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Effect of barn conversions on local populations of Barn Owl *Tyto alba*

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In southwest England most Barn Owls nest and roost in old barns and the practice of converting these into dwellings is well known. Sites containing Barn Owls which were due for conversion were selected to determine the effect of such developments on local distribution and status. Twenty study areas of 1.5 km radius were studied for an average of 40 months. Within each study area every potential roosting or nesting site was searched every four months. The occupation of sites by Barn Owls, habitat quality and rodenticide use were recorded. Within some study areas the central (occupied) site remained unchanged. Within others it was lost through conversion or demolition. The loss of a single occupied site was shown to have a marked effect upon the resident birds which generally abandoned not only the lost site but also other nearby sites. It is concluded that the loss of one occupied site can have a disproportionally large negative effect even in areas where numerous alternative sites exist.

There is little doubt that Barn Owl populations have suffered a severe decline in Britain. The evidence for this is, however, largely anecdotal.[1] In Britain and elsewhere in Europe the experience of farmers and ornithologists points to a prolonged and large-scale decline between the 1930s and the 1980s.[1–4] In 1932 the first Barn Owl survey estimated the total population in England and Wales at 12 142 pairs.[5] Slightly more than 50 years later (1983–85), a similar survey estimated the total population at 3778 pairs,[6] a decline of 69%. However, Percival[7] suggested that: 'there is no satisfactory quantitative information available to identify how large the decline has been and whether it is still continuing'.

The Barn Owl Trust, based in Devon, has received numerous anecdotal reports of cases where Barn Owls have apparently disappeared following the conversion of old barns. The practice of barn conversion is well established in Devon (E. Howick, unpubl. data) and over 90% of known Barn Owl sites in the county are in buildings not trees.[6,8] The effect on the Barn Owl population might be reduced by providing alternative sites but the willingness of Barn Owls to move to an alternative site within their home range has not been investigated. Barn Owls are sedentary and once established at a site are highly faithful to it.[9] Few records of movement in established adult birds exist and are considered abnormal.[10] In southwest Scotland, nest site fidelity was 99.3% in males and 95.1% in females.[1] Out of eight birds colour-ringed as adults in east Devon and subsequently recaptured, only one had moved to a new site.[11]

The majority of buildings used by Barn Owls for nesting and roosting are agricultural rather than domestic[6,8] and most are traditional stone or cob barns rather than modern.[1,8] However traditional farm buildings, especially barns, are being lost at a significant rate through decay and demolition as well as through conversion.[12] Modern farm buildings are now more numerous than traditional types but do not generally provide suitable cavities for Barn Owls.[1,12] Trees with suitable hollows for roosting and nesting are also disappearing as a result of field enlargement, Dutch elm disease and old

age.[1,3,13] However, quantitative information on the rate of loss of roosting and nesting sites and its impact on Barn Owl populations is lacking.[1]

Nest boxes are commonly erected for Barn Owls. Where these are placed in areas of suitable habitat but with few potential nesting sites, the effect can be to increase significantly the number of nesting pairs.[1,14] Conversely, erecting boxes in an area where habitat is poor but ample sites are available may have little or no beneficial effect. This study aimed to determine the effect of the loss (through conversion) of occupied barn sites on local Barn Owl distribution and status.

METHODS

Study areas

To assess the impact of the loss of sites (formerly occupied by Barn Owls) on local Barn Owl distribution and status it is necessary to anticipate the dates when sites will be lost. This may allow time for population monitoring prior to site loss. Thus, buildings occupied by Barn Owls which were known to be due for conversion or demolition were selected for study. During 1985–90, information on occupied Barn Owl sites in Devon and, to a lesser extent, Cornwall, was collected via media appeals and general enquiries received by the Barn Owl Trust. Out of approximately 100 occupied breeding and roosting sites reported to the Trust, 20 were due for conversion (or other site loss) in 1991 or 1992.

Each of the 20 sites became the centre of a circular study area of 1.5 km radius, this being the distance within which the great majority of nesting and roosting activity takes place.[1,15] Within each area an exhaustive search was undertaken of every structure, tree cavity or natural crevice with an access hole greater than 70 mm × 70 mm. Potential sites searched included traditional and modern farm buildings, bale stacks, domestic buildings, churches, ruins, live and dead trees, tree stumps etc. Four study areas were in Cornwall, the remaining 16 in Devon (Fig. 1). Good evidence that Barn Owls had used the central sites prior to the study period was not available. However, a combination of anecdotal information from local people, the accumulation of old pellet

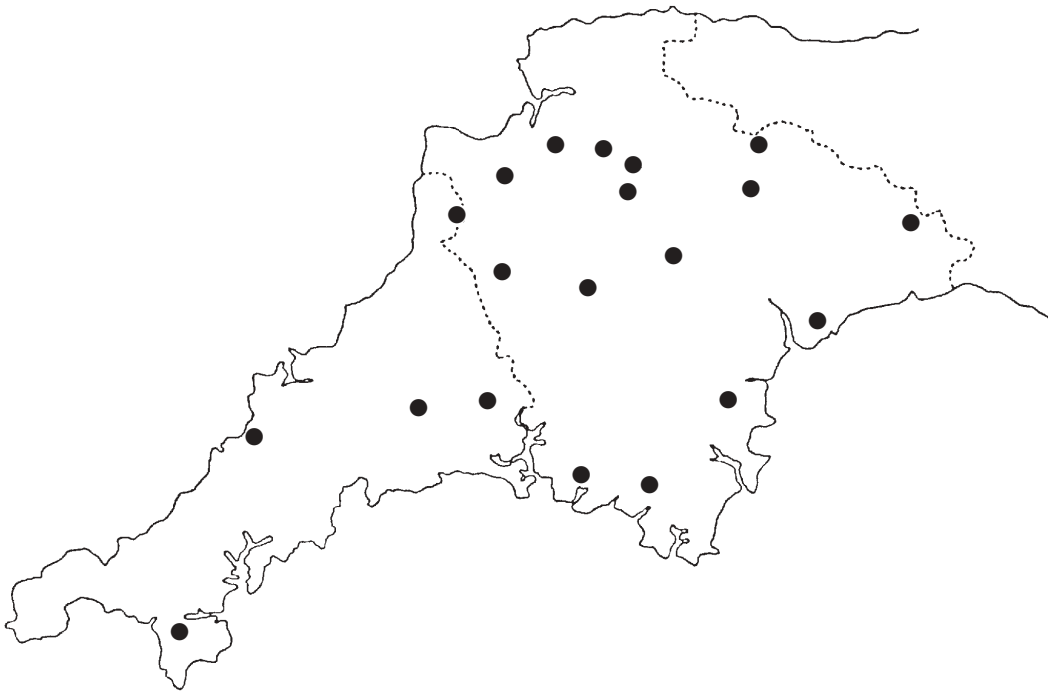

Figure 1. The location of study areas in Devon and Cornwall.

debris and, in some cases, British Trust for Ornithology ringing data, suggested that all sites had been used by Barn Owls in previous years, including several years immediately prior to the start of the study in April 1990.

Period covered

Fieldwork commenced on 1 April 1990 and was concluded on 20 December 1993 (with the exception of one study area which was searched for the last time in April 1994). The first search of each study area was conducted during April 1990 to August 1991 and each area was subsequently searched at four-monthly intervals. Familiarity with the drying and decomposition rates of pellets enabled an assessment of site occupation for the four-month period prior to the first survey. Over the three years and eight months of the research, the majority of study areas were searched ten or 11 times; the minimum number of searches was eight.

Recording of potential roosting/breeding sites and site occupation

Barn Owl pellets and feathers are distinctive and searching for them is a very effective way of locating occupied sites.[3,9] The discovery of eggs or nestlings is the only reliable evidence of breeding.[9] Searches for monitoring the distribution and status of Barn Owls within each study area were carried out every four months. This frequency will have ensured that no site occupation was missed. This is because Barn Owls with a mean egg-laying interval of 2.5 days (range 2–7),[1] mean clutch size of 5.8[16] (range 2–12[1]), mean incubation period of 31 days[1] (range 27–34[17]) and mean fledging age of 62.5 days,[1] will occupy their nest site for a mean duration of 108 days (3.5 months) and an absolute minimum of 87 days. In addition, fledged young are in the habit of returning to the nest.[3] Recently used nests show downy feathers and have a distinctive smell, and abandoned eggs may remain for many months (personal observations).

Birds can breed in any month of the year[17] and some pairs may lay second clutches.[1] Tyson and Madge[18] have reported several cases of double broods and one case of triple brooding within a 12-month period in the county of Devon. Because of this, each study area had to be searched throughout the year.

Where Barn Owl feathers and pellets were located, all were removed except at potential nest-places. Thus, on subsequent searches, any pellets or feathers found were presumed to indicate occupation during the previous four months. In the case of potential nest-places no pellets were removed (owing to the species' habit of laying eggs on pellet debris); however, the signs were either described in detail in field notes or photographed. In order to age pellets found in the field, a reference collection of pellets was established for comparison. Thus fresh (wet) wild Barn Owl pellets were stored in the open in a dry outbuilding. The natural drying and decay of these pellets was monitored and pellets found in the study areas were compared with these to help determine their age. Evidence of occupation by other owl species was recorded.

Most potential Barn Owl sites were in closely spaced groups (i.e. groups of farm buildings). A place containing any number of potential Barn Owl sites is hereafter referred to as a 'location'. Some locations consisted of only one potential Barn Owl site whereas others consisted of a clump of potential sites (separated by less than 100 m).

In each study area the Barn Owl status at all potential locations was scored as follows: 0 = absent, no signs of occupation found; 1 = occasionally used, one or more feathers found, fewer than 10 pellets; 2 = roosting, ten or more pellets found; 3 = breeding, one or more eggs or young seen.

The central location for each study area was given the code letter 'A'. In study areas where location A presented more than one potential roosting or breeding site, each site was referred to as A1, A2 etc. and the Barn Owl use score (0 to 3) recorded for each separately in order to record any changes in the occupancy of individual sites within the central location. All other locations within each study area were referred to simply by reference letter (such as B) and one Barn Owl use score was recorded for that location as a whole.

It is possible that Barn Owls might desert an area for reasons completely unrelated to nest-site or roost-site loss. In particular, the loss of prey-rich habitat may result in reduced productivity and increased mortality.[1] The

use of rodenticides on farms has also been identified as a cause of Barn Owl mortality through secondary poisoning.[6,19] Therefore, these factors were quantified within each of the 20 study areas.

Habitat recording

During the first search of each study area, according to a classification system based on Taylor,[1] all habitats were mapped (scale 1:12 500) within 1 km radius of the central site, this being the distance within which the great majority of hunting activity takes place, particularly during the breeding season.[1,15] The classification was as follows: unsuitable = open water, built-up areas, mature woodland without clearings, bare rock; poor = intensively managed grassland, bare soil, cereals, other annually cultivated crops; average = hay field, rough grazing; good = rough grassland.

Hedgerows and double hedgerows (lanes) were also mapped. At the end of the study period each study area was remapped in an identical manner, such that there were ultimately 40 maps. The area covered by each habitat class within the 1 km radius was determined from these habitat maps.

Recording of rodenticide usage

Within each 1.5 km radius study area, details of rodenticide use on each farm or small holding were recorded for each of the following periods: first survey to June 1991 (including a period before any site change); July 1991 to June 1992; July 1992 to last survey (including a period after any site change).

Rodenticide use was separated into categories as follows: (a) no rodenticide used; (b) no data; (c) first generation (Warfarin, Diphacinone, Coumatetryl, Chlorophacinone) or unknown rodenticide used; (d) second generation (Brodifacoum, Bromadialone, Difenacoum and Alphachloralose).

No attempt was made to quantify the amount of bait used, the amount eaten by rodents, the species of rodent and the availability of poisoned rodents as this could not be achieved with any degree of accuracy. However, cases where additional bait was used to clear an unusually heavy infestation of Brown Rats *Rattus norvegicus* were noted. For data analysis 'unknown rodenticide used' was included as first generation as recommended (P. Chanin & I. Newton, pers. comm.).

For the first and last time periods, the total number of locations where first generation or second generation rodenticides were used was calculated, separately, for each study area. Locations where both classes of rodenticide were used simultaneously were counted as second generation.

Index of owl activity

At the end of the 44-month study period an 'index of owl activity' was calculated for each study area by summing the Barn Owl use scores for all locations across the first three visits (the year prior to any site change) and, separately, across the last three visits (the year after site change if indeed there had been any). For this purpose owl activity at the central location (A) was counted in the same way as all other locations were counted (by taking the highest value for any A site at each visit).

Categorization of study areas

Three categories of conversion were recognised: (a) conversion/loss (n = 9), where the building occupied by the birds was converted or demolished, effectively preventing access by Barn Owls; (b) conversion with provision (n = 3), where the building occupied by the birds was converted to a non-agricultural use and an access hole allowing entry, together with a cavity allowing roosting or breeding, was incorporated into the conversion (or another building within 50 m) prior to, or at the time of the conversion; (c) control (n = 8), where the building(s) occupied by the birds remained unchanged.

RESULTS

Comparability of study areas in each category

The mean altitude of the central locations of all study areas within each category was: conversion, 139.5 m (range 60–250); conversion with provision, 101.7 m (range 40–165); control, 119.9 m (range 44–180).

All study areas were situated in farmland

habitats typical of the area: predominantly intensively managed grassland, annually cultivated crops and deciduous woodland. Strips of rough grass associated with coniferous plantations and waterways were absent and, overall, there was very little rough grassland within the study areas (see Table 1). Hedgerows were a common feature in all study areas. A very small amount of hedgerow loss occurred during the study (see Table 2).

All of the study areas afforded numerous locations with potential roosting and breeding sites, most of which were not occupied by Barn Owls during the study period. The average number of potential roosting and/or nesting locations in each study area (not including the central location) was: control, 14.5 (range 13–22); conversion, 12.6 (range 10–19); conversion with provision, 14.3 (range 13–20).

In total, 904 buildings and 26 hollow trees were systematically searched every four months.

The centre of each study area (location A) contained a well-used Barn Owl roosting site. Sixteen of these were also used for breeding. In addition, locations where an occupied Barn Owl site was converted or demolished were not always the breeding site.

Owl activity, habitat and rodenticide use

The entire data set was subject to an analysis of variance (using MINITAB) in order to determine significant factors and possible causes of any significant change in owl activity recorded.

Overall there was no relationship found between the amount of good habitat within study areas and the level of owl activity. Similarly there was no relationship found between changes detected in owl activity and changes in the amount of good habitat. However, considering only those study areas without site loss (n = 11), there was a weak positive correlation (r = 0.383 ns) between changes in owl activity and changes in the amount of good habitat.

First and second generation rodenticides were in use at numerous locations within all study areas (see Table 3). Overall there was no relationship found between the number of locations using rodenticides within a study area and the level of owl activity. Similarly no

Table 1. Habitats available at the start and end of the study period (within 1 km of the central location) within the 20 study areas expressed as the mean percentage of land covered by each habitat class (excluding 'unsuitable').

	Start			*End*		
	Good	*Average*	*Poor*	*Good*	*Average*	*Poor*
Control (n = 8)	5.0	5.7	72.1	5.0	6.1	71.7
Conversion (n = 9)	3.5	9.3	73.6	5.9	7.5	73.0
Conversion with provision (n = 3)	3.5	3.7	85.3	2.0	3.5	87.0

Table 2. Average total hedgerow length at the start of the study (in metres) and average amount of hedgerow loss (within 1 km of the central location) within the 20 study areas.

	Length	*Loss*
Control (n = 8)	28 136	32.9 (0.12%)
Conversion (n = 9)	30 278	57.8 (0.19%)
Conversion with provision (n = 3)	31 204	137.3 (0.44%)

Table 3. Average number of locations within the 20 study areas of 1.5 km radius where first generation and/or second generation rodenticides were used before and after any change to sites. Locations where rodenticide use was recorded as 'unknown rodenticide used' were included as first generation.

	Start		*End*	
	1st	*2nd*	*1st*	*2nd*
Control ($n = 8$)	1.8	5.6	1.5	6.4
Conversion ($n = 9$)	0.4	4.8	0.7	4.9
Conversion with provision ($n = 3$)	1.3	5.7	1.0	5.0

relationship was found between changes in owl activity and changes in the number of locations using rodenticides. In fact, there were no obvious changes in rodenticide use throughout the study period.

The relationships between owl activity and habitat and rodenticides were not significant. The only significant interaction was between owl activity and barn conversion.

Owl activity and conversions

Considering all study areas, there was no significant difference in the levels of owl activity between study area categories at the start of the study period. However, at the end of the study there was a significant difference ($F = 4.00$, $P < 0.05$, $n = 20$). In study areas where barn conversions without provision for Barn Owls occurred, there was a significant difference between owl activity at the start and owl activity at the end of the study ($F = 8.92$, $P < 0.01$, $n = 9$). Whilst activity in control areas decreased slightly, activity decreased markedly in conversion areas where no provision was made. In conversion areas where specific provision for Barn Owls was made ($n = 3$) there was no decrease in owl activity (see Fig. 2).

Indirect or 'knock-on' effect

In study areas where occupied sites were lost, it was apparent that, at the time of site loss (or soon after), other sites became unoccupied. In study areas where occupied Barn Owl sites were lost and no provision for the birds was made, the mean owl activity score recorded before site loss was 16.8 and after site loss 5.3,

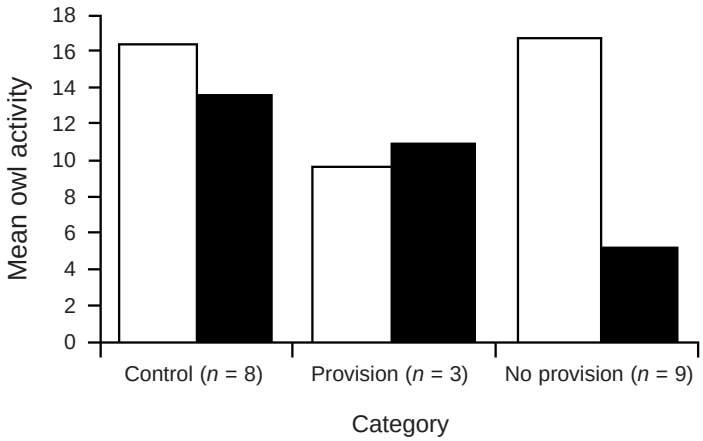

Figure 2. Barn Owl activity in the study areas in the 12-month periods prior to and after barn conversions. ❒, Start; ■ end.

a decline of 68.2%. In the same study areas, but excluding all owl activity at sites which were lost, the mean owl activity scores were as follows: start 13.9, end 5.1, a decline of 63.2% (see Fig. 3). Thus, most of the decline in owl activity found within study areas where sites were lost (n = 9) occurred at sites which remained available. When one occupied site was lost, other sites within 1.5 km were also abandoned. No such effect was found in study areas where specific provision for Barn Owls was made (n = 3) or in areas where no site loss occurred (n = 8).

DISCUSSION

The study areas were all broadly similar in altitude, land use and climate, and all areas afforded numerous alternative potential roosting or breeding sites which were unoccupied by Barn Owls throughout the study period. The number of locations where rodenticides were used and the type of rodenticide used in each study area were also similar.

Within the majority of study areas, Barn Owls were found to use a number of sites in addition to the central location (normally containing a breeding site). Similar results were found in studies by Cayford[15] and Taylor[1], where most breeding pairs used roosting (only) sites in close proximity to their breeding sites.

Effects of site loss

The loss of one occupied Barn Owl site can have a disproportionately large negative effect even in areas where numerous alternative sites exist. When one of a number of sites used by the birds is lost, it might have been expected that the birds would remain in the same area, continue using their other sites and, possibly, begin to use another site (previously unoccupied) as a 'replacement' for the lost site. In fact, in the nine study areas where one occupied site was lost, there was a significant decline in activity. At the time when the birds were 'evicted' from the central study site, other occupied sites were abandoned. This 'knock-on' effect occurred to some extent in seven out of the nine study areas in which the central occupied site was lost. The birds disappeared entirely from five study areas.

If the lost site was the nest site, and if there was something about the site which made it uniquely attractive to the birds, then they may have been forced to abandon the entire (1.5 km radius) area: there was no 'suitable' alternative nest site. However, in the five study areas which were abandoned by the owls, the lost site was a nest site in only two cases. In another two cases, the breeding site was abandoned when a roosting site was lost.

It is unclear as to why this knock-on effect should occur given that Barn Owls are highly

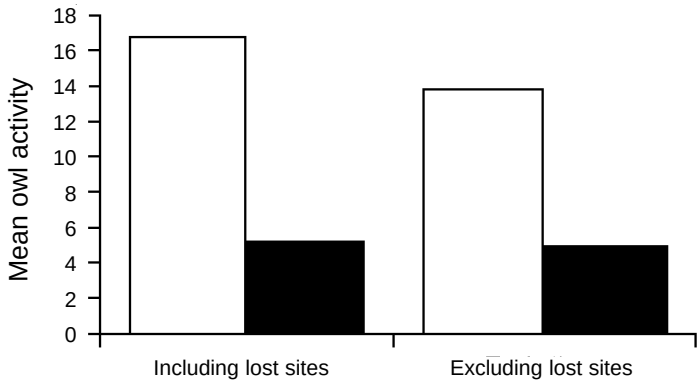

Figure 3. Barn Owl activity within the nine study areas where loss of sites occurred during the study period (1990–94) and no specific provision for Barn Owls was made, including and excluding all owl activity at sites which were lost. ❒, Start; ■ end.

sedentary. Taylor[1] inferred that Barn Owls are able to move to new sites and suggested that, in the long term, the loss of occupied sites can have little overall effect within large study areas, provided that potential alternative sites are available. The study areas within this project were comparatively small and the study period comparatively short. There is no evidence at present to indicate whether the knock-on effect is short- or long-term. However, the nine study areas where the loss of one occupied site occurred were all surveyed for between one and three years after site loss. The level of owl activity did not show any recovery at all in eight of these study areas, while the remaining one showed only a small recovery.

Further research is needed to ascertain why the knock-on effect occurs, its impact on the survival and productivity of the individual birds concerned, and the time period over which the effect can be detected.

Alternative provision

In the three study areas where provision for Barn Owls was incorporated prior to or at the time of conversion, the birds stayed, made use of the provision, and the occupation of other sites within these study areas remained largely unchanged.

The number of study sites with alternative provision was small and this prevented statistically significant conclusions from being drawn. However, it would seem that incorporating suitable provision for Barn Owls in the conversion of occupied sites could be effective in maintaining the presence of resident birds and this is certainly worthy of further study.

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