BTO Research Report 424

The BTO Barn Owl Monitoring Programme: fifth year 2004

Authors

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1. EXECUTIVE SUMMARY

1.1 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 of Amber conservation concern in the UK but has been poorly covered by the national, long-running population monitoring schemes operated by BTO. The BTO Barn Owl Monitoring Programme (BOMP) was set up in 2000 with the aim:

> *To monitor 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 throughout five regions of England and matched for nest box design. In 2002, a network of volunteer ornithologists began gathering additional information at '*BOMP Network*' sites over a wider geographical area.

1.3 This is the fifth report of BOMP, covering the five seasons 2000–04. Rates of occupancy are investigated, along with breeding statistics, in relation to year, geographical location, main habitat type and weather conditions.

1.4 In 2004, 198 sites were monitored by WCP and a further 333 were visited by BOMP Network volunteers. WCP sites are located across the whole of England, although as a consequence of sampling methodology they tend to be concentrated in the southern and eastern regions. BOMP network sites are more broadly scattered across the UK, including several locations 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 five years of the study, as has the proportion where breeding Barn Owls have been recorded. This may indicate a decline in Barn Owl populations over this period, but may also be an artefact of site selection, which may have originally been biased towards sites that were known to have been occupied in previous years.

1.6 The proportion of WCP sites occupied by breeding Barn Owl was lower than that at BOMP Network sites. This probably reflects the different lengths of time over which the two types of site have been monitored. As WCP sites have been monitored since 2000, there have been five years for the population to attain a more natural level, whereas monitoring only began at BOMP Network sites three years ago. The current levels of occupancy at BOMP Network sites are very similar to those at WCP sites after three years of monitoring.

1.7 While the decline in the presence of Barn Owls at WCP sites is linear, that in breeding occupancy fluctuates between years, peaking in 2000, 2002 and 2004, leading to significant annual variation in the proportion of boxes occupied by non-breeding individuals or pairs. A similar relationship can be observed at BOMP Network sites, although it is less pronounced.

1.8 Weather conditions have previously bee reported to affect both Barn Owl abundance and in particular the proportion of pairs that are in sufficient condition to breed, with the likelihood that cold, wet weather during the winter reduces 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 indicated that breeding occupancy, but not overall presence, was significantly lower following cold wet winters at WCP sites. This result suggests that, while inclement winter conditions in these

years may not have influenced survival rates, they may have resulted in a loss of body condition leading to suspension of breeding during the following breeding season. .

1.9 Occupancy rates were also influenced by geographic location. Sites to the west and the north of the UK were significantly more likely to contain breeding Barn Owls, than to the south and east. Possible causes behind these patterns are discussed, including the potential influence of climate, habitat and nest site availability.

1.10 Habitat also influenced occupancy rates, with a higher proportion of sites overall occupied by breeding Barn Owl in natural grassland areas and fewer in arable and pastoral areas, possibly due to differences in prey availability. The apparent suitability of habitats did differ between WCP and BOMP Network sites, but this might simply reflect the different geographical distributions of the two sets of sites.

1.11 Sufficient data were collected over the five years of the study to permit analysis of laying dates, clutch sizes and brood sizes, although sample sizes for clutch size were relatively small. None of the productivity parameters displayed any significant trends over the period 2000-2004, nor were they related to the geographical location of the site. Habitat did have a significant effect on brood size, which was highest in rough grassland areas, when the WCP and BOMP Network datasets were combined, but not when they were analysed separately.

1.12 Weather conditions during the breeding season did display some influence on productivity. Clutch sizes were larger on average during wetter springs and there was weak evidence to suggest that brood sizes might also be larger during cold, wet springs. It is possible that rainfall at this time promotes vegetation growth, increasing the availability of food for small mammals. Increased prey abundance could positively influence female condition, leading to larger clutch sizes, and might also reduce the probability of brood reduction due to starvation.

1.13 Weather conditions during the winter months also had a significant effect on Barn Owl productivity, with females laying later and producing smaller clutches after cold, wet winters. This relationship is as predicted if adverse weather conditions over the winter lead to a loss of body condition due to the increased costs of thermoregulation and a reduction in hunting opportunity or efficiency.

1.14 NRS data for Barn Owl over the period 1980-2002 were also used to calculate laying date, clutch size and brood size. There were no annual trends in any of the parameters derived and neither geographical location nor habitat type was found to influence productivity. Weather conditions during the breeding season did not influence productivity, but brood sizes were negatively related to winter rainfall. Again, this supports the hypothesis that inclement weather over the winter period reduces the body condition of the adults, leaving less energy to invest in their offspring during the following breeding season.

1.15 Occupancy rates of three other species – Stock Dove, Jackdaw and Kestrel – were also analysed with respect to year, geographical location and habitat. Many of the significant relationships identified were in the opposite direction to those identified for Barn Owl, suggesting that there may be a degree of competitive exclusion occurring.

1.16 The increasing value of BOMP to conservationists is shown by the inclusion of its results in the annual and widely disseminated *The State of the UK's Birds 2004* (Eaton *et al*. 2004) that reports the current status and trends of bird populations in the UK, as well as in the annual report of the Rare BreedingBirds Panel, published in the journal British Birds (Ogilvie & RBBP 2003).

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 is poorly monitored by other BTO surveys, such as the Breeding Bird Survey, as it is mostly active at night, is largely non-vocal and occurs at low densities. To overcome these problems, BOMP methodology involves participants visiting known nest sites annually to ascertain whether Barn Owls are using the site each year and to collect data about the productivity of any breeding attempts observed. Each year the data are collated at the BTO and analysed, with the aim of producing annual trends in occupancy rates and a range of 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*. 2004) and in the reports of the Rare Breeding Birds Panel (e.g. Ogilvie & RBBP 2003). This report presents an analysis of the first five years of BOMP data (2000-2004).

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 make it more noticeable than other owls and many 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 is relatively widely known and appreciated.

Throughout the 18th and early 19th centuries, it 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, supported 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 1968–72, the population was estimated to number between 4,500 and 9,000 pairs (Sharrock 1976), but these figures are based on only partly quantified observations.

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, and 4,400 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 mean 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. Because the confidence interval around the Project Barn Owl figure

included the previous Hawk Trust estimate and as the methodologies were not identical, it was not clear whether any further decline had occurred between these two surveys. It is important to note that such surveys need to be carried out over a 3-4 year period: the difficulty of assessing trends between annual surveys has been emphasised by the finding that, in southwest Scotland, numbers of breeding pairs of Barn Owls 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 ample 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). 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. More recently, it has been included on the Amber List of Birds of Conservation Concern (Gregory *et al*. 2002) 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 a number of local Biodiversity Action Plans under Local Agenda 21 of the International Convention on Biodiversity.

Much conservation work has focused on the Barn Owl in recent years, stimulated in many cases by the work of the Hawk and Owl Trust, Barn Owl Trust and other specialist groups in fostering more widespread recognition of the species' conservation importance. Attention has been directed towards the creation and management of areas of suitable hunting habitat, increasing the availability of prey, providing habitat corridors to promote dispersal, coupled with the provision of nest boxes in areas where a shortage of nest and roost sites could 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 and mortality due to collisions with road traffic (Bourquin 1983, Shawyer 1985, 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 1985, 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 the list, in 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. This is particularly important given the species' 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. Furthermore, concerns about the use of newer types

of rodenticide 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 change.

2.3 Potential impacts of weather conditions and climate change

The effects of weather, in particular climatic extremes, on Barn Owl survival and productivity has been reported previously (Shawyer 1987). Strong winds, heavy rain and snow are likely to impede hunting directly by reducing visibility and manoeuvrability and indirectly, by reducing the activity levels of rodent prey. Such inclement conditions can also lead to increased thermoregulatory costs and declines in prey species abundance. The increased costs associated with such conditions may either result in lower rates of adult survival or may lead to a reduction in adult body condition causing a reduced investment in reproduction or, in extreme cases, the suspension of breeding. Weather conditions may also influence vegetation growth that may, in turn, have implications for the abundance and/or the visibility of small mammal species.

The UKCIP02 report (Hulme *et al*. 2002) predicts that temperatures in the UK will rise by an average of 2.0-3.5°C by 2080, with temperatures in summer and autumn likely to increase more than those in winter and spring. Very hot spells in summer are likely to become more frequent and very cold winters less so. Mean annual rainfall is predicted to decrease by up to 15% by 2080, although there may be large regional differences, with the southeast becoming generally drier than the northwest. Rainfall is likely to decrease during the summer months, but increase during the winter, with intense periods of winter rain becoming more frequent. Under a High Emissions scenario, rainfall in the southeast is predicted to fall by up to 50% in the summer, but increase by up to 30% in the winter. Winter snowfall will become a rare event, possibly decreasing by up to 90% by 2080.

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 species. BOMP's overall aim and strategy are:

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

The key activities of BOMP are as follows:

- *To establish a set of Barn Owl sites, which provide a broadly representative coverage of the British Barn Owl population, for annual monitoring.*
- *To assess changes in numbers attempting to breed, using the rates of site occupancy.*
- *To monitor breeding productivity of Barn Owls, using standardised nest recording.*
- *To monitor survival rates and dispersal of Barn Owls, through the ringing of both young birds and adults.*

- *To examine breeding performance and site occupancy in relation to environmental variables, in particular the type of 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 is undertaken by a combination of professionals and volunteers. The Wildlife Conservation Partnership (WCP) undertakes fieldwork to monitor a set of '*core sites*' in England and undertakes methodological development. BOMP coverage was greatly swelled in 2002 by opening the scheme to volunteers and developing 'BOMP Network' sites. Even if unable to contribute formally to BOMP, fieldworkers have been encouraged to submit extra records to the national Barn Owl databases held by BTO's Nest Record and Ringing Schemes.

The programme for BOMP has developed steadily since it started in 2000 and can be summarised as follows:

2000 breeding season: Funding for the programme was confirmed in June, when fieldwork by WCP began. At this time, most nests already contained small young. This reduced the opportunities to catch adult birds (especially males) for ringing, which is best undertaken during the period of egg laying and incubation. WCP defined a core set of sites for annual monitoring, piloted recording methods and gathered preliminary data at 159 sites.

2001 breeding season: A letter outlining the objectives of the Barn Owl Monitoring Programme was sent to more than 200 active Barn Owl ringers and nest recorders in early March 2001. Development of the BOMP network continued, and a few volunteers piloted recording methods. Foot and Mouth Disease (FMD) caused a major problem from late February onwards. Volunteers were unable to gain full access to many sites, and 20% of the WCP core sites could not be visited, although data were still collected by WCP at 170 sites. Since access restrictions in some areas persisted until the end of the year, plans for recording late broods in October could not be implemented.

2002 breeding season: A total of 559 sites were monitored in 2002, 197 by WCP and 362 by BOMP Network participants. Occupancy rates and productivity were analysed in relation to year, Government Office Region, and habitat type. Factors governing the amount of food stored in prey larders and the occupancy rates of other species were also investigated.

2003 breeding season: A total of 591 sites were monitored in 2003, 200 by WCP and 391 by BOMP Network participants. Occupancy rates and productivity were analysed in relation to year, Northing, Easting, habitat type, temperature and rainfall. The report also included an analysis of the impact of the 2001 Foot and Mouth Disease outbreak on the UK Barn owl population.

2004 breeding season: A total of 531 sites were monitored in 2004, 198 by WCP and 333 by BOMP Network participants. Occupancy rates and productivity were analysed in relation to year, Northing, Easting, habitat type, temperature and rainfall. The report also included an analysis of the influence of temperature and rainfall on NRS data collected between 1980 and 2002.

Throughout the project, opportunities have been taken to publicise BOMP, to recruit more volunteers, to provide feedback, and to raise public awareness about the population status of the Barn Owl. We produce an annual newsletter that acts as a forum for the exchange of ideas and information between volunteers, in addition to providing feedback. The BTO works with other organisations concerned with the conservation of Barn Owls, thereby ensuring that the monitoring results provide effective guidance for conservation action.

This report presents a summary of results obtained during the first four seasons of BOMP. Annual reports for 2000 (Crick *et al*. 2001), 2001 (Beaven *et al.* 2002), 2002 (Leech *et al*. 2003) and 2003 (**Leech *et al*. 2005**) are also available.

3. METHODS

3.1 Overall strategy of BOMP

Barn Owl biology and behaviour means that the species is most easily surveyed by the monitoring of potential nest sites during the breeding season (Bunn *et al*. 1982, Shawyer *et al*. 1987, Bibby *et al*. 1992). Absolute numbers of Barn Owls are difficult to assess (Toms *et al*. 2001) and so the rates of site occupancy are a useful guide to overall population levels of breeding Barn Owls. Nest visits allow the recording of information concerning productivity and also provide good opportunities to trap and ring adult and young birds, thereby 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 WCP. Additional studies carried out at WCP sites aid the methodological development of the overall scheme. Many BOMP sites are within central strongholds of the Barn Owl's range, and therefore in the areas that are most important to the species' viability, while others are in more peripheral areas, where the amplitude of population changes is likely to be greater.

It should be noted that nest site occupancy provides a minimum estimate of Barn Owl abundance in a specified area, as 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. However, given the species' high degree of site faithfulness (Taylor 1991), it is reasonable to assume that significant changes or trends in site occupancy provide useful information about the species' status and population trends.

BOMP's collection of detailed information concerning breeding performance and survival can be complemented by 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). Percival (1990) found from Nest Record Scheme data that nests visited only during the late chick stage did not fledge significantly more chicks than others that had also been visited earlier in the breeding period. 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 only visited at the 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 will not compromise the welfare of Barn Owls, nor the integrity of the data gathered, provided that they are 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 the field experience of WCP. The guidelines appeared as an Appendix in a previous annual report (Beaven *et al*. 2002).

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 barn conversions, the shifting location of bale-stacks and waterlogging of natural sites, and because accurate recording of eggs and young is often difficult 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 throughout the UK, almost all of the sites that have been registered are nest boxes. The widespread distribution of boxes 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 their occupation indicates the benefit that conservation measures have had for the species. Although some individuals who erect nestboxes generally inspect them too, BOMP provides a framework for collating such observations, ensuring that the data are recorded to a recognised standard and 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 by them 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) in trees, 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, with the characteristics of pole-boxes but mounted on trees. WCP also monitors supplementary ('extra') sites that are included in the programme in most years.

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.

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), potentially reducing parasite loads in the box. However, to counter these positive effects, nest boxes may be more obvious to competing species or predators and may provide less shelter from the elements in some circumstances.

3.3 Fieldwork methods

Monitoring at BOMP Network sites is carried out at two levels of commitment, described to potential contributors as Option 1 and Option 2. Full details of these are given in the Guidance Notes (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 surrounding site*: The habitat surrounding the site is recorded using the standard BTO habitat codes (Crick 1992), which incorporate 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 about 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 and wing 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, to provide an indication of food availability.
- *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, or its pin, and consulting one of two separate (pin and feather) growth curves (Shawyer 1998). A further growth curve for the 11 days following hatching is also being developed using the length of the relaxed wing chord (Shawyer *in prep*).
- *Sexing of young*: The degree of speckling on the underside of the body and wings can be used to estimate 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 also being assessed.
- *Measurement of dead chicks (length of 7th primary)*: primary feather 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 fewer than 100 adults are ringed each year, and 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, 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 and also involves 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 and pers. comm.).
- 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.
- The presence of moulted wing feathers from the female between late April and mid July may be an effective indicator that a second brood will not be attempted; this, too, is being investigated.
- 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 *in prep*.)

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, but these curves need to be validated for use, as part of BOMP, to make sure that a curve specific to Barn Owls is available.

3.4 Data collation

WCP data are recorded on standard paper forms developed during the first year of BOMP (Appendix 2). During the 2002 and 2003 breeding seasons, BOMP Network data were recorded on an equivalent form on which all the information for Option 1 and Option 2 could be entered (Appendix 3). Prior to the 2004 breeding season, a number of changes were made to the BOMP Network recording system (for new form design see Appendix 4):

3.4.1 Incorporation of BOMP sites into the NRS

Whilst the nature of the data collected by BOMP participants and volunteers recording Barn Owls for the NRS is almost identical, the information was being submitted in two slightly different formats and loaded into two distinct databases. Furthermore, some recorders were submitting the same data to both schemes, making any attempt to combine the datasets time consuming and increasing the potential for replication of data.

To ensure that BOMP and NRS productivity data for Barn Owl could be pooled easily each year, it was decided that BOMP data relating to nest contents should be submitted on Nest Record Cards or electronically via Integrated Population Monitoring Reporter (IPMR) and loaded into the NRS Oracle database each years along with any standard nest records submitted (see Appendix 5 for example of a Nest Record Card and a NRS Coding Card). Each BOMP participant was therefore registered as a nest recorder and supplied with a NRS Starter Pack (see www.bto.org/survey/nest_records/index.htm

for more details). The BOMP Site Code was recorded on each record together with a letter indicating the number of the brood (A = first brood, B = second brood, etc.). This 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 technique is that it allows BOMP records to be checked easily for inconsistencies using the standard programs 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).

3.4.2 Changes to the BOMP Network recording form

While the habitat recording, habitat features, site details, prey items, pellet and feather moult sections remained unchanged on the redesigned BOMP Network forms, a number of changes were made to the other sections:

- Removal of habitat maps. The habitat map on the front of the form significantly increased the production time when sites were registered initially and was becoming the limiting factor controlling the number of new sites that could be registered each season. Extracting information from the map is also a very time-consuming and expensive procedure. As much of the information (habitat, adjacent sites) that could be culled from these maps was already recorded elsewhere on the form, the decision was made not to add them to forms for newly registered sites in future.
- Site use tick box. The original form design did not allow participants to record the occupancy status of the site specifically and relied on handwritten notes that could be both difficult to interpret and time consuming to input. A tick box was therefore added to the form which enables observers to differentiate between sites at which Barn Owls were roosting and those in which they were breeding, sites that were not used, sites that were usable but not occupied, sites that were unusable because of damage to boxes or to the presence of other species and sites that were not visited.
- Number of nesting attempts. A tick box was added to allow observers to record explicitly (if known) the number of breeding attempts that had occurred at each site.
- Proximity of other potential nest sites. Space was provided in which to record the number of alternative nesting sites within 500m (thereby summarising information that was previously given on the site map) and to record the number of these that were checked for Barn Owl occupancy. This change was intended to allow differentiation between sites at which Barn Owls had truly vacated and those at which they had simply moved to a nearby site to breed but had continued to occupy the territory. Analysis of these data led to some sites previously registered separately being treated as 'paired' sites in future analyses.
- Other species present. Tick boxes were provided to allow observers to record explicitly the presence of other species at the nest site and to differentiate between breeding and roosting birds. Previously, any information about additional species was obtained from handwritten notes in the section of the form designed to record Barn Owl nest contents, which could be very difficult to interpret.
- Nest contents. The section of the form relating to nest contents was removed as all the information is now submitted through IPMR or via Nest Record Cards. The submission method used is also recorded on the form.

As in previous years, the data were input into two separate MS Access databases, one containing WCP data and the other containing BOMP Network data.

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'.

Barn Owls may start to lay a repeat clutch before the first brood has 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 was the potential for simultaneous breeding.

During the 2004 season, for the first time, BOMP Network participants were able to record the identity of registered sites that were located within 500m of each other. If these sites had not been occupied simultaneously by breeding Barn Owls at any point over the three study years (2002-2004) then they were treated as paired sites for the purpose of all 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 this analysis the midpoints between earliest and latest possible FEDs were used provided they were known 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 falls outside the 10-day cut-off point, resulting in greatly reduced sample sizes for the analyses. However, additional measurements of chicks at WCP sites permit laying dates to be estimated 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 32 days.

3.5.3 Clutch and brood size

The key factor to ascertain in determining clutch size is whether egg laying has finished or not. Thus records were omitted from these analyses if nests were only visited once, if they were 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 young (Crick *et al*. 2003). Clutch sizes of a single egg were also excluded from the analysis as this sample is likely to include clutch sizes estimated at '1+' where eggs were present but no count was made. 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 both the BOMP and the NRS datasets.

3.5.4 Nesting success

The simplest measure of nesting success is to calculate the proportion of monitored nests that successfully fledged at least one offspring. However, such estimates of nest success are subject to biases caused by early egg losses (Snow 1955) and the problems of categorising nests not followed to fledging (Mayfield 1961, see Crick *et al.* 2003 for summary).

To overcome these problems, Mayfield (1961, 1975) suggested a method for estimating nest success that was based on the calculation of the daily survival or failure rates of nests. The method allows the inclusion of all nests, so long as they have been visited at least twice. Nest survival rates are based on the 'nest-day' as the unit of exposure of nests to mortality factors. Ten nest-days can represent one nest observed twice, 10 days apart, or 10 nests observed twice each, on two successive days. To calculate a daily nest failure rate, the number of nests that fail during the period of observation are summed and divided by the total number of nest-days over which observations were made. Further details of the methodology and a summary of the assumptions can be found in Crick *et al.* (2003). This methodology was used to calculate failure rates for both BOMP and NRS data.

3.5.5 Data for repeat broods

As 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 1st August were removed from the dataset prior to analysis.

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. Records from the NRS dataset were also assigned to the habitat categories listed in Table 3.6.1 on the basis of the primary habitat code noted by the recorder.

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	PAST
E3	Farmland	MIXED
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. Where one or more habitat types were equally prevalent (N=10), that which was most likely to influence Barn Owl breeding success was selected as the primary habitat. 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 representative of that from which the BOMP data are derived. Mean monthly values for these variables were obtained from the Hadley Centre for Climate Prediction and Research (www.metoffice.com/research/hadleycentre/obsdata/index.html) for the years 2000-2004 (BOMP data) and for the years 1980-2002 (NRS data).

For the analyses of occupancy rates, 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 breeding behaviour 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 1990-2003 (N=190) 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.

The influence of temperature and precipitation over the winter period were analysed separately due to the relatively high degree of correlation between these two weather variables over the five study years (R^2=0.91, P=0.012). The influence of temperature and rainfall during the breeding season were also analyses separately as, although the two variables were not strongly correlated over the five-year period as a whole (Mar-Jun, R^2=0.21, P=0.437; May-Aug, R^2=0.28, P=0.360), there was evidence of strong correlation within the first four years of the survey (Leech *et al*. 2005).

3.8 Statistical models

All analyses were performed in SAS v8.02. As the datasets used in the analyses of occupancy rates, laying dates as calculated from chick feather development (WCP sites only), clutch sizes and brood sizes at BOMP sites 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. Due to the relative paucity of data, repeat values for a small number of sites only (N=2) were present in the dataset used for the analysis of laying date at BOMP sites as calculated by the standard NRS programs (all sites). These repeat values were therefore removed from the dataset and a standard GENMOD procedure was subsequently used for analysis.

Whilst the NRS dataset does undoubtedly contain data for the same sites in different years, such replication is more difficult to detect, 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.

For all analyses of occupancy rates and failure rates, a binomial error distribution was assumed and a logit link function was specified. For all analyses of laying date information, a normal distribution was assumed and an identity link function was specified. For all analyses of clutch and brood size data, a Poisson error distribution was assumed and a log link function was specified. In all models, Northing, Easting, year and primary habitat type were included as independent variables.

4. RESULTS

4.1 BOMP coverage

The number of both core and supplementary sites monitored by WCP has remained approximately constant since the 2002 breeding season, but the number of sites covered by BOMP Network participants is more variable (Table 4.1.1).

	2000	2001	2002	2003	2004
WCP sites	159	170	197	200	198
BOMP Network sites	-	-	362	391	333
TOTAL	159	170	559	591	531

Table 4.1.1 Total number of BOMP sites surveyed annually 2000-2004

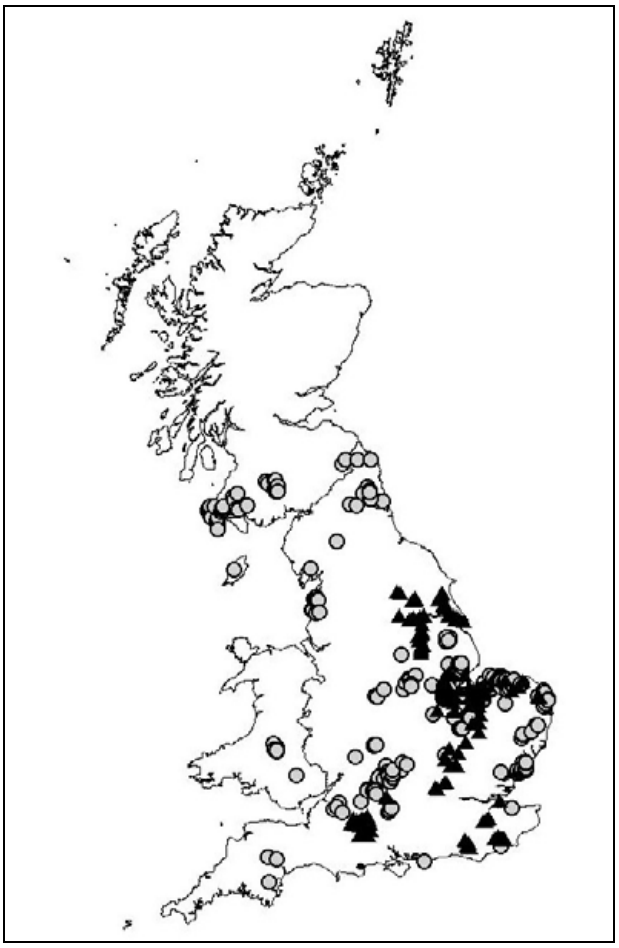

Figure 4.1.1 Distribution of WCP (black triangle) and BOMP Network (grey circle) sites monitored in 2004.

While coverage is still very good, with over 500 sites being monitored annually, the total number of BOMP sites for which we received data in 2004 fell by 60 in 2004 as a result of a number of

participants leaving the scheme. However, several new participants have already contacted the BTO to express interest in monitoring sites during the 2006 breeding season and we intend to continue actively recruiting new volunteers over the coming winter.

The totals for Network sites are slightly lower than those published in previous reports. The new form design allowed participants to record the identity of any other registered BOMP sites within 500m of each nest site. If two sites were within 500m and had never been occupied simultaneously then they were re-classified as a single site, in line with the treatment of paired WCP sites, thus reducing the annual totals in previous years by around 25-30 sites.

Figure 4.1.1 shows the distribution of BOMP sites monitored in 2004. As in previous years, coverage was generally good in the South, East and North of England, but poorer in western England. Coverage in Scotland was good in the southwestern lowlands, but poor elsewhere and very few BOMP sites were monitored in Wales even though Barn Owls breed throughout much of the country (Gibbons *et al*., 1993).

4.2 Barn Owl occupancy rates

The influence of location, year and habitat on Barn Owl nest site occupancy was investigated for the dataset as a whole and for WCP and BOMP Network sites separately (Table 4.2.1). In total, over the five study years, Barn Owls were present in 1531 of the 1980 sites visited (77.3%) and were found to be breeding in 1233 (63.3%). The effect of site type is not significant (Table 4.2.1), indicating that Barn Owls are no more likely to be present at sites monitored by WCP than at BOMP Network sites.

	DF	X^2	P
All sites (N=1677)			
Northing	1	5.31	0.021
Easting	1	12.27	<0.001
Year	1	32.00	<0.001
Primary habitat	3	1.67	0.645
Site type (WCP/Network)	1	2.67	0.102
WCP sites (N=872)			
Northing	1	5.60	0.018
Easting	1	4.47	0.035
Year	1	28.82	<0.001
Primary habitat	3	7.85	0.049
BOMP Network (N=805)			
Northing	1	0.55	0.460
Easting	1	3.64	0.056
Year	1	6.36	0.012
Primary habitat	2	3.39	0.184

Table 4.2.1 Influence of location, year and habitat on the presence of Barn Owl, whether breeding or non-breeding.

Year had a significant effect on presence at both WCP and BOMP Network sites (Table 4.2.1), the probability of Barn Owl being present having decreased over the survey period (2000-2004 for WCP sites, 2002-2004 for BOMP Network sites). Analysis of WCP data indicated an increased probability of presence in northern and western sites. No such relationship was identified within the BOMP

Network dataset, which covers a wider geographical area (Figure 4.1.1), although there was a non-significant trend towards an increased probability of Barn Owl presence in the west of the country. Habitat type was not found to influence the likelihood of Barn Owl being present at BOMP Network sites but a weakly significant relationship between habitat and presence was identified within the WCP dataset. Further analysis indicated that the probability of Barn Owl being present was highest in areas of rough grassland and lowest in the more intensively managed pastoral habitats.

	DF	X^2	P
All sites (N=1677)			
Northing	1	1.53	0.217
Easting	1	10.89	0.001
Year	1	36.46	<0.001
Primary habitat	3	2.50	0.475
Site type (WCP/Network)	1	5.20	0.023
WCP sites (N=872)			
Northing	1	1.77	0.184
Easting	1	8.11	0.004
Year	1	28.44	<0.001
Primary habitat	3	7.23	0.065
BOMP Network (N=805)			
Northing	1	1.11	0.292
Easting	1	0.77	0.380
Year	1	9.94	0.002
Primary habitat	2	5.28	0.072

Table 4.2.2 Influence of location, year and habitat on the presence of breeding Barn Owl

The probability of Barn Owl breeding at a given site did differ significantly between WCP and BOMP Network sites, with breeding more likely to occur at the latter (Table 4.2.2). Breeding occupancy has declined over time at both WCP and BOMP Network sites. However, the pattern of decline in presence and that in breeding occupancy was noticeably different (Figure 4.2.1), resulting in marked inter-annual variation in the proportion of sites containing non-breeding individuals, particularly at WCP sites (df = 4, X^2=23.30, P<0.001). Such variation was less apparent, but still significant, at BOMP Network sites (Figure 4.2.2, df = 2, X^2=10.39, P=0.006). Regional variation was restricted to a westerly bias in the likelihood of breeding at WCP sites towards the west of England (Table 4.2.2). No significant effect of habitat type was identified within either category of site, although there was a non-significant tendency for Barn Owl to breed at a greater proportion of WCP sites in rough grassland at a greater proportion of BOMP Network sites in pastoral areas.

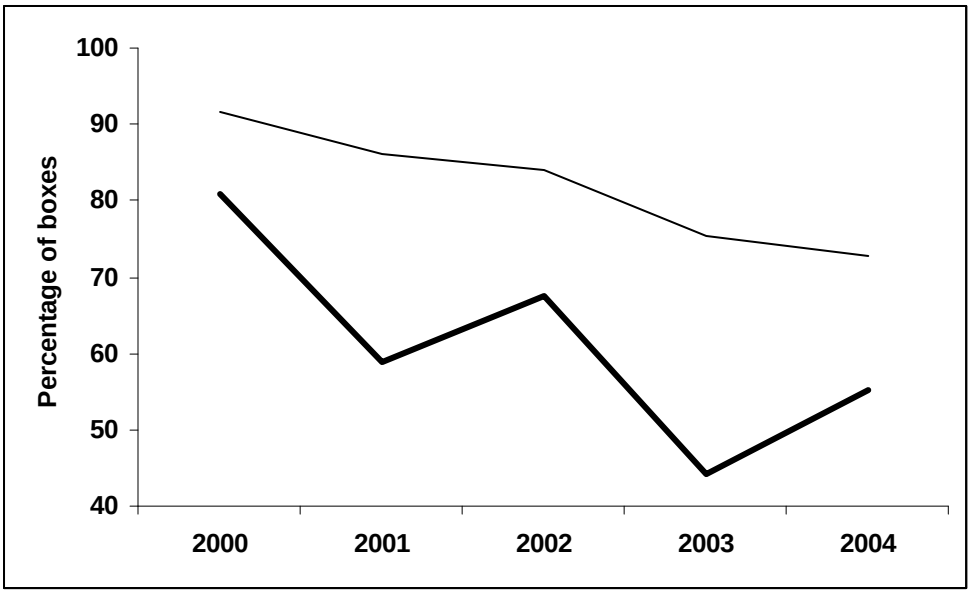

Figure 4.2.1 Annual variation in percentage of WCP sites at which Barn Owls present (thin line) and in which Barn Owls breeding (thick line)

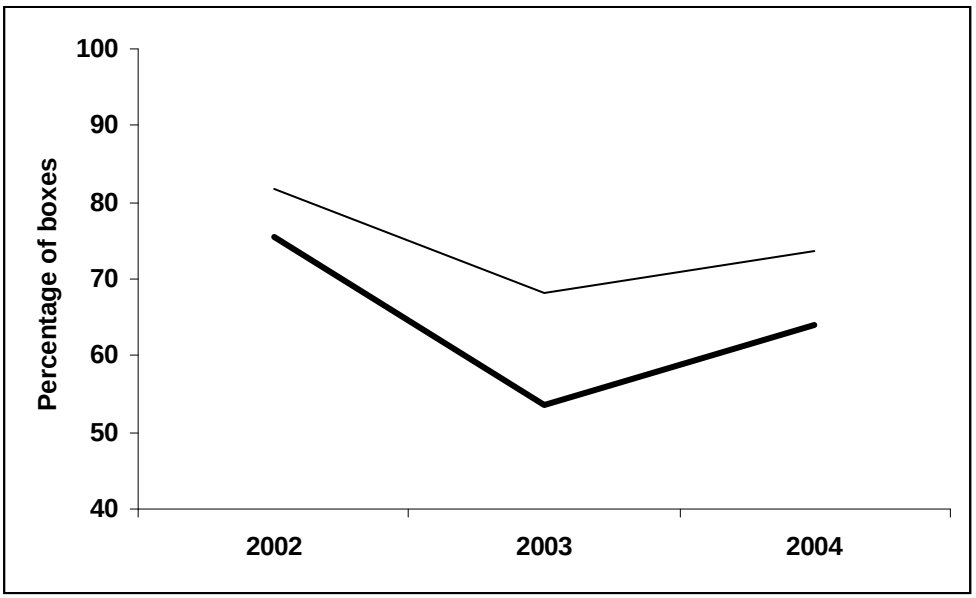

Figure 4.2.2 Annual variation in percentage of BOMP Network sites at which Barn Owls present (thin line) and in which Barn Owls breeding (thick line)

The longer run of data available for WCP sites enabled further analysis of occupancy rates with respect to winter weather conditions (Table 4.2.3). It will be possible to carry out a comparable analysis for he BOMP Network dataset in future years. No evidence was found to suggest that the probability of Barn Owls being present at a WCP site was related either to mean temperature or to rainfall during the preceding winter. However, the likelihood of a site being occupied by a breeding Barn Owl was significantly related to both temperature and precipitation, with breeding occupancy rates lower following wet, cold winters. The proportion of non-breeding birds occupying boxes was therefore lower after warm, dry winters.

	DF	X^2	P
Presence of Barn Owls			
Temperature (CET)	1	0.45	0.503
Precipitation (EWP)	1	0.93	0.335
Breeding occupancy			
Temperature	1	12.16	<0.001
Precipitation	1	18.01	<0.001
Non-breeding occupancy			
Temperature	1	12.36	<0.001
Precipitation	1	16.71	<0.001

Table 4.2.3 Influence of weather conditions on box occupancy at WCP sites (N=872).

4.3 Barn Owl productivity

Due to the paucity of visits to BOMP sites during the laying and incubation periods, the number of breeding attempts for which the date of laying of the first egg could be calculated with sufficient accuracy to be retained in the statistical models was relatively low. It is therefore perhaps unsurprising that laying dates calculated in this manner displayed no significant annual or regional variation, nor did they vary significantly between habitat types (Table 4.3.1).

	DF	X^2	P
All sites (N=46)			
Northing	1	0.08	0.780
Easting	1	0.25	0.616
Year	1	0.02	0.900
Primary habitat	3	3.03	0.387
Site type (WCP/Network)	1	0.19	0.660
WCP sites (N=17)			
Northing	1	1.06	0.303
Easting	1	0.27	0.606
Year	1	0.02	0.880
Primary habitat	3	4.71	0.194
BOMP Network (N=29)			
Northing	1	0.32	0.572
Easting	1	0.05	0.829
Year	1	0.33	0.566
Primary habitat	2	1.82	0.402

Table 4.3.1 Influence of location, year and habitat on laying date as estimated by standard Nest Records Unit programs.

At WCP sites, laying dates were also calculated based on nestling age as estimated by the stage of feather development, a technique developed by Colin Shawyer (see Section 4.3). However, while this

methodology vastly increases the sample size, there was still no evidence that laying dates at WCP sites varied significantly between years, between regions or between habitat types (Table 4.3.2).

	DF	X^2	P
First egg date (N=297)			
Northing	1	0.01	0.912
Easting	1	2.69	0.101
Year	1	0.01	0.933
Primary habitat	3	3.19	0.363

Table 4.3.2 Influence of location, year and habitat on laying date as calculated by Colin Shawyer.

The number of sites at which accurate clutch sizes could be calculated was also relatively small due to the relatively low pre-hatching visit rate. There was no evidence that clutch size varies annually, regionally or between habitat types at either WCP or BOMP Network sites (Table 4.3.3).

	DF	X^2	P
All sites (N=110)			
Northing	1	0.19	0.660
Easting	1	0.78	0.378
Year	1	0.65	0.420
Primary habitat	3	5.46	0.141
Site type (WCP/Network)	1	3.29	0.070
WCP sites (N=23)			
Northing	1	2.71	0.100
Easting	1	1.05	0.305
Year	1	4.65	0.310
Primary habitat	3	5.59	0.133
BOMP Network (N=87)			
Northing	1	0.27	0.600
Easting	1	0.90	0.344
Year	1	0.24	0.621
Primary habitat	2	0.64	0.727

Table 4.3.3 Influence of location, year and habitat on clutch size.

Brood sizes could be ascertained for a far greater number of sites. Data form BOMP Network sites indicated that brood sizes had become progressively smaller over the period 2002-2004 (Table 4.3.4), although no temporal trend was identified at WCP sites, for which a longer run of data are available (2000-2004). Whilst brood sizes in the combined dataset did vary significantly between habitats, with the greatest number of nestlings produced per pair at sites located in areas of rough grassland, this effect did not persist when the data from WCP and BOMP Network sites are analysed separately (Table 4.3.4).

	DF	X^2	P
All sites (N=791)			
Northing	1	1.32	0.251
Easting	1	0.00	0.978
Year	1	1.74	0.187
Primary habitat	3	8.72	0.033
Site type (WCP/Network)	1	0.00	0.971
WCP sites (N=329)			
Northing	1	0.60	0.437
Easting	1	0.77	0.380
Year	1	0.18	0.671
Primary habitat	3	5.35	0.148
BOMP Network (N=462)			
Northing	1	0.92	0.337
Easting	1	0.07	0.799
Year	**1**	**6.31**	**0.012**
Primary habitat	2	5.23	0.156

Table 4.3.4 Influence of location, year and habitat on brood size.

The relationship between productivity and weather conditions during the breeding season was investigated using both the combined dataset (Table 4.3.5) and the WCP data in isolation (Table 4.3.6). Neither laying date nor brood size displayed any significant relationship with temperature or rainfall during the breeding season, although a non-significant trend towards larger brood sizes during colder, wetter springs was identifiable. Clutch size did display a positive relationship with rainfall, however, indicating that clutch sizes were significantly larger during years where the mean precipitation during the laying period was greater (Tables 4.3.5 & 4.3.6).

	DF	X^2	P
First egg date (N=46)			
Temperature (CET)	1	1.75	0.186
Precipitation (EWP)	1	1.89	0.170
Clutch size (N=110)			
Temperature	1	1.55	0.214
Precipitation	1	4.05	0.044
Brood size (N=791)			
Temperature	1	3.42	0.064
Precipitation	1	2.72	0.099

Table 4.3.5 Influence of weather conditions during the breeding season on productivity (all sites).

	DF	X^2	P
First egg date (N=17)			
Temperature (CET)	1	0.61	0.436
Precipitation (EWP)	1	2.01	0.156
CRS first egg date (N=297)			
Temperature	1	0.44	0.506
Precipitation	1	1.49	0.223
Clutch size (N=23)			
Temperature	1	0.00	0.963
Precipitation	1	4.30	0.038
Brood size (N=329)			
Temperature	1	0.34	0.559
Precipitation	1	0.28	0.598

Table 4.3.6 Influence of weather conditions during the breeding season on productivity (WCP sites only).

Using the combined and WCP datasets, the influence of weather conditions during the preceding winter were also investigated (Tables 4.3.7 & 4.12). Whilst there was no apparent influence of weather conditions on laying date as calculated by standard Nest Record Scheme programs, those calculated for WCP sites using Colin Shawyer's method demonstrated a significant positive relationship with precipitation and a significant negative relationship with temperature (Table 4.3.8). This result indicates that, on average, clutches were initiated later following cold, wet winters. When the WCP data were analysed in isolation, a significant negative relationship between precipitation and clutch size was identified, indicating that the mean number of eggs laid per clutch was smaller in breeding seasons following wetter winters (Table 4.3.8). No relationship between brood size and any aspect of winter weather was identified.

	DF	X^2	P
First egg date (N=46)			
Temperature (CET)	1	0.07	0.789
Precipitation (EWP)	1	0.08	0.782
Clutch size (N=110)			
Temperature	1	2.36	0.124
Precipitation	1	3.27	0.071
Brood size (N=791)			
Temperature	1	0.74	0.391
Precipitation	1	2.37	0.124

Table 4.3.7 Influence of weather conditions during the preceding winter on productivity (all sites).

	DF	X^2	P
First egg date (N=17)			
Temperature (CET)	1	0.04	0.842
Precipitation (EWP)	1	0.30	0.584
CRS first egg date (N=297)			
Temperature	1	3.91	0.048
Precipitation	1	5.59	0.018
Clutch size (N=23)			
Temperature	1	3.50	0.061
Precipitation	1	4.78	0.029
Brood size (N=329)			
Temperature	1	0.65	0.419
Precipitation	1	0.79	0.376

Table 4.3.8 Influence of weather conditions during the preceding winter on productivity (WCP sites only).

4.4 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*) (Table 4.4.1).

	2000 N=156	2001 N=158	2002 N=187	2003 N=190	2004 WCP N=190	2004 Network N=300
Stock Dove	5.13%	18.99%	21.39%	25.79%	16.84%	10.67%
Jackdaw	5.77%	9.49%	23.53%	26.32%	22.63%	10.00%
Kestrel	7.41%	10.13%	17.11%	12.11%	15.26%	7.00%

Table 4.4.1 Proportion of sites occupied by breeding Stock Dove, Jackdaw and Kestrel at WCP sites (2000-2004) and BOMP Network sites (2004).

Data concerning the presence and reproductive status of additional species have been collected at WCP sites since 2000, allowing the investigation of annual trends in breeding occupancy rates. Breeding occupancy rates of Stock Dove, Jackdaw and Kestrel have all increased significantly since the start of the Programme (Table 4.4.2). All three species exhibited significant regional variation, with the likelihood of a site containing breeding Stock Dove or Jackdaw increasing towards the north and the east of England and the probability of breeding Kestrel being present increasing towards the south and east of England (Table 4.4.2). Habitat type has no influence on the occupancy rates of Stock Dove or Kestrel, but breeding Jackdaw are most frequently found in pastoral areas and least likely to be found in areas of rough grassland (Table 4.4.2).

	DF	X^2	P
Stock Dove			
Northing	1	6.63	0.010
Easting	1	10.25	0.001
Year	1	11.43	0.001
Primary habitat	3	0.37	0.947
Jackdaw			
Northing	1	10.76	0.001
Easting	1	7.97	0.005
Year	1	26.24	<0.001
Primary habitat	3	12.12	0.007
Kestrel			
Northing	1	4.43	0.035
Easting	1	21.34	<0.001
Year	1	15.13	<0.001
Primary habitat	3	0.40	0.941

Table 4.4.2 Influence of location, year and habitat on the presence of breeding Stock Dove, Jackdaw and Kestrel at WCP sites (2000-2004, N=879).

Whilst many BOMP Network participants recorded the presence of these species at sites during 2002 and 2003, systematic recording only commenced in 2004. Analyses presented in Table 4.4.3 are therefore currently restricted to a single year and should be interpreted with caution. Breeding occupancy rates of Stock Dove and Kestrel are higher towards the south of Britain but no such regional variation was identified for Jackdaw. Habitat type was significant only for Jackdaw, which is most likely to be found breeding at sites in pastoral areas.

	DF	X^2	P
Stock Dove			
Northing	1	12.88	<0.001
Easting	1	0.51	0.477
Primary habitat	3	0.02	0.992
Jackdaw			
Northing	1	0.17	0.679
Easting	1	1.92	0.166
Primary habitat	3	6.17	0.046
Kestrel			
Northing	1	11.67	<0.001
Easting	1	0.00	0.948
Primary habitat	3	0.52	0.773

Table 4.4.3 Influence of location, year and habitat on the presence of breeding Stock Dove, Jackdaw and Kestrel at BOMP Network sites (2004, N=235).

4.5 Analysis of NRS data

Factors influencing Barn Owl productivity were also investigated using the Nest Record Scheme (NRS) dataset for the years 1980-2002. As with the BOMP dataset, three aspects of productivity were calculated - laying date, clutch size and brood size. None of these parameters displayed any significant annual or regional variation, nor did they vary significantly between habitats (Table 4.5.1).

	DF	X^2	P
First egg date (N=98)			
Northing	1	0.01	0.917
Easting	1	1.16	0.281
Year	1	0.32	0.571
Primary habitat	4	2.70	0.609
Clutch size (N=264)			
Northing	1	2.32	0.128
Easting	1	0.08	0.773
Year	1	0.00	0.953
Primary habitat	4	1.48	0.830
Brood size (N=1398)			
Northing	1	0.00	0.962
Easting	1	2.10	0.147
Year	1	0.91	0.341
Primary habitat	4	6.13	0.190

Table 4.5.1 Influence of location, year and habitat on first egg date, clutch size brood size as calculated from NRS data 1980-2002.

Similarly, no relationship was identified between any or the reproductive parameters calculated and the weather conditions during the breeding season (Table 4.5.2). However, whilst neither temperature nor rainfall during the preceding winter had a significant influence on laying date or clutch size, winter rainfall negatively influenced brood size, indicating that the mean number of chicks per nest was lower during breeding seasons following wetter winters (Table 4.5.3).

	DF	X^2	P
First egg date (N=98)			
Temperature (CET)	1	1.38	0.241
Precipitation (EWP)	1	1.85	0.174
Clutch size (N=264)			
Temperature	1	0.40	0.526
Precipitation	1	0.01	0.942
Brood size (N=1398)			
Temperature	1	0.53	0.466
Precipitation	1	1.42	0.233

Table 4.5.2 Influence of weather conditions during the breeding season on first egg date, clutch size brood size as calculated from NRS data 1980-2002.

	DF	X^2	P
First egg date (N=98)			
Temperature (CET)	1	1.18	0.278
Precipitation (EWP)	1	2.45	0.118
Clutch size (N=264)			
Temperature	1	0.00	0.953
Precipitation	1	0.02	0.888
Brood size (N=1398)			
Temperature	1	1.99	0.159
Precipitation	1	10.94	0.014

Table 4.5.3 Influence of weather conditions during the preceding winter on first egg date, clutch size brood size as calculated from NRS data 1980-2002.

5. DISCUSSION

It is clear that BOMP has successfully established a protocol for data collection that enables trends in population size and in breeding statistics to be calculated and is already providing valuable data for the conservation of the species. BOMP's value is shown by the inclusion of its results in the annual and widely disseminated document *The State of the UK's Birds* 2003 (Eaton *et al*. 2004) that reports the current status and trends of bird populations in the UK, as well as in the annual report of the Rare Breeding Birds Panel, published in the journal *British Birds* (Ogilvie & RBBP 2003). 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.* 14% of the national population of Barn Owl 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). While the non-random nature of the sample may influence the resulting trends to some degree, there is every reason to expect that BOMP would detect a major real change in population and would provide information about the demographic mechanisms and environmental factors underlying any change, thus providing valuable pointers to direct effective conservation efforts.

5.1 Occupancy rates

The proportion of sites at which Barn Owl is recorded as breeding has continued to decline significantly both at WCP sites over the last five years (2000-2004) and at BOMP Network sites over the last three (2002-2004), although the proportion of sites at which Barn Owl was present, either breeding or merely roosting, has declined only in the former. Such declines in occupancy over time could be an artefact of the non-random selection of monitoring sites. If BOMP participants were more likely to select sites at which Barn Owl was known to be present or breeding in previous years, then initial occupancy rates may be have been artificially inflated and a subsequent decrease might be predicted until a more natural level is reached.

Occupancy rates of breeding Barn Owl in any given year were found to be significantly higher at BOMP Network sites in any given year. However, in 2002, three years after monitoring commenced at WCP sites, 66.33% of them were occupied by breeding Barn Owl, a similar figure to that at BOMP Network sites in 2004 (63.35%), three years after monitoring had commenced at these sites. It is therefore possible that this difference in occupancy is primarily due to the time lag between the start of monitoring at the two sets of sites.

However, while overall presence has declined in a linear manner, breeding occupancy has oscillated annually at WCP sites, being relatively high in 2000, 2002 and 2004 and relatively low in 2001 and 2003 (Figure 4.2.1). This relationship is less apparent, but still present, at BOMP Network sites (Figure 4.2.2). These analyses suggest that additional factors may be influencing inter-annual variation in the probability of birds actually breeding at a site. The causes of such variation may become more apparent as the time series increases.

Weather conditions may have an effect on both Barn Owl abundance and the proportion of pairs that are in sufficient condition to breed (Hardy *et al*. 1981, Shawyer 1987), with cold, wet weather during the winter reducing the availability of small mammal prey (Hornfeldt 1994) and the ability of Barn Owl to hunt successfully. Analysis of temperature and precipitation data for the UK indicated that this was indeed the case, with the proportion of WCP sites occupied by breeding pairs significantly reduced following inclement winters. It is not currently possible to analyse the BOMP Network data in this way because the run of years available is too short. Interestingly, this decrease in breeding occupancy was not due to a decline in presence of birds at nest sites, but rather to a reduction in the proportion of owls at occupied sites that were electing to breed. Low temperatures and high rainfall since 2000 have not necessarily led to decreased survival, but instead may have caused an increased proportion of the population to suspend breeding due to poor body condition. However, it should be

noted that the UK has not experienced a really severe winter, which can lead to increased Barn Owl mortality (Shawyer 1987), since 1986.

At least two other studies since those of Shawyer, including one in Scotland (Taylor 1992) and one in Utah (Marti 1994) have identified a negative relationship between the number of breeding pairs of Barn Owl and the weather conditions over the previous winter, although in both cases the weather parameter used was snow cover and the mechanism suggested by Marti was actually increased adult mortality rather than suspension of breeding. 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.

Both overall presence and breeding occupancy also vary geographically. Barn Owl was both present and bred at a higher proportion of WCP sites in the north and west of England. There was also an increased tendency for Barn Owl to be present at BOMP Network sites in the west of the UK, but this relationship was not significant. These results may be the result of lower densities of nestboxes in these regions or the lower availability of other nest sites (Toms *et al.* 2000), or alternatively they may also be a reflection of differences in climate and habitat quality. The westerly-biased occupancy rates of this species may be a response to milder winter weather, in particular higher temperatures, in the west of the country due to the proximity of the Gulf Stream, which may influence survival rates and/or body condition as discussed above.

Analysis of WCP data also indicated that owls were present at a higher proportion of northern sites, although no such trend was identified within the BOMP Network dataset. The underlying causes of this relationship are not immediately obvious, but may relate to agricultural land use. Farming in the north of the UK is generally less intensive than that in the south and it is possible that the availability of prey may be greater as a result. Although BOMP participants are asked to record details of the habitat immediately surrounding the nest site in some detail, it is possible that this may not give an accurate representation of the area utilised by hunting birds, particularly if they tend to concentrate on linear grassland margins or hunt further from the nest site. Further analyses of BOMP data using habitat information collected on a coarser scale, such as CS2000 Land Cover data (Haines-Young *et al.* 2000), may help to identify the cause of the observed relationship more precisely.

The type of habitat surrounding the nest site did explain some of the variance in occupancy rates. Barn Owl was significantly more likely to be present at WCP sites in areas of natural grassland and lowest in pastoral areas. There was weak evidence to suggest that the probability of sites containing breeding Barn Owl displayed a similar relationship. Such a relationship might be predicted if less intensively managed natural grassland can support a higher density of prey species on which Barn Owl can feed, the closely cropped sward of grazing land providing less cover and less food for small mammals (Fuller & Gough 1999). However, at BOMP Network sites there was a non-significant tendency for the proportion of sites at which Barn Owl bred to be high in pastoral areas relative to areas of rough grassland. The apparent difference in the direction of these relationships may reflect variation in the relative distribution of BOMP Network and WCP sites nationally. Again, further analysis of the data using CS2000 Land Cover data may help to clarify the observed relationships.

5.2 Productivity

None of the three measures of productivity – laying date, clutch size and brood size – collected by BOMP participants displayed any significant relationship with Northing, Easting, year or habitat type within either the WCP or the BOMP Network dataset. Productivity did show some relationship with weather conditions during the breeding season, however. Clutch sizes were significantly higher on average during wetter springs, and there was weak evidence to suggest that colder, wetter weather during the breeding season was also positively correlated with brood size. These results are in the opposite direction to those predicted should inclement weather impose greater energetic costs on either the chicks or the parents investing in them. However, wet weather during spring may promote vegetation growth, which may in turn provide more food for small mammals, leading to an increase in

rodent abundance and therefore in food availability. Females may therefore be in better condition and able to produce a larger clutch and parents may be able to support a larger brood.

Weather conditions during the preceding winter also influenced productivity, most notably at WCP sites where mean laying dates were later and mean clutch sizes were smaller following cold, wet winters. Such a relationship is predicted if adults are more energetically stressed during inclement weather, due either to the increased costs of thermoregulation or to a decreased ability to hunt. Females may therefore take longer to reach breeding condition the following spring, resulting in delayed laying. This hypothesis was supported by the unusually low weights of some adult female Barn Owls captured by WCP at BOMP sites during April 2003, all of which failed to breed during that particular season. If some individuals attempt to breed despite being in relatively poor condition, a decrease in clutch size would also be predicted. This type of life history trade-off between survival and investment in reproduction might be expected for a relatively large bird species that is likely to survive for a number of breeding seasons. Analysis of NRS data also supports the hypothesis that winter weather can impact on productivity during the following breeding season as mean brood sizes were found to be smaller following wetter winters. Adults in poorer condition may be able to invest less energy in provisioning their offspring, leading to brood reduction.

Several other studies have identified correlation between winter weather conditions and productivity, including one previous analysis of NRS data (Percival 1990), which identified a negative influence of snow cover, temperature and rainfall on clutch size and nestling survival. However, neither de Bruijn (1994) nor Marti (1994) identified any relationship between snow cover and productivity within their study populations.

5.3 Barn Owl breeding success and climate change

The UK Climate Impacts Programme (UKCIP) was set up by DEFRA in 1997 to co-ordinate research into the repercussions of climate change at a national level. The UKCIP02 report (Hulme *et al*. 2002) 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. Whilst the he UKCIP02 report predicts that temperatures in the UK will rise by an average of 2.0-3.5°C by 2080, with temperatures in summer and autumn likely to increase by more than those in winter and spring, rainfall is likely to decrease during the summer months, but increase during the winter, with intense periods of winter rain becoming more frequent. The results of these analyses suggest that increasing winter precipitation may have a pronounced effect on Barn Owl productivity, with a reduction in the proportion of pairs breeding, delays in laying and a reduction in average clutch and brood sizes, which may in turn have a negative impact on the size of the Barn Owl population in the UK. If we are correct in our assumption that the size of small mammal populations is positively correlated to rainfall bat the start of the breeding season, the warmer, drier springs predicted may further reduce food availability and therefore productivity.

5.4 Occupancy rates of other species

Analyses of the breeding occupancy rates of the additional species for which data were analysed – Stock Dove, Jackdaw and Kestrel – at WCP sites identified significant increases in the probability of all three breeding at BOMP sites has increased during the study period. This result could reflect the increasing population sizes of all three species over the last five years as detected by the Breeding Bird Survey (Baillie *et al*. 2005). Alternatively it may suggest that the declines in Barn Owl occupancy allowed the other species to utilise a greater proportion of sites. Although anecdotal evidence suggests that Barn Owl and other bird species may breed simultaneously in the same site, the presence of Barn Owl may generally reduce the probability of other species using a site. Although the same relationship would be observed were competitive exclusion acting in the opposite direction, it is difficult to see how any of these species, and Stock Dove in particular, could out-compete an owl for a site. Jackdaw nests may prevent owls gaining entry to some sites, but any sites at which this was recorded were removed from the analysis of Barn Owl occupancy rates.

All three species were also more prevalent at sites in the east of England. While this might reflect a real bias in the distribution of the population, atlas data (Gibbons *et al*., 1993) suggest that this might be true only in the case of Kestrel, and that Jackdaw is actually more abundant in the west of the country. Again, the competitive exclusion hypothesis offers an alternative explanation, as Barn Owl occupancy is generally higher in the west of the country. The same could be said of the southerly bias in occupancy rates of Kestrel, as Barn Owl occupancy at WCP sites is highest towards the north of England, but this does not explain the northerly bias in Stock Dove and Jackdaw occupancy rates. Atlas data cannot shed any light on this result either, as populations of both species display a southerly bias. One possible causal factor may be the availability of natural nest sites. If there are fewer trees and farm buildings providing nesting cavities in the north of the country, Jackdaw and Stock Dove may be more likely to nest in boxes erected for Barn Owls. Kestrel bred most frequently at sites in pastoral areas. As optimal hunting habitat for Kestrel is probably similar to that of Barn Owl, which was least abundant in pastoral areas, this result may again reflect the possibility of competitive exclusion.

5.5 Recommendations for future analyses

Our analyses of Barn Owl occupancy rates and breeding performance in relation to weather suggest that future climate change may actually be detrimental to the species. While it might have been considered that Barn Owl, being a generally southerly species, would benefit from warmer and drier summers, our analyses suggest that the wetter winters and drier springs expected with climate change may actually be detrimental to the species. It would be useful to take these analyses further and assess in a quantitative manner how Barn Owl breeding performance might change under different scenarios of climate change.

Several of the analyses above, suggest that examination of BOMP data in relation to the CS2000 Land Cover data may help to clarify the underlying causes of the geographical and habitat relationships with occupancy rates identified by this study.

One important parameter influencing overall Barn Owl productivity may be the number of broods produced per season. We are currently developing methods that may allow the estimation of multiple brooding by Barn Owl through observations of female moult and pellet shredding. These may provide valuable indicators of which sites should be followed up later in the season, as it is currently impractical to revisit all WCP core sites to assess the frequency of multiple brooding.

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. As yet, it is too early to assess these parameters. 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.

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.

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 Owl. In future years it would be worth considering whether the scheme could be extended to cover these species, in particular the amber-listed Kestrel.

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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

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?

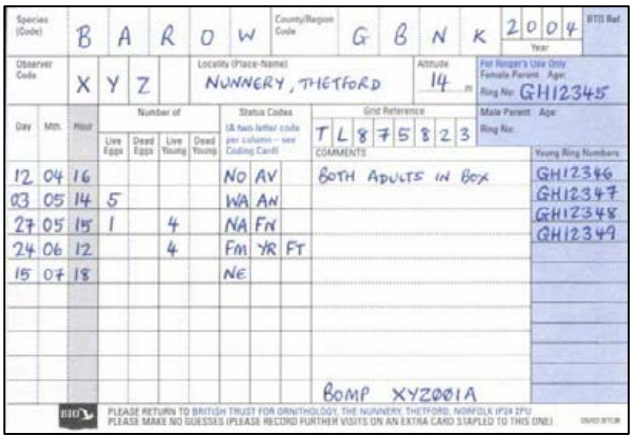
- It is not necessary to submit cards or an IPMR record if there has NOT been a nesting attempt at this BOMP site during the year.
- However please remember to tick the 'SITE NOT USED' box on the front of the BOMP form.
- 'Nil returns' ('Site Not Used') are as important as 'Site Used' ones (needed to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



- 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.

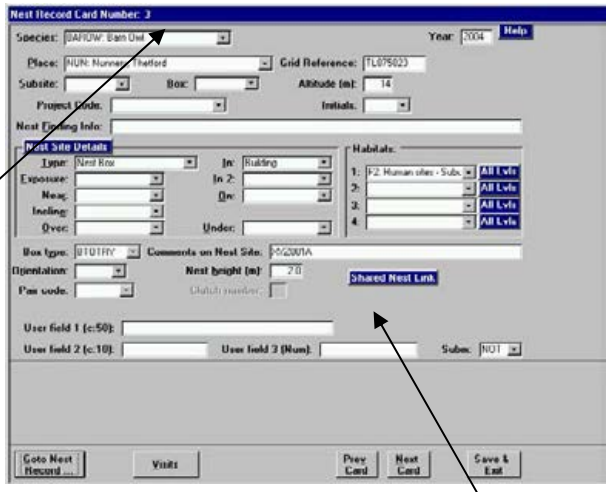
(2) IPMR (INTEGRATED POPULATION MONITORING REPORTER)

Box on back of each BOMP form:

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

IPMR submission file number:

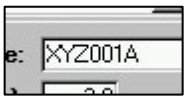
Record number(s) within this file:



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.**

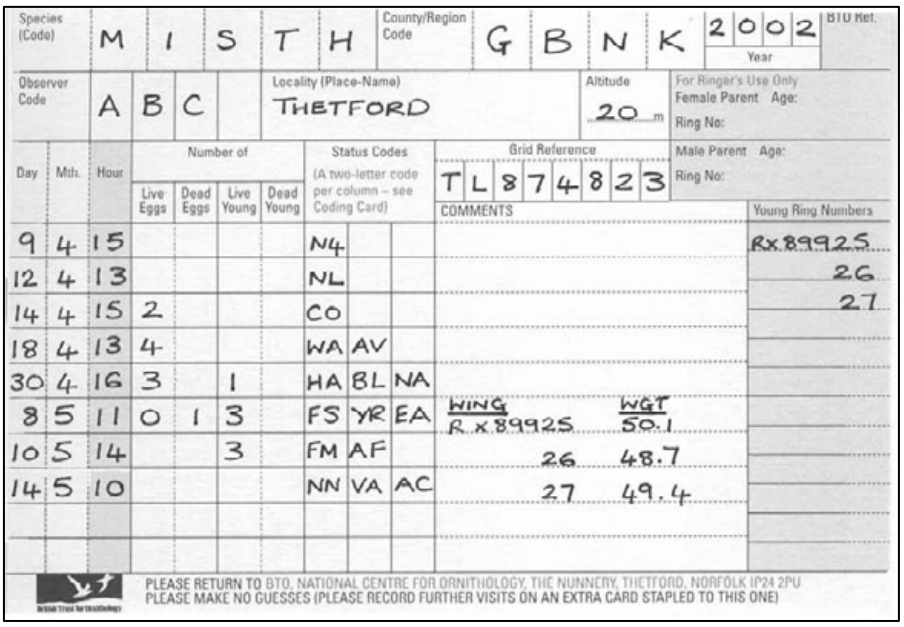
Barn Owl Monitoring Programme Coordinator
BTO
The Nunnery
THETFORD
Norfolk IP24 2PU
Tel: 01842 750050 Email: barnowls@bto.org

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					NY				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	

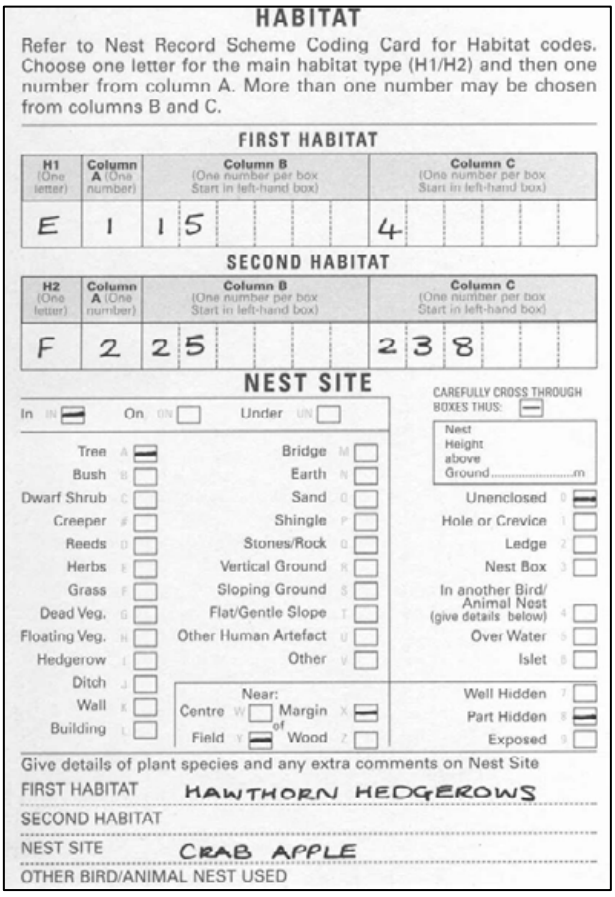
PLEASE RETURN TO BTO, NATIONAL CENTRE FOR ORNITHOLOGY, THE NUNNERY, THETFORD, NORFOLK IP24 2PU
PLEASE MAKE NO GUESSES (PLEASE RECORD FURTHER VISITS ON AN EXTRA CARD STAPLED TO THIS ONE)

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 IN ☐ On ON ☐ Under UN ☐

CAREFULLY CROSS THROUGH BOXES THUS: ☒

Tree A ☐ Bush B ☐ Dwarf Shrub C ☐ Creeper D ☐ Reeds E ☐ Herbs F ☐ Grass G ☐ Dead Veg. H ☐ Floating Veg. I ☐ Hedgerow J ☐ Ditch K ☐ Wall L ☐ Building M ☐

Bridge M ☐ Earth N ☐ Sand O ☐ Shingle P ☐ Stones/Rock Q ☐ Vertical Ground R ☐ Sloping Ground S ☐ Flat/Gentle Slope T ☐ Other Human Artefact U ☐ Other V ☐

Near: Centre W ☐ Margin X ☒ of Field Y ☒ Wood Z ☐

Nest Height above Ground.....m

Unenclosed 0 ☒ Hole or Crevice 1 ☐ Ledge 2 ☐ Nest Box 3 ☐ In another Bird/Animal Nest (give details below) 4 ☐ Over Water 5 ☐ Islet 6 ☐

Well Hidden 7 ☐ Part Hidden 8 ☒ Exposed 9 ☐

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

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

Region 5 SOUTHWEST | Visit No 2 | Date 20/7 | Hrs
Site Name | Box No/s. * * | CRS 252
Grid Ref | Box Type A

WILDLIFE CONSERVATION PARTNERSHIP

Nest Contents

Species	1st Roost	2nd Roost	Repeat Roost	1st Clutch	2nd Clutch	Repeat Clutch	1st Brood	2nd Brood	Repeat Brood	Position
Barn Owl	216									Top/Bottom/NA
										Top/Bottom/NA
										Top/Bottom/NA

Moulted feathers No | Yes | W | T | B | few many

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

Egg shells No | Yes | Number
Whole pellets No | Yes | Number | Shredded

Prey

	No	Yes	Number	Weight
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.				

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	
Fine spots	Med.spots	Large spots	Diamonds	Freckles	(tick)
No collar	Pale collar	Med. collar	Dark collar		(tick)

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	
Fine spots	Med.spots	Large spots	Diamonds	Freckles	(tick)
No collar	Pale collar	Med. collar	Dark collar		(tick)

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 grass micro-feature/s				crop types	
main	6	Margin: field track lane road rail	Bank: river canal stream ditch			wheat barley brassica beet potatoe bulb	
subsidiary	1 1 3	boundary size/grass structure	Width m: 1-3 4-8 9+	Grass: short . short+tussock . long+tussock+thatch		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 Field Y ☐ Wood	X ☐ Z ☐	Part Hidden	8 ☐
				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		2nd letter	
A	= Adult	D	= Dead
M	= Male	F	= Feeding young at nest
F	= Female	I	= Identified by colour mark, at nest
P	= Pair	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		2nd letter	
E	= At egg stage	A	= Eggs not hatched, infertile, or addled
J	= At young stage	B	= Injured/broken
X	= At egg or young stage	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	1	Mixed-aged or semi-natural	1	Dense shrub layer
		2	Coniferous	2	Coppice with standards	2	Moderate shrub layer
		3	Mixed broadleaved & coniferous (at least 10% of each)	3	Coppice no standards	3	Sparse shrub layer
		4	Broadleaved water-logged	4	Mature plantation (taller than 10m, with closed canopy)	4	Dense field layer
		5	Coniferous water-logged	5	Young plantation (5-10m, open canopy)	5	Moderate field layer
		6	Mixed broad-leaved and coniferous water-logged	6	Parkland (scattered trees and grassy areas)	6	Sparse field layer
				7	High-medium disturbance from people	7	Grazed (moderate to heavy)
				8	Low disturbance	8	Lightly grazed
						9	Dead wood present
						10	Dead wood absent

Appendix 5 (continued)

	COLUMN A	COLUMN B	COLUMN C
RUBLAND very ng wood- 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			