A test of the use of artificial nest forms in common swift *Apus apus* nest boxes in southern England

Dick Newell

Action for Swifts, Old Beach Farm, 91 Green End, Landbeach, Cambridge, CB25 9FD, UK

SUMMARY

Common swifts *Apus apus* have shown significant declines in the UK over recent decades, and one possible cause is loss of nesting sites. Nest boxes have previously shown to be effective for this species. Here we test whether the addition of an artificial 'nest form' affected the occupancy of nest boxes. Nest boxes that contained a form were 4.6 times more likely to be occupied by common swifts than nest boxes without a form. The design of the form did not appear to affect occupancy rate. Further study is needed to discover whether nest forms increase overall occupancy rates.

BACKGROUND

The BTO/JNCC/RSPB Breeding Bird Survey showed that, between 1995 and 2016 common swifts *Apus apus* declined in the UK by 53% (BTO 2018). According to IUCN criteria, common swifts are categorised as Endangered in Great Britain (Stanbury *et al*. 2017).

Although fewer insects, a rise in predator numbers and losses on migration could all contribute to the decline of swifts, widespread anecdotal evidence indicates that a principal cause is the large-scale loss of nest sites due to building refurbishment, insulation and destruction. These losses could be mitigated by the provision of large numbers of artificial nest sites.

While nest boxes have proved to be effective for swifts, there is little research on the optimum design for this species. Several factors might influence occupancy rates and productivity including size, shape, entrance geometry, interior darkness and placement. Two previous studies have monitored swift nest boxing projects to look for correlations with a number of factors (Wortha *et al*. 2004, Schaub *et al*. 2015), although neither was based upon experiments. Schaub *et al.* (2015) concluded that swifts preferred externally mounted boxes a few metres apart near the roof edge. Wortha *et al.* (2004) found that swifts preferred nest boxes on rough walls to those on smooth walls. Neither study addressed factors inside the nest box, although Wortha *et al.* reported that boxes narrower than 15 cm were rarely accepted, conflicting with extensive experience in the UK.

When swifts are prospecting new nest sites, they will explore a number of opportunities before making a choice. This paper reports on the results of experiments to determine how the provision of an artificial nest form within a nest box affects that choice. Nest forms are structures placed inside nest boxes, intended to be a similar shape to a swift's natural nest, giving the birds a head start when they first occupy a nest box. The earliest reference that we have found to providing a nest form is in David Lack's book, *Swifts in a Tower*, where he placed a small ring of straw in the back of each box (Lack 1956, page 49). There has been no systematic study of their effect on nest box occupancy.

ACTION

We tested the use of nest forms by swifts at four different sites. Three tests were conducted in church belfries. Nest forms were added to nest boxes at two sites in the belfry of St. Mary's church, Ely in Cambridgeshire (OS Grid Reference TL538802): the east side contained 24 swift nest boxes, and the south and west sides contained 56 boxes (Figure 1). Another test was carried out in the belfry of All Saints church, Worlington, Suffolk (TL691738), which contained 18 boxes. In each of these three sites, we placed nest forms in alternate nest boxes. In the fourth site (Oxford Museum of Natural History tower, SP515069), 12 nest forms were scattered among 52 nest boxes (see Table 1). Nest forms were placed in the nest boxes before the breeding season began, and then were checked for occupancy at the end of a subsequent breeding season, one or more years later (Table 1).

Nest forms are sold commercially for breeding budgerigars *Melopsittacus undulatus* as well as common swifts. They can cost up to £10 each. For this experiment we made nest forms out of a range of materials including MDF, plywood and fibre-board at a fraction of the cost (Figure 3). They were fashioned using a lathe or routing tool resulting in an indentation 85 mm in diameter, to match the diameter of a natural swift's nest (own measurements). The depth of the indentation varied from 10 - 20 mm. The shape of the forms is shown in Figure 2a.

Statistical analysis was performed using R version 3.5.2 (R Core Team 2018). The odds ratios are conditional maximum likelihood estimates from the function fisher.test. The Woolf test from package vcd (Meyer *et al*. 2017) was used to perform a test for homogeneity of the odds ratios across sites. The Cochran-Mantel-Haenszel test was then used to test the null hypothesis that there was no association between nest form and occupancy.

In a separate experiment, we explored whether swifts preferred a nest form with a potentially more 'comfortable' concave bottom (Figure 2b) compared to a simple, steep-sided nest form with a flat bottom (Figure 2c). Twenty nest forms with a flat bottom (Figure 2c) and 20 forms with a concave bottom (Figure 2b), all made of fibreboard, were placed in nest boxes in the belfry of St John's church, Bury St Edmunds, Suffolk (TL852646) in 2018.

*To whom correspondence should be addressed: dick.newell@gmail.com

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Figure 1. Fourteen nest boxes in St Mary's church, Ely, UK, showing four boxes with nest forms and one box without a nest form occupied by common swifts. Photograph by Dick Newell.

RESULTS

Across all four sites there was a highly significant association between the presence of nest forms in a nest box and box occupancy (Cochran-Mantel-Haenszel exact test, p = 0.0002) with an overall common odds ratio of 4.6 (Table 1). There was no evidence for heterogeneity of the odds ratios between the four sites ($\chi_3^2 = 0.40$, p = 0.94), suggesting that the birds showed a similar preference for boxes with forms across all the sites.

It is possible that occupancy of boxes without forms could increase over time, as opportunities to nest in unoccupied boxes with a nest form decrease. This would lead to lower odds ratios at sites where the forms have been present for longer.

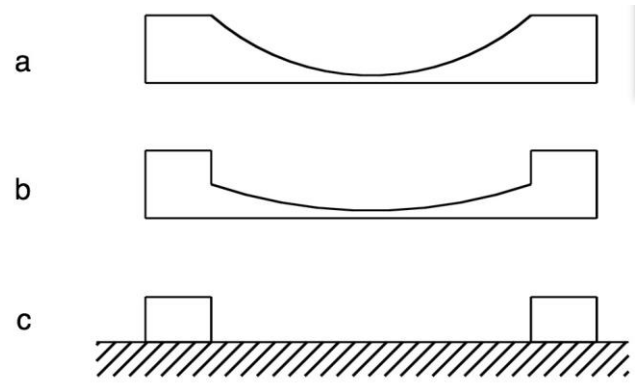

Figure 2. Cross section of three nest form shapes.

However, the result from nest boxes on the south and west sides of the belfry of St Mary's church, Ely, does not support this expectation. Even after seven years, the odds ratio at this site was similar to that in the other three sites.

In a further test, the occupancy of nest forms of two different designs was compared (Figure 2). Of 20 forms of type 2b and 20 forms of type 2c that were installed in a belfry, seven of each type were occupied in the first year, indicating that swifts may not have a preference. This result suggests that nest forms with a flat bottom, which are easier to manufacture with a hole saw or jigsaw, should be good enough. A larger experiment would be needed to confirm this preliminary result.

DISCUSSION

Although swifts are more likely to occupy a nest box with a nest form, we cannot say that overall occupancy rates have been increased by the addition of nest forms; we may have only influenced how the birds distribute themselves among the boxes. We have now added nest forms to all unoccupied nest boxes, and will continue monitoring to discover if this affects overall rates of occupancy.

First year breeding: We believe that provision of a nest form increases the proportion of swifts that attempt to breed in their first year of occupancy, when they often only build a nest ready for the following year (Erich Kaiser *pers comm*). It is for this reason that it is not necessary, indeed not good practice, to clear out a swift's nest at the end of a breeding season.

Table 1. Comparison of the occupancy of common swift nest boxes with and without nest forms at four sites (the east side of the belfry at St Mary's church in Ely, the south and west sides of the belfry at St Mary's church in Ely, the belfry of All Saints church in Worlington, and the tower of the Oxford Museum of Natural History).

	With nest form			Without nest form			Odds ratio	Start year	Inspection year
	Occupied	Not occupied	% occupied	Occupied	Not occupied	% occupied			
St Mary's church (east side)	7	5	58.3	3	9	25.0	3.9	2009	2011
St Mary's church south & west sides)	14	14	50.0	5	23	17.9	4.5	2011	2018
All Saints church	5	4	55.6	1	8	11.1	8.7	2013	2014
Oxford Museum of Natural History	3	9	25.0	3	37	7.5	4.0	2017	2018
Total	30	32	48.4	12	68	15.0	4.6	-	

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Figure 3. Two well-grown Common Swift chicks on a nest form. Photo Rob Mungovan.

Accidental egg displacement: It is not unusual for swifts to displace eggs accidentally from concave nest forms with a sloping rim (Figure 2a). This is not to be confused with deliberate ejection of eggs in times of stress, such as the entrance of an intruder.

A swift's egg is 16 mm in diameter. Nest forms with a vertical rim at least 9 mm high (Figure 2b) seem to eliminate this problem (personal observation, Brian Cahalane personal communication).

Provision of nest material: Small feathers or pieces of cut straw scattered in a nest box, or placed in the nest form are used by swifts to build a nest (personal observation, Tim Collins personal communication). This is simple to do and is probably worth doing.

Problems with fibre-board: In other projects, we have discovered that nest forms made of a soft material, such as fibre-board, can be pecked to pieces by great tits *Parus major* and house sparrows *Passer domesticus*, so, where this occurs, they need to be made of a tougher material.

In conclusion, swifts are considerably more likely to occupy nest boxes with a nest form (common odds ratio 4.6). The precise shape of the nest form does not seem to matter. Nest forms with a flat bottom are accepted with equal frequency to those with a concave bottom. Nest forms with a vertical rim at least 9 mm high reduce accidental egg displacement.

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