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A nest-box trial for British Marsh Tits *Poecile palustris*

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Abstract

Two experimental nest-box trials were attempted, which aimed to maximize uptake by Marsh Tits in British woodland. Nest-boxes which more closely approximated the dimensions of natural cavities were used more frequently than standard nest-boxes, but the overall uptake was low. We conclude that nest-boxes are an inefficient method of monitoring Marsh Tits, at least in the British context, and researchers should concentrate efforts on locating and monitoring natural nest-sites.

The Marsh Tit is a small (10-12 g) woodland passerine which nests in secondary tree-cavities (Broughton *et al.* 2011), and its abundance in Britain declined by 73% from 1967-2011, placing it on the Red List of birds of conservation concern (Baillie *et al.* 2014). Consequently, monitoring of demographic trends has become more urgent, including breeding success and productivity. However, Marsh Tits are infrequent users of nest-boxes (Perrins 1979), which are the most efficient means of monitoring breeding parameters, particularly for 'citizen science' projects such as the BTO's Nest Record Scheme. The reasons for this low uptake are unknown, but may include nest-box competition from dominant Blue Tits *Cyanistes caeruleus* and Great Tits *Parus major*, a preference for different cavity properties than offered by standard nest-boxes, or microhabitat selection around nest-sites (Broughton *et al.* 2012). The aim of this paper is to report on two experimental nest-box trials which aimed to use information on territory location, nest placement and natural nest-sites to maximize nest-box uptake by Marsh Tits. If successful methods could be applied more widely, then this would facilitate nest recording and ringing of nestlings for improved population monitoring.

Since 2003 we have studied Marsh Tits in the 155 ha Monks Wood National Nature Reserve in Cambridgeshire, eastern England (52° 24' N, 0° 14' W), and neighbouring woods within 5 km, including aspects of nest-site selection and nest placement in natural cavities. Each year at least 80% of the Marsh Tit population was marked with individual combinations of colour-rings, all birds were sexed according to behaviour and biometrics, all breeding territories were mapped, and 200 nests were located up to 2014 (see Broughton *et al.* 2008, 2011, 2012 for details). The study woods were largely unmanaged ancient woodland, dominated by Common Ash *Fraxinus excelsior*, English Oak *Quercus robur*, Common Hazel *Corylus avellana* and hawthorns *Crataegus* spp..

In December 2003 we began a nest-box trial aimed at improving occupation by Marsh Tits, using nest-boxes approximating the standard 'small hole-entrance' design recommended by du Feu (2003). Boxes were erected in pairs at 15 locations in previous Marsh Tit breeding territories, close (< 10 m) to recent nest-sites where possible (five locations), with inter-box distances of 3-5 m to leave a nest-box available for Marsh Tits should one be taken by the dominant and common Blue Tits (Nilsson & Smith 1988).

Nest-boxes were constructed from 18 mm rough-sawn, pressure-treated pine, and painted with dark brown, non-toxic preservative on all surfaces. Internal floor dimensions were 104 x 148 mm (154 cm<sup>2</sup>), with a depth of 170 mm below a 26 mm entrance hole to exclude Great Tits. Nest-boxes were fixed to young trees (10-20 cm diameter at breast height) with the entrance hole at a height of 1-1.5 m, similar to many natural nests in this area (Broughton *et al.* 2011). Each box had a random compass orientation (bearing not recorded).

Nest-box occupation during the 2004-2008 breeding seasons was monitored during 5-7 visits throughout April-June, timed to coincide with nest-building and egg-laying, incubation, nestlings, and post-fledging to record breeding outcome and remove old nests.

For a second trial in 2011-14, a bespoke 'Marsh Tit nest-box' was designed to more closely mimic the natural cavities used by this species, based on dimensions recorded by Ludescher (1973), Wesolowski (1996) and our observations. This design (Fig. 1) had an internal floor area of 78 x 78 mm (61 cm<sup>2</sup>), and a depth of 150 mm below a 26 mm entrance hole, creating a smaller and narrower cavity than recommended by du Feu's (2003) standard design. Pressure-treated pine (22 mm width) was used, with a hinged non-sloping roof, and boxes were painted with a black (roof) and dark green, non-toxic preservative on external surfaces. The standard nest-boxes were removed in winter 2010, and pairs of the new bespoke nest-boxes were installed at 25 locations, again targeting Marsh Tit territories and all at previous nest-sites. A further nine locations were added before the 2012 breeding season, and three more by 2013, taking the total to 37 locations in seven woods in 2013-2014.

Nest-box entrances were positioned 0.3-1.8 m (mean = 0.9, SD = 0.4 m) above the ground, with 18% orientated in each of the south-east and south-west compass quadrants, 24% facing north-east and 40% north-west. This broadly matched the distribution of the 200 natural nest-sites, where the corresponding values were 19-21%, 28% and 32%. Nest-boxes were monitored during the 2011-14 breeding seasons as per the first trial.

For both trials, a pair of nest-boxes at each location was treated as a single unit, and Marsh Tit occupation was calculated as the percentage of available nest-box locations which were used in each breeding season. However, while this approach allowed comparison with other nest-box studies it took no account of Marsh Tit distribution, and this was addressed by also calculating the percentage of Marsh Tit pairs which used a nest-box location only where these were available within their territory.

Our results showed that nest-box occupation by Marsh Tits was generally very low, and sample sizes were insufficient to perform meaningful statistical tests of annual variation in usage of nest-box designs. As such, we simply compared the overall frequency of nest-box uptake in both trials using Fisher's exact test, pooling annual data for the number of occupied territories containing nest-boxes and the number Marsh Tits pairs that used them. Although the pooled data contained some of the same individual birds in consecutive years, nest-sites were not limiting in this area, their re-use was inconsistent, and territory boundaries varied between years (Broughton *et al.* 2011, 2012). As such, nest-site choices by the same individuals in different years were considered unique events.

In the first trial most (87-100%) standard nest-box locations fell within Marsh Tit territories each year, but a nest-box was used just once (Table 1), giving a mean annual uptake of just 1.3% (SD = 2.9%) of all locations. In comparison, Blue Tits occupied 60-87% of nest-box locations annually, but used both nest-boxes at only 7-20% of locations, indicating that competition for nest-sites was not limiting uptake by Marsh Tits. Where at least one nest-box location fell within a Marsh Tit territory, an average of only 1.7% (SD = 3.7%) of pairs used them.

The second trial was more successful than the first in attracting Marsh Tits to nest-boxes, with a mean annual uptake of 8.8% (SD = 10.2%) of all locations (Table 1). Most nest-box locations fell within occupied territories (65-96% annually), and in 2011 nest-boxes were used by almost one third of the 19 pairs of birds which had access to them. However, over the full duration of the second trial an average of only 14.1% (SD = 11.9%) of Marsh Tit pairs selected nest-boxes each year. While this uptake was low, overall use of this bespoke design by Marsh Tits was significantly greater than for the standard nest-boxes (Fisher's exact test:  $P = 0.02$ , Table 1).

Other species using the bespoke nest-boxes in the second trial included Blue Tits (68-80% of locations annually), Great Tits (a 26 mm hole not excluding all birds), Coal Tits *Periparus ater* and Wrens *Troglodytes troglodytes*, but at least one nest-box remained vacant at 54-76% of locations each year, and so competition was not considered significant in limiting uptake by Marsh Tits.

Overall, our results suggest that nest-boxes with a smaller floor area are more attractive to Marsh Tits than the standard nest-box design (cf. du Feu 2003). The dimensions of the bespoke nest-boxes in our more successful second trial were similar to those used in Sweden, where an average uptake of approximately 25-30% was achieved in wooden nest-boxes with a 74 cm<sup>2</sup> floor area (95 x 78 mm) and 130 mm depth below a 26 mm entrance hole (Nilsson & Smith 1988; Nilsson 1991, Lambrechts *et al.* 2010). These nest-boxes, like ours, were installed in pairs at inter-box distances of up to 10 m, which appears to enhance uptake.

Nevertheless, other nest-box schemes have attracted Marsh Tits to a standard design, erected singly, and with a larger entrance hole. In Croatian deciduous forest, for example, Doleneč (2006) achieved an average annual uptake of 11% using 150 nest-boxes with a floor area of 120 x 120 mm (144 cm<sup>2</sup>) and a 29 mm entrance hole. This is despite the forest containing abundant Common Hornbeam *Carpinus betulus*, which can provide many cavities for nesting Marsh Tits (Wesołowski 1996).

Unlike our trials, however, no other Marsh Tit study reports the rate of nest-box use relative to their availability within breeding territories, and few report uptake as a percentage of available nest-boxes. From Carpenter (2008), it can be constructed that 8% of 24 pairs in Wytham Woods (Oxfordshire, southern England) selected nest-boxes in 2007, where *Schwegler 2M* nest-boxes (floor area 113 cm<sup>2</sup>, 140 mm depth below a 26 mm or 32 mm entrance hole) were available to excess. Also, Sells (1984) reported a Marsh Tit uptake of 9-19% of 73-79 standard, randomly-distributed nest-boxes (accessible to Great Tits) in Bourton Wood (Gloucestershire, southern England). However, the average annual uptake of 12% for this five-year period fell to just 7% over 40 years (J.D. Sells, pers. comm.). Nevertheless, in good years nest-boxes must have been used by the majority of Marsh Tits in the 100 ha plantation of larch-fir-beech *Larix-Abies-Fagus*, which was presumed to have a scarcity of high-quality natural cavities (Sells 1984).

In contrast to Sells' (1984) study area, our study woods appeared to have an abundance of natural nest-sites for Marsh Tits (Broughton *et al.* 2011), which may explain some of the disparity between the uptake of standard nest-boxes in our first trial and Sells' general nest-box scheme. Yet, our targeting of Marsh Tit territories with bespoke, paired nest-boxes in the second trial only achieved an average uptake of 14%, just twice that observed by Sells overall, and little more than that derived from Carpenter (2008) from a high-density nest-box scheme aimed at Great and Blue Tits. Furthermore, our best average uptake was only slightly higher than that achieved by Doleneč (2006), who also made no design or methodological concessions for Marsh Tits. The rate of Marsh Tit occupation in Nilsson &

Smith's (1988) targeted nest-boxes was also much higher than ours, despite our methods being most similar to theirs.

Natural nest-sites are unlikely to have been rare in these Croatian and Swedish studies, which raises the question of why use of nest-boxes is so infrequent among British Marsh Tits (Perrins 1979). A presumed greater abundance of dominant Great and Blue Tits in British woods could be limiting nest-box uptake by Marsh Tits, although data were not available to test this. In any case, Marsh Tits are also capable of defending nest-cavities from prospecting Blue Tits (four successful defences observed in the study period; Broughton et al. 2011) and so are unlikely to suffer excessive competition for small-entrance nest-boxes (e.g. 26 mm).

Instead, the low uptake of nest-boxes by British Marsh Tits may be related to a low breeding density and specific preferences for the microhabitat around nest-sites, such as parts of the territory where the woodland is most mature (Broughton et al. 2012). Therefore, randomly-placed nest-boxes would have a low chance of being in locations most preferred by the few available birds.

Two key conclusions emerged from our nest-box trials. Firstly, nest-boxes are an inefficient means of monitoring nesting Marsh Tits, at least in the British context. Although targeting of known territories and nest-sites with bespoke nest-boxes was more successful than the use of standard nest-boxes, or the random placement of nest-boxes in other studies, overall rates of occupation were still very low. We recommend that researchers wishing to monitor Marsh Tit nests direct their efforts toward locating natural nests and adopt techniques for monitoring and ringing nestlings in such cavities (e.g. Wesolowski 2001; Broughton et al. 2011; Broughton & Hinsley, in press).

Secondly, unoccupied nest-boxes in vacant habitat showed that provision of artificial nest-sites did not increase the Marsh Tit breeding population in our study area. This confirms that Marsh Tit abundance was not limited by nest-sites, unlike e.g. Great Tits in other areas (e.g. Minot & Perrins 1986). Additionally, our results, and Carpenter's (2008) data from Wytham Woods, showed that provision of excess nest-boxes was not associated with high uptake by Marsh Tits (cf. du Feu 2003), and this approach may be best avoided so as not to assist the dominant tit species to the potential detriment of remaining Marsh Tit populations (through e.g. inter-specific competition: Broughton & Hinsley, in press).

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Table 1. Availability and uptake of nest-box locations (each containing a pair of nest-boxes) by Marsh Tits during trials of a standard and bespoke nest-box design.

Year	Total nest-box locations	Occupied nest-box locations (%)	Territories with nest-boxes	Pairs using nest-boxes (%)
First trial: standard nest-boxes				
2004	15	0 (0.0)	12	0 (0.0)
2005	15	0 (0.0)	12	0 (0.0)
2006	15	1 (6.7)	12	1 (8.3)
2007	15	0 (0.0)	11	0 (0.0)
2008	15	0 (0.0)	9	0 (0.0)
Second trial: bespoke nest-boxes				
2011	25	6 (24.0)	19	6 (31.6)
2012	34	2 (5.9)	19	2 (10.5)
2013	37	1 (2.7)	11	1 (9.1)
2014	37	1 (2.7)	19	1 (5.3)

## FIGURE LEGEND

Figure 1. Bespoke nest-box design targeted at Marsh Tits during a second trial aimed at increasing nest-box uptake. The design intends to mimic the dimensions of natural nest-sites more closely than standard nest-box designs, with an internal floor area of 78 x 78 mm and depth of 150 mm below the 26 mm entrance hole. The nest-box is fixed to a young tree with wire, and numbered to assist with recording.





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117x155mm (300 x 300 DPI)