	Rana sp.
No / Yes													
Number													
Weight													

Adults present: No / Fem AN AV / Male AN AV — Captured: Female AT / Male AT

Female — weight — Ring no. — Control or Recap. no.

Brood Patch: No / Yes

Moult status	No Pins	Short Pins	Medium Pins	Long Pins	Feathered over
Size	Small	Medium	Large	Very Large	
Condition	Contracted	Flat	Swollen	Wrinkled	
Colour	Grey/absent	Buff	Yellow	Yellow/Pink	Pink/veined
IPMR	0 1 2 3 4 5				

Male — weight — Ring no. — Control or Recap. no.

1st Egg Date /

Plumage

underbody score: 0 / 1 / 2 / 3 / 4 (trick)

Fine spots / Med. spots / Large spots / Diamonds / Freckles (trick)

No collar / Pale collar / Med. collar / Dark collar (trick)

feather colour: P10 9 8 7 6 5 4 3 2 1 — S1 2 3 4 5 6 7 8 9 10 11 12

Estim. age

underbody score: 0 / 1 / 2 / 3 / 4 (trick)

Fine spots / Med. spots / Large spots / Diamonds / Freckles (trick)

No collar / Pale collar / Med. collar / Dark collar (trick)

feather colour: P10 9 8 7 6 5 4 3 2 1 — S1 2 3 4 5 6 7 8 9 10 11 12

Estim. age

Clutch — size

	weight	length	width	density	Viable Age	Viable Status	Non viable Cause	Non viable Content
1								
2								
3								
4								
5								
6								
7								
8								

Failed E - [brackets]

◯ Estimated from from brood size

KEY:

Egg Status	Cause death	Content	Appearance of young
WA warm	EA not hatched	FY fresh yolk	NA naked
CA calling	EB broken	DY decomposed yolk	TO egg tooth present
PE pipping	EP predation	HE dessicated yolk	DO1 1st down present
FR clean	EM man unint	EE early-term embryo	DO2 2nd down present
SO soiled	EI man inten.	ME mid-term embryo	BL blind
CO cold		LE late-term embryo	EY eyes just open

Brood — size

	weight	P7/growth status	wing chord	Appearance	Age	Sex	Ring nos.
1							
2							
3							
4							
5							
6							
7							
8							

Failed J - [brackets]

Habitat types — main: 6 — subsidiary: 1 1 3

main grass micro-feature/s — boundary size/grass structure

Margin: field track lane road rail — Bank: river canal stream ditch — Width m: 1-3 4-8 9+ — Grass: short short+tussock long tussock+thatch

crop types: wheat barley brassica beet potatoe bulb

stock types: beef dairy sheep horses

Appendix 3 BOMP recording form used at BOMP Network sites 2002-2003

Barn Owl Monitoring Programme

Observer: «Title» «Initials» «SURNAME»	Observer Code: «Monitoring_No»	Year:
Our Site Code: «Our_Ref»	Your Site Code: «Their_Ref»	Your Site Name: «Site_Name»

Summary of breeding attempts

- Is this the first or second breeding attempt by this pair this year? First/Second/Don't know

If there was more than one attempt by this pair and you were able to monitor the other attempt please use an additional recording form (supplied) and attach it to this form.

- If this is the first attempt, was there another attempt by this pair? Yes/No/Don't know

- Were you able to monitor another attempt? Yes/No

Your Site Code: ☐

- Were there other active nest sites within the monitoring area? Yes/No/Don't know

If so, please mark the location(s) on the map below.

Area Map

Please mark: other known potential sites as ?
other occupied sites as ?

Habitat Recording (to nearest 5%)

A Woodland (more than 5m tall)		
A1	Broad-leaved woodland	
A2	Coniferous woodland	
A3	Mixed woodland	
B Scrubland (woodland less than 5m tall)		
B1	Regenerating woodland	
B4	Young coppice	
B5	New plantation	
B6	Clear-felled woodland	
C Semi-natural grassland/marsh		
C5	Other dry grassland	
C6	Water meadow/grazing marsh	
C9	Saltmarsh	
D Heathland & Bogs		
E Farmland		
E1	Improved grassland	
E2	Unimproved grassland	
E4	Tilled land	
F Human Sites		
G Water Bodies		
J Other (Please specify in space below)		
J1		
J2		
J3		
J4		
TOTAL		**100%**

IMPORTANT FEATURES FOR BARN OWLS
Are these present in the area? (tick all boxes that apply)

Major Roads	☐	River/Ditch	☐	Other livestock	☐
Minor Roads	☐	Canal	☐	Hedgerows	☐
Paths	☐	Sheep	☐	Grassy margins	☐
Railways	☐	Cattle	☐	Disused railways	☐

SITE DETAILS (tick all boxes that apply)

Tree	☐	**Building**	☐	**Other**	☐
Species……		**Type**		Polebox	☐
Alive	☐	Farm	☐	Balestack:	
Dead	☐	Domestic	☐	Inside	
Isolated	☐	Church	☐	Building	☐
In hedge	☐	Military	☐	Outside	☐
Small copse	☐	Building in use	☐	**Other**……	
Edge of wood	☐	Disused	☐	……	
In nest box	☐	In nest box	☐	……	
In cavity	☐	In roof space	☐	……	
Other……		**Other**……		……	
……		……		……	

Appendix 3 (continued)

VISIT DETAILS

Date (*e.g.* 26/07)	Time (24 hours)	No. Live Eggs	No. Dead Eggs	No. Live Young	No. Dead Young	Status Codes (A two letter code per column) See coding sheet			Comments	Birds present? Male/Female/Pair	Other species Present? (5 letter code)	Pellets found? Yes/No/Approx. Number	No. Prey items found				
													Field Vole	Wood Mouse	Common Shreww		

SUMMARY: No. eggs laid _____ No. eggs hatched _____ No. young fledged _____

OPTION 2 ONLY: RINGING DETAILS AND BIOMETRICS

ADULTS								CHICKS					
Date (*e.g.* 26/07)	Ring No.	Sex (M,F,U)	Brood Patch (0-5)	Wing Length (mm)	Moult (B/W/A)	Weight (g)	Talon Flanges (Score)	Date (*e.g.* 26/07)	Ring No.	P7 Length (mm)	Wing Length (mm)	Head/bill Length (mm)	Weight (g)

Please return to:

Barn Owl Monitoring Programme,
BTO, The Nunnery, Thetford, Norfolk IP24 2PU

Appendix 4. BOMP recording form used at BOMP Network sites 2004-present

Barn Owl Monitoring Programme

Observer: «Title» «Initials» «SURNAME»	**Observer Code: «Monitoring_No»**	**Year: 2005**
BTO Site Code: «Our_Ref»	**Your Site Code: «Their_Ref»**	**Your Site Name: «Site_Name»**

Summary of breeding attempts

(1) BARN OWL USE OF BOMP SITE THIS YEAR
(*tick one):
- ☐ NESTING (at least 1 egg laid)
- ☐ ROOSTING ONLY
- ☐ SITE NOT USED
- ☐ SITE NOT VISITED
- ☐ SITE UNUSABLE? (Destroyed)
- ☐ SITE UNUSABLE? (Other species)

Comments:

(2) HOW MANY NESTING ATTEMPTS WERE MADE BY BARN OWLS HERE THIS YEAR?
(* please indicate)
1 ☐ 2 ☐ 3 ☐ UNKNOWN ☐

(3) HOW MANY POTENTIAL BARN OWL BREEDING SITES ARE WITHIN c. 500m OF THIS BOMP SITE?
(1km = 1000m)
NUMBER: ☐ DON'T KNOW: ☐

(4) HOW MANY OF THESE POTENTIAL SITES DID YOU CHECK FOR BREEDING BARN OWLS THIS YEAR?
NO. OF SITES CHECKED: ☐ NONE: ☐

Are any of these potential sites are registered for the Programme? If so, please give their BTO Site Codes here:

(5) HOW MANY OF THESE POTENTIAL SITES WERE OCCUPIED BY BREEDING BARN OWLS (BREEDING DEFINED AS AT LEAST ONE EGG LAID)? ☐

Habitat Recording (to nearest 5%)

A Woodland (more than 5m tall)		
A1	Broad-leaved woodland	
A2	Coniferous woodland	
A3	Mixed woodland	
B Scrubland (woodland less than 5m tall)		
B1	Regenerating woodland	
B4	Young coppice	
B5	New plantation	
B6	Clear-felled woodland	
C Semi-natural grassland/marsh		
C5	Other dry grassland	
C6	Water meadow/grazing marsh	
C9	Saltmarsh	
D Heathland & Bogs		
E Farmland		
E1	Improved grassland	
E2	Unimproved grassland	
E4	Tilled land	
F Human Sites		
G Water Bodies		
J Other (Please specify in space below)		
J1		
J2		
J3		
J4		
TOTAL		**100%**

IMPORTANT FEATURES FOR BARN OWLS
Are these present in the area? (tick all boxes that apply)

Major Roads ☐	River/Ditch ☐	Other livestock ☐
Minor Roads ☐	Canal ☐	Hedgerows ☐
Paths ☐	Sheep ☐	Grassy margins ☐
Railways ☐	Cattle ☐	Disused railways ☐

SITE DETAILS (tick all boxes that apply)

Tree ☐	**Building Type** ☐	**Other** ☐
Species……		Polebox ☐
Alive ☐	Farm ☐	Balestack:
Dead ☐	Domestic ☐	Inside
Isolated ☐	Church ☐	Building ☐
In hedge ☐	Military ☐	Outside ☐
Small copse ☐	Building in use ☐	**Other**……
Edge of wood ☐	Disused ☐	……
In nest box ☐	In nest box ☐	……
In cavity ☐	In roof space ☐	……
Other……	**Other**……	……
……	……	……
……	……	……

Appendix 4 (continued)

VISIT DETAILS FOR THIS BOMP SITE:

SUBMITTED ON A NEST RECORD CARD (*tick) ☐ (Please label as per Instruction Sheet)	**SUBMITTED USING IPMR** (*tick) ☐ (Please label as per Instruction Sheet) IPMR submission file number: Record number(s) within this file:

BARN OWL SITE INFORMATION

DATE (eg 26/7/04)	NESTING ATTEMPT NUMBER (A, B or U)	FIELD VOLE PREY (Number)	WOOD MOUSE PREY (Number)	COMMON SHREW PREY (Number)	OTHER PREY ITEMS (Species and number)	WERE BARN OWL PELLETS FOUND? (*YES/NO and approx. number)	WERE ANY OF THESE PELLETS CHEWED? (*YES/NO)	MOULTED PRIMARY FEATHERS? (*YES/NO)

OTHER SPECIES PRESENT

	BREEDING	ROOSTING
Kestrel	☐	☐
Little Owl	☐	☐
Stock Dove	☐	☐
Jackdaw	☐	☐
Tawny Owl	☐	☐

OTHER SPECIES* (give details here)

Did any of these species interfere with the BARN OWL nesting attempt?

ADULT BARN OWL RINGING DETAILS

FEMALE RING NUMBER:

MALE RING NUMBER:

NESTLING BARN OWL RINGING DETAILS

ATTEMPT 'A' RING NUMBERS:

ATTEMPT 'B' RING NUMBERS:

Please return this completed BOMP form to the BTO as soon as possible at the end of the season (by 31 December at the very latest) **EVEN IF THE SITE IS NOT USED BY BARN OWLS**

Barn Owl Monitoring Programme Coordinator
BTO, The Nunnery, THETFORD, Norfolk, IP24 2PU
Telephone: 01842 750050 Email: barnowls@bto.org

If you are applying for a ring refund, please enter the details of the person/group to whom we should send the refund below:

Name: Permit No:

Appendix 5. Nest Record Card and NRS Coding Card

Species (Code) | County/Region Code | Year | BTO Ref.

Observer Code | Locality (Place-Name) | Altitude .....m | For Ringer's Use Only: Female Parent Age: / Ring No:

Grid Reference | Male Parent Age: / Ring No:

Day	Mth.	Hour	Number of: Live Eggs	Dead Eggs	Live Young	Dead Young	Status Codes (A two-letter code per column – see Coding Card)	COMMENTS	Young Ring Numbers

PLEASE RETURN TO BTO, NATIONAL CENTRE FOR ORNITHOLOGY, THE NUNNERY, THETFORD, NORFOLK IP24 2PU
PLEASE MAKE NO GUESSES (PLEASE RECORD FURTHER VISITS ON AN EXTRA CARD STAPLED TO THIS ONE)

Appendix 5 (continued)

HABITAT

Refer to Nest Record Scheme Coding Card for Habitat codes. Choose one letter for the main habitat type (H1/H2) and then one number from column A. More than one number may be chosen from columns B and C.

FIRST HABITAT

H1 (One letter)	Column A (One number)	Column B (One number per box Start in left-hand box)	Column C (One number per box Start in left-hand box)

SECOND HABITAT

H2 (One letter)	Column A (One number)	Column B (One number per box Start in left-hand box)	Column C (One number per box Start in left-hand box)

NEST SITE

In IN ☐ On ON ☐ Under UN ☐

CAREFULLY CROSS THROUGH BOXES THUS: —

Nest Height above Ground.....m

Tree	A ☐	Bridge	M ☐	Unenclosed	0 ☐
Bush	B ☐	Earth	N ☐	Hole or Crevice	1 ☐
Dwarf Shrub	C ☐	Sand	O ☐	Ledge	2 ☐
Creeper	# ☐	Shingle	P ☐	Nest Box	3 ☐
Reeds	D ☐	Stones/Rock	Q ☐	In another Bird/ Animal Nest (give details below)	4 ☐
Herbs	E ☐	Vertical Ground	R ☐		
Grass	F ☐	Sloping Ground	S ☐		
Dead Veg.	G ☐	Flat/Gentle Slope	T ☐		
Floating Veg.	H ☐	Other Human Artefact	U ☐	Over Water	5 ☐
Hedgerow	I ☐	Other	V ☐	Islet	6 ☐
Ditch	J ☐				
Wall	K ☐	Near:		Well Hidden	7 ☐
Building	L ☐	Centre W ☐	Margin of Wood X ☐	Part Hidden	8 ☐
		* Field Y ☐	Wood Z ☐	Exposed	9 ☐

Give details of plant species and any extra comments on Nest Site

FIRST HABITAT

SECOND HABITAT

NEST SITE

OTHER BIRD/ANIMAL NEST USED

Appendix 5 (continued)

STATUS CODES

NEST BUILDING STAGE

N0	= Nest site empty	N3	= 3/4 built
N1	= quarter built	N4	= Complete, unlined
N2	= half built	NL	= Lined

EGGS

CO	= Cold	WA	= Warm
UN	= Uncovered	CV	= Covered
FR	= Fresh	DE	= Growing embryo present
HA	= Hatching	PE	= Pipping/calling from egg

YOUNG

- NA = Naked
- TO = Egg tooth present
- DO = Downy
- BL = Blind
- EY = Eyes just open
- IP = Primary feathers in pin
- FS = Primary feathers short; less than 1/3 emerged from sheath
- FM = Primary feathers medium ; 1/3 to 2/3 emerged from sheath
- FL = Primary feathers large; more than 2/3 emerged from sheath
- RF = Ready to fledge
- LB = Young left nest naturally before fledging; still nearby
- YR = Young ringed
- AY = Audible young in nest

ADULT ACTIVITY

Combine (e.g. **AN**, **PD** etc)

1st letter

- A = Adult
- M = Male
- F = Female
- P = Pair

2nd letter

- D = Dead
- F = Feeding young at nest
- I = Identified by colour mark, at nest
- N = On/at nest
- T = Trapped at/near nest
- V = In vicinity of nest
- B = Building nest or carrying nest material

STATUS CODES (continued)

OUTCOME: SUCCESS

Use these when some/all young have successfully left the nest

- AC = Adult carrying food near nest
- EX = Young 'exploded' from nest
- HS = Hatched shell fragments in empty nest of gamebirds, waders, etc.
- MR = Marked young retrapped/resighted
- NE = Nest empty, undisturbed with well-trodden lining, containing feather scale and/or droppings
- NN = Fledged young near nest
- SY = Some young fledged, other live young still in nest
- SL = Last young seen leaving
- VA = Adult visibly agitated or alarms near nest
- YC = Young capable of leaving nest on the previous visit

OUTCOME: FAILURE

Use these codes on any visit to describe the fate of individual eggs and/or young.

Combine (e.g. **EP**, **XF** etc)

1st letter

- E = At egg stage
- J = At young stage
- X = At egg or young stage

2nd letter

- A = Eggs not hatched, infertile, or addled
- B = Injured/broken
- C = Killed or thrown out by Cuckoo
- D = Deserted/starved/dead
- E = Empty damaged nest
- F = Flooded
- I = Man - intentional
- L = Livestock
- M = Man - unintentional
- O = Other/unknown
- P = Predation
- T = Thrown/fallen out
- U = Usurped from nest by another species
- W = Wind Damage

OUTCOME: UNKNOWN = OU

NB: For partially successful nests (i.e. where only part of clutch/brood produces fledged young) write both success and failure codes.

BTO Nest Record Scheme

BTO

NEST RECORD SCHEME CODING SYSTEM

Coding Card revised January 2003

British Trust for Ornithology,
The Nunnery,
Thetford, Norfolk, IP24 2PU
Tel: 01842 750050, Fax: 01842 750030
Charity No. 216652

HABITAT CODES

Please fill in at least Column A, and then B and C if possible.
***ONLY ONE CODE** should be chosen from Column A, but more than one can be selected from Columns B and C.*

	COLUMN A	COLUMN B	COLUMN C
A WOODLAND (more than 5m tall)	1 Broadleaved 2 Coniferous 3 Mixed broadleaved & coniferous (at least 10% of each) 4 Broadleaved water-logged 5 Coniferous water-logged 6 Mixed broad-leaved and coniferous water-logged	1 Mixed-aged or semi-natural 2 Coppice with standards 3 Coppice no standards 4 Mature planta-tion (taller than 10m, with closed canopy) 5 Young planta-tion (5-10m, open canopy) 6 Parkland (scattered trees and grassy areas) 7 High-medium disturbance from people 8 Low disturbance	1 Dense shrub layer 2 Moderate shrub layer 3 Sparse shrub layer 4 Dense field layer 5 Moderate field layer 6 Sparse field layer 7 Grazed (moderate to heavy) 8 Lightly grazed 9 Dead wood present 10 Dead wood absent

Appendix 5 (continued)

	COLUMN A	COLUMN B	COLUMN C
RUBLAND very ing wood- l less n 5m tall)	1 Regenerating natural or semi-natural woodland 2 Downland (chalk) 3 Heath scrub 4 Young coppice 5 New plantation 6 Clear-felled woodland, with or without new saplings 7 Other	1 Broadleaved 2 Coniferous 3 Mixed broadleaved & coniferous (at least 10% of each) 4 Broadleaved swamp scrub 5 Coniferous swamp scrub 6 Mixed broadleaved & coniferous swamp scrub 7 High-medium disturbance from people 8 Low disturbance	1 Predominantly tall (3-5m) 2 Predominantly low (1-3m) 3 Dense shrub layer 4 Moderate shrub layer 5 Sparse shrub layer 6 Extensive bracken 7 Dense field layer 8 Moderate field layer 9 Sparse field layer 10 Grazed (moderate to heavy)
MI- TURAL ASSLAND D MARSH	1 Chalk downland 2 Grass moor (unenclosed) 3 Grass moor mixed with heather (unenclosed) 4 Machair 5 Other dry grassland 6 Water-meadow/ grazing marsh 7 Reed swamp 8 Other open marsh 9 Saltmarsh	1 Hedgerow with trees 2 Hedgerow without trees 3 Tree-line without hedge 4 Other field boundary (wall, ditch, etc.) 5 Isolated group of 1-10 trees 6 No field boundary 7 Montane 8 High-medium disturbance from people 9 Low disturbance	1 Ungrazed 2 Cattle 3 Sheep 4 Horses 5 Rabbits 6 Deer 7 Other grazers 8 Extensive bracken 9 Hay

	COLUMN A	COLUMN B	COLUMN C
D HEATHLAND AND BOGS	1 Dry heath 2 Wet heath 3 Mixed wet/ dry heath 4 Bog 5 Breckland 6 Drained bog	1 Montane 2 Raised bog 3 Valley/ basin bog 4 Blanket bog 5 Heath mixed with rough grass 6 Heath without grass 7 Heath with extensive bracken 8 Undetermined bog 9 Isolated group of 1-10 trees 10 High-medium disturbance from people	1 Ungrazed 2 Cattle 3 Sheep 4 Horses 5 Rabbits 6 Deer 7 Other grazers 8 Ploughed 9 Burned 10 Planted with saplings <0.5m tall
E FARMLAND	1 Apparently improved grassland 2 Apparently unimproved grassland 3 Mixed grass/ tilled land 4 Tilled land 5 Orchard 6 Other farming	1 Hedgerow with trees 2 Hedgerow without trees 3 Tree-line without hedge 4 Other field boundary (wall, ditch, etc.) 5 Isolated group of 1-10 trees 6 Farmyard (active)	1 Ungrazed 2 Cattle 3 Sheep 4 Horses 5 Other stock 6 Bare earth 7 Autumn cereal 8 Spring cereal 9 Root crops 10 Other crops
F HUMAN SITES	1 Urban 2 Suburban 3 Rural	1 Building 2 Gardens 3 Municipal parks/ recreational areas 4 Sewage works "urban" 5 Near road (within 50m) 6 Near active railway line (within 50m) 7 Other 8 Rubbish tip	1 Industrial 2 Residential 3 Well-wooded 4 Not well-wooded 5 Large area of garden (more than 450m^2) 6 Medium area of garden (100-450m^2) 7 Small area of garden (less than 100m^2) 8 Many shrubs 9 Few shrubs

	COLUMN A	COLUMN B	COLUMN C
G WATER BODIES (freshwater)	1 Pond (less than 50m^2) 2 Small water-body (50-450m^2) 3 Lake/unlined reservoir 4 Lined reservoir 5 Gravel pit, sand pit, etc 6 Stream (less than 3m wide) 7 River (more than 3m wide) 8 Ditch with water (less than 2m wide) 9 Small canal (2-5m wide) 10 Large canal (>5m wide)	1 Undisturbed/ disused 2 Water sports (sailing etc) 3 Angling (coarse or game) 4 Coarse angling 5 Game fishing 6 Industrial activity 7 Sewage processing "rural" 8 Other disturbance 9 Small island	1 Eutrophic (green water) 2 Oligotrophic (clear water, few weeds) 3 Dystrophic (black water) 4 Marl (clear water, large water-weeds) 5 Slow-medium running 6 Fast-running 7 Dredged 8 Undredged 9 Banks cleared 10 Banks vegetated
H COASTAL	1 Marine - open shore 2 Marine shore - inlet/cove/ loch 3 Estuarine 4 Brackish lagoon	1 Mud or silt 2 Sand 3 Shingle 4 Rocky 5 Fully vegetated 6 Sparse/ medium vegetation 7 Inter-tidal 8 Below low-water mark	1 Cliff vertical/ steeply sloping 2 Dune 3 Flat/gently sloping 4 Small island 5 Spit 6 Dune slack 7 Sloping ground 8 Undisturbed 9 Disturbed
I INLAND ROCK	1 Cliff 2 Scree/boulder slope 3 Limestone pavement 4 Other rock outcrop 5 Quarry 6 Mine/spoil/ slag heap 7 Cave	1 Active 2 Disused 3 Montane 4 Non-montane 5 High disturbance from climbers/ walkers etc. 6 Medium disturbance 7 Low disturbance	1 Bare rock 2 Low vegetation present (mosses, liverworts etc) 3 Grasses present 4 Scrub present
J MISCELLANEOUS			