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Provision of supplementary food for wild birds may increase the risk of local nest predation

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In countries such as the UK, USA and Australia, approximately half of all households provide supplementary food for wild birds, making this the public's most common form of active engagement with nature. Year-round supplementary feeding is currently encouraged by major conservation charities in the UK as it is thought to be of benefit to bird conservation. However, little is understood of how the provision of supplementary food affects the behaviour and ecology of target and non-target species. Given the scale of supplementary feeding, any negative effects may have important implications for conservation. Potential nest predators are abundant in urban areas and some species frequently visit supplementary feeding stations. We assess whether providing supplementary food affects the likelihood of nest predation in the vicinity of the feeder, by acting as a point attractant for potential nest predators. We provided feeding stations (empty, peanut feeder, peanut feeder with guard to exclude potential nest predators) in an area of suburban parkland in the UK and monitored the predation rate of eggs placed in artificial nests located at distances that replicated the size of

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typical suburban gardens. Nest predators (Magpies *Pica pica*, Grey Squirrels *Sciurus carolinensis*) were frequent visitors to filled feeders, and predation caused by Magpies, European Jays *Garrulus glandarius* and Grey Squirrels was significantly higher when nests were adjacent to filled feeders. The presence of a feeder guard did not significantly reduce nest predation. As supplementary feeding is becoming increasingly common during the breeding season in suburban habitats, we suggest that providing point attractants to nest predators at this time may have previously unconsidered consequences for the breeding success of urban birds.

Keywords: artificial nest, bird feeding, corvid, Eurasian Jay, Eurasian Magpie, garden, Grey Squirrel, predation, urban ecology.

Garden bird feeding engages more people with wildlife than any other activity. Some 48% of households in Britain (Davies *et al.* 2009) and 53 million households in the USA feed wild birds (U.S. Fish and Wildlife Service 2011), providing an enormous and highly localised additional food resource. For example, in suburban Reading, UK, over 55% of householders provide supplementary food for wild birds, two-thirds of whom feed year-round (Orros & Fellowes 2015a). The majority of individuals provide peanuts, a range of seed types (e.g. sunflower, nyger, wheat) and fat to birds visiting their gardens. A conservative estimate suggests that enough food is provided annually in the UK to support over 30 million garden birds (Orros & Fellowes 2015a). This is reflected by the size of the UK bird food industry, which ten years ago was estimated to be worth £200 million per annum (British Trust for Ornithology 2006). This figure is likely to be considerably higher today.

Supplementary feeding in urban areas affects the abundance and distribution of species as diverse as Red Kite *Milvus milvus* (Orros & Fellowes 2014, 2015b), hummingbirds (Hill *et al.* 1998, Courter *et al.* 2013) and Blackcap *Sylvia atricapilla* (Chamberlain *et al.* 2005, Rolshausen *et al.* 2009, Plummer *et al.* 2015). While feeding has been shown to increase adult overwinter survival (Jansson *et al.* 1981, Brittingham & Temple 1988), its effects on bird productivity are variable, and overwinter supplementary feeding has been found to both increase (Robb *et al.* 2008) and reduce (Plummer *et al.* 2013a, b) breeding success in subsequent seasons. Similarly, supplementary feeding experiments

during the breeding period have found mixed results, with evidence for both reductions (Harrison *et al.* 2010) and increases (Peach *et al.* 2013, Smith & Smith 2013) in productivity. Furthermore, feeding stations may facilitate the transmission of disease (Bradley & Altizer 2007), which can lead to rapid population declines (e.g. trichomonosis in Greenfinches *Chloris chloris*; Robinson *et al.* 2010).

Urban birds tend to lay eggs earlier, have smaller than average clutch sizes, lower nestling weight and lower productivity per nesting attempt (Chamberlain *et al.* 2009). Open-cup nesters decline in numbers with increasing urbanisation but remain part of the avifauna (Máthé & Batáry 2015) and UK gardens hold significant populations of several such species (Bland *et al.* 2004). While food availability and habitat suitability are important limiting factors for urban bird populations (Shochat 2004, Máthé & Batáry 2015), nest predation is a key cause of nest failure for open-cup nesters (Ricklefs 1969, Martin & Li 1992), possibly also limiting their populations (Jokimaki & Huhta 2000). Predator densities in urban areas may be higher than those in rural areas in the case of some nest predators, such as corvids (Jokimaki & Huhta 2000, Antonov & Atanasova 2003, Jokimäki *et al.*, 2005, Sorace & Gustin 2009), although it is unclear if this apparent increase in potential predator density depresses prey populations (Shochat 2004, Madden *et al.* 2015). Eurasian Magpies *Pica pica* and introduced Grey Squirrels *Sciurus carolinensis* are common in UK urban areas and are frequent nest predators (Eaton *et al.* 2013, Bonnington *et al.* 2014a). Increased nest predation in an urban area is associated with increased corvid density, although no association was found with Grey Squirrel population size (Bonnington *et al.* 2015).

Nest predators, such as Eurasian Magpies and Grey Squirrels, may be attracted by garden feeding stations (Chamberlain *et al.* 2005, Väisänen 2008, Bonnington *et al.* 2014b). As a result, people providing supplementary food can purchase caged feeders, which aim to exclude larger species, including squirrels and corvids. At a domestic garden scale the provision of bird feeders reduces the local abundance of insects (Orros & Fellowes 2012, Orros *et al.* 2015), and the provision of supplementary food for ungulates (Cooper & Ginnett 2000, Selva *et al.* 2014) and woodland predators (Borgmann *et al.* 2013) increases local nest predation. In each case the supplementary food appears to attract predators to a point source, and the predators in turn foraged locally on other prey.

The most parsimonious explanation is that the presence of a reliable or high quality food resource increases both the local densities of potential nest predators and the time they spend foraging near the food source.

It is not known whether supplementary feeding of the type practised by tens of millions of garden owners increases the risk of local nest predation in urban and suburban habitats. These habitats support significant populations of native bird species in the UK including a number of open-cup nesting species that have undergone national declines in recent decades, such as Blackbird *Turdus merula*, Dunnock *Prunella modularis*, and the UK red-listed Song Thrush *Turdus philomelos* (Gregory & Baillie 1998, Bland *et al.* 2004). Given the near ubiquity of supplementary feeding in urban areas, and the recommendation from bird conservation NGOs (e.g. RSPB 2009) to feed birds throughout the year, it is possible that individuals providing supplementary food in their gardens are inadvertently increasing nest predation rates suffered by their garden birds. To investigate this further it is first necessary to establish whether nest predation is elevated near bird feeding stations. By using both guarded (food inaccessible to nest predators) and unguarded feeders (food accessible), we can assess whether it is the presence of food (both accessible and inaccessible) or the availability (food accessible in unguarded feeders) of food that affects predation rates.

Studying nest predation using real nests would result in considerable practical and ethical challenges. As a result, artificial nests provide an important tool for studying bird nest predation (Major & Kendal 1996, Miller & Hobbs 2000). Typically, nests are baited with quail and/or model eggs and monitored over a set period. Artificial nests are undefended by adults and lack the activity of real nests; nevertheless, they provide experimental nest predation data at scales which would be difficult to achieve in natural studies, while avoiding the ethical issues of experimenting with natural nests (Major & Kendal 1996, Moore & Robinson 2004). Using camera-monitored artificial nests, we investigated nest survival around caged, uncaged and empty bird feeders. Our objectives were to determine whether (a) potential nest predators were attracted to bird feeding stations providing supplementary food, (b) if so, if this was associated with differences in rates of nest predation, (c)

whether increased nest predation was associated with access to food (unguarded feeders) or the presence of food (guarded and unguarded feeders) and (d) whether nest predation rates were affected by distance from the supplementary food source.

METHODS

Study area

The study was conducted at the University of Reading's Whiteknights Campus (UK; 51° 27' N, 0° 58' W), in an area of open parkland and woodland comprising approximately 68% natural land covers overall, embedded in a typical UK suburban landscape, broadly conforming to the suburban definition of Marzluff *et al.* (2001). The town of Reading covers approximately 40 km² and has a population of 230 000 people (Office for National Statistics 2013).

Experimental design

Experimental work was carried out between 5 May and 17 June 2014, covering the peak bird breeding season for the UK (Robinson 2005). Fifty-four locations were selected on the edge of grassy clearings and open spaces with adjacent areas of shrubs and bushes, 50-100 m apart, replicating typical suburban feeder distribution (Fuller *et al.* 2008). The experiment consisted of six two-week sample cycles. During each cycle, 9 peanut feeders (CJ Wildlife small defender feeder, Shrewsbury, UK) were positioned (three empty, three filled and unguarded, three filled and fitted with a cage guard). Feeders were randomly placed in each of the study locations, one week before the nests, to allow habituation. Sites were not reused and all were at least 20 m from the closest building. Experimental cycles were staggered at one week intervals to reduce the sampling time required for the whole experiment.

Two artificial nests were placed, diametrically opposite each other, at distances of *c.* 5 m ('near') and 10 m ('far') from each feeder (± 1 m), replicating typical distances between feeders and suburban garden boundaries (Gaston *et al.* 2007). In total, 108 nests were placed (one 'near', one

‘far’, at each of the 54 feeder locations). Nests were constructed of 15-cm squares of small-gauge wire mesh lined with dried grass and attached to branches to imitate a Blackbird nest (Kurucz *et al.* 2010, Kurucz *et al.* 2012). Nests were placed at a height of 1.5 ± 0.5 m in locations selected to mimic natural Blackbird nest-sites, and to provide similar visual accessibility to potential predators following Swanson *et al.* (2012). Two fresh Japanese Quail *Coturnix japonica* eggs were placed in each nest (Buler & Hamilton 2000). Blackbird is a common breeding species in UK gardens along with the less common but similarly sized Song Thrush (Bland *et al.* 2004), making them an appropriate species to simulate. Nests were monitored for seven days (168 hours) as 90% of predation events occurred within six days of placement (Burke *et al.* 2004). Each nest was continually monitored by a concealed motion-triggered camera trap (Ltl Acorn 5310; Ltl Acorn Inc, USA), set to the highest sensitivity setting, taking three photographs with a three second interval when triggered.

Feeders were checked every 3.5 days and refilled where necessary. Feeder usage was sampled using camera traps, but each was monitored for 3.5 days either at the beginning or end of the week to ensure coverage with limited traps. At any one time one of each feeder type was monitored and two thirds of all feeders were sampled for usage.

Nest fate was recorded and for predated nests, predation time and predator identity determined. Any damage to or removal of eggs was considered as a predation event. Visitation rates per species were recorded at the feeders; as visitors could not be individually identified, a visitor was considered an individual when either separated by a photograph without the animal or when four or more minutes had elapsed without a feeding event.

Data analysis

All analyses were carried out within the program R (R Core Team 2016), with nest survival tested using Cox’s proportional hazard model in the base R survival package (version 2.39-4, Therneau 2015). This approach was used over a logistic exposure or regression approach (Shaffer 2004) because the exact survival time and fate was known for each nest and exposure period did not vary. Covariates were feeder type (empty, guarded, unguarded), distance from feeder (near, far) and study

week block (as a random effect) with time to predation (hours) and predation status as response variables. No interaction terms were fitted. We evaluated the relative fit of each candidate model using Akaike's Information Criterion with a small-sample bias adjustment, comparing models using Akaike weights and ΔAICc (Burnham & Anderson 2002).

Mean daily feeder visitation (as a proxy for usage) was first compared using Kruskal-Wallis tests between treatments, by individual species, all potential 'predator' species, all small birds and all animals. Binomial logistic mixed model regression was then used to test for specific relationships between animal feeder usage and predation overall. Two separate global models were constructed both with study week block as a random effect factor and whether a nest was predated as the binomial response variable in the R lme4 package (version 1.1-12, Bates et al 2015). First, a model that considered overall predator visits and small bird visits to feeders as variables effecting nest predation. Second, a model considering feeder visits by Squirrels, Magpies and small birds as variables effecting nest predation. Because Magpie and Squirrel visits are subsets of overall predator visits, it was not possible to utilise species and overall visits in the same model. Jays were not included in the individual models due to their infrequent visits. Relative model fit was then evaluated separately using ΔAICc and Akaike weights for both global models as above against a null model containing only the intercept and study week as a random factor. There were insufficient data to effectively compare effectors on predation for individual predator species or at specific feeder types.

RESULTS

Feeder visitation

Thirty-three of the 54 feeders were monitored (10 empty, 11 guarded, 12 unguarded). Eleven species were recorded making 5251 individual feeder visits (empty feeders = 17, guarded = 3522, unguarded = 1712 visits). Grey Squirrels contributed 43.9% of visits to unguarded and 9.3% of visits to guarded feeders, while smaller birds were more likely to visit guarded feeders (Table 1). Magpies were a regular visitor to unguarded feeders, but rare at empty and guarded feeders. One exception was an

individual guarded feeder that received frequent visits (Fig. 1). Despite predating 27.5% of all recorded nests, Jays only visited feeders eight times. All species visiting more than two individual feeders (excluding unknowns) showed a significant difference between their feeder usages (Table 1, Fig. 1).

Nest survival

Of the 108 experimental nests, 102 were successfully monitored, with 74 recorded predation events (Magpie = 37, Jay = 28, Grey Squirrel = 8, one unknown). Six nest predation events were missed due to camera errors or human interference and so were omitted from the analysis (3 empty, 2 guarded and 1 unguarded). From the different feeder types 51.5% of empty feeder nests, 76.5% of guarded feeder nests and 88.6% of unguarded feeder nests were predated during the course of the experiment. No predation events were recorded between 20:10 and 05:32.

When AICc selection was carried out on the global hazard model, the AICc selected model with distance from feeder removed had a Δ AICc of less than 2 from the global model so for completeness we present both the global (Wald = 23.05, df = 6.42, $P < 0.001$, AICc = 600.4, model weight = 0.210; Table 2) and the AICc selected model (Wald = 22.93, df = 5.43, $P < 0.001$, AICc = 598.5, model weight = 0.672; Table 2). Separate post hoc ANOVAs of both models (following Therneau 2015) found that feeder type and week were significant effectors of nest survival overall ($\chi^2 = 11.8$, df = 2, $P = 0.003$ and $\chi^2 = 17.6$, df = 3.4, $P < 0.001$ for feeder type and study week respectively in both models). In both models, nests near filled feeders were significantly more likely to be predated than those near empty feeders, and week was a significant covariate with identical hazard ratios after rounding (Table 2, Fig. 2). Nest distance from feeder did not significantly affect predation rates in the global model ($P = 0.67$) and was eliminated in the AICc selected model (Table 2). No significant difference in survival was found between nests adjacent to guarded and unguarded feeders (post-hoc Tukey test, $P = 0.82$; Fig. 2).

Nest predation and feeder usage

Overall feeder activity by predators (Grey Squirrels, Jays and Magpies) was significantly associated with increased nest predation (Wald $Z = 2.518$, $P = 0.019$) in the AICc selected mixed effect model (Table 3). In the model considering individual predator usage, Grey Squirrel usage was significantly associated with increased overall nest predation (Wald $Z = 2.305$, $P = 0.021$) in the AICc selected model (Table 3). However, support for this model was weak, with little separation between all possible model AICcs and similar Akaike weights in several models (Table 3). Usage by small birds was not a significant factor in any model (Table 3).

DISCUSSION

Our results suggest that the provision of supplementary food during the breeding season for wild birds in a form that is common in urban and suburban habitats may increase the likelihood of local nest predation. The survivorship of nests adjacent to unguarded feeders was less than 20% of that seen when artificial nests were placed near empty feeders. There was no difference in nest survival near guarded feeders when compared with those placed adjacent to unguarded feeders. Increased predation was associated with Magpies, Jays and Grey Squirrels. Magpies and Grey Squirrels were significantly more likely to visit unguarded feeders, while Jays were largely absent. Overall, nest predation was associated with increased predator visits, particularly by Grey Squirrels, to feeders. There was no effect on nest predation rates of distance to feeder at the scales we considered. Species assemblages differed between treatments; empty feeders received few or no visits, guarded feeders were mostly visited by small passerines and unguarded feeders attracted a higher proportion of corvids and Squirrels. Despite being unable to feed at guarded feeders, predators still made up 9.4% of total visits to them. No mammalian nest predators other than Grey Squirrels were recorded despite being present at the study site and in UK urban areas generally (e.g. Brown Rat *Rattus norvegicus*, mice *Apodemus* spp., Red Fox *Vulpes vulpes*, Domestic Cats *Felis catus*: Baker & Harris 2007, Thomas *et al.* 2012). Two nests recorded mouse visits, but no predation attempts were observed.

Nests adjacent to filled feeders suffered greatly increased predation rates, with the majority of nest predation events caused by corvids (Magpies and Jays) and Grey Squirrels. Nest predation by corvids is a frequent occurrence in urban habitats (Jokimaki & Huhta 2000, Thorington & Bowman 2003, Jokimäki et al., 2005, Bonnington *et al.* 2015), where densities are high due to their omnivorous diet and adaptability, as well as reduced numbers of larger predators and/or competitors (Soh *et al.* 2002, Marzluff *et al.* 2007).

Despite our record of animal usage and clear evidence for an effect of the presence of supplementary food, the exact nature of the link between feeder usage and local nest predation remains unclear. There is a significant positive relationship overall between feeder usage by predators, in particular Grey Squirrels, and increased nest predation. Predation by Grey Squirrels themselves was lower than the two corvid species, suggesting there was not a direct link between Squirrel feeder usage and nest predation by Squirrels. We lack sufficient samples and model support to investigate this further, but we speculate that their presence at bird feeders may influence predation rates by Jays and Magpies. We propose two non-mutually exclusive mechanisms that may lead to this.

First, Jays and Magpies may be responding to the increased density of other omnivores that have been attracted by the presence of supplementary food. They in turn may be more likely to enter the feeder area, associating it with increased feeding potential, even if they themselves are not primary users of the bird feeders. In particular the frequency of Jay predation was unexpected due to their infrequent attendance at feeders, whereas Magpies utilised feeders but in low numbers. Second, the presence of Squirrels on feeders may exclude other omnivorous predators as well as small birds, resulting in increased foraging in the vicinity of the feeders, hence increasing local nest predation. Taken together, these results suggest that feeder usage by nest predators is associated with increased predation on our experimental nests, but this effect is not simply a result of nest predators being attracted to a point source, but instead perhaps also by being attracted by other feeder users to the vicinity of the food source.

We tested to see if nest predation changed with distance from the feeder, but there was no effect. The distances chosen for the study (5 and 10 metres) were relatively small and are consistent with the layout of a typical UK suburban garden (Smith *et al.* 2006, Loram *et al.* 2007). However, we

suggest that there could still be a distance effect. While not explicitly recorded, we observed no evidence of increased predation suffered by nests placed close to an empty feeder when the closest replicate was a filled feeder. Therefore we suggest that while the increased risk of nest predation is present when nests are within 10 metres of a feeder, this effect may be lost at a distance up to 40 metres away (the minimum distance between a feeder and the next closest nest associated with another feeder under our experimental design). Further testing over a larger range of distances with independent nests would be required to effectively test this theory.

The use of artificial nests presents some interpretive challenges (Buler & Hamilton 2000, Burke *et al.* 2004, Moore & Robinson 2004). They lack the odours, activity and defending adults of natural nests (Swanson *et al.* 2012). Concerns have also been raised over the use of quail eggs in artificial nests, with suggestions that they may be too large for some small predators (Burke *et al.* 2004). This also means that artificial nests may not be representative of smaller common UK open cup nesting birds, such as Robin *Erithacus rubecula* and Dunnock, in terms of egg and nest size as well as concealment. Some studies have substituted model eggs made from modelling clay, both to give a smaller prey item and so that when nests are not monitored by cameras it allows predator identification through marks left on the eggs (Major & Kendal 1996, Burke *et al.* 2004). These studies have found that rodents (not including squirrels) cause a significant proportion of artificial nest predation events. As only two nests were visited by mice and none by rats (and no feeder visits by rats were recorded), either the system in this experiment is different or previous results have been skewed by the attraction of these rodents to the smell and/or taste of the model eggs (Rangen *et al.* 2000). While for practical and ethical reasons the use of artificial nests remains the standard approach for understanding the causes and consequences of nest predation, such caveats suggest that interpreting the results of artificial nest studies should be taken as indicative rather than definitive, particularly when applied to bird species of different sizes or with different nesting habits such as ground or cavity nesting birds.

The urban landscape presents a challenging environment for wild birds to live and breed (Chace & Walsh 2006, Chamberlain *et al.* 2009). Together with potentially limited natural food (McKinney 2008) and high numbers of generalist predators (Sorace & Gustin 2009), urban areas also hold the

majority of the UK's estimated 10.3 million cats (Murray *et al.* 2010) which predate millions of birds annually (Thomas *et al.* 2012, Thomas *et al.* 2014). Nevertheless, significant populations of birds are supported within urban environments (Bland *et al.* 2004) and species richness can be greater than in adjacent rural areas (Chace & Walsh 2006), in part because of the combined efforts of millions of people providing supplementary food (Fuller *et al.* 2008).

However, while some species are effectively human commensals, others including open-cup nesters such as thrushes, are increasingly under challenge in urban habitats (Máthé & Batáry 2015) and do not necessarily use the supplementary food people supply. In consequence, supplementary feeding may strongly benefit one avian guild to the detriment of others through increased local nest predation. Any effect we have on their demographic processes through supplementary feeding may have important conservation consequences and warrants further investigation. However, while we have shown that nests close to filled feeders suffer considerably higher predation rates, it is not clear if such predation would affect the population dynamics of urban birds. As with other anthropogenic pressures (e.g. the presence of cats), testing this would not be straight-forward, in particular given the ubiquity of supplementary feeding in urban ecosystems. Nevertheless, while difficult, this work suggests that the question is worthy of further exploration.

Furthermore, we find that feeder type affects the assemblage of species feeding upon it. When feeders are unguarded, corvids and Grey Squirrels exclude small passerines (this study; Bonnington *et al.* 2014a, Orros & Fellowes 2015a). We suggest that this not only reduces the volume of food available to target species through competition, it may also support increased population sizes of predatory species through a demographic response (Davies *et al.* 2009). We suggest that people who choose to provide supplementary food for birds consider using guarded feeders to minimise opportunities to support predatory species, and consider in the context of the ecology of their own gardens whether feeding during the breeding season is appropriate.

Providing supplementary food during the breeding season is widespread (Orros & Fellowes 2015a) and can increase local bird population size (Peach *et al.* 2013, Smith & Smith 2013). Urban areas may be important for the conservation of some bird species and species richness in suburban areas can be greater than that found in adjacent urban and rural areas largely as a result of the

decisions made by millions of homeowners (Marzluff 2001, Chace & Walsh 2006, Väisänen 2008).

Our results suggest a possible negative indirect effect of supplementary garden bird feeding on local nesting success by attracting nest predators to point sources of food. It would be unfortunate if our most common act of engagement with wildlife was counter-productive during the breeding season.

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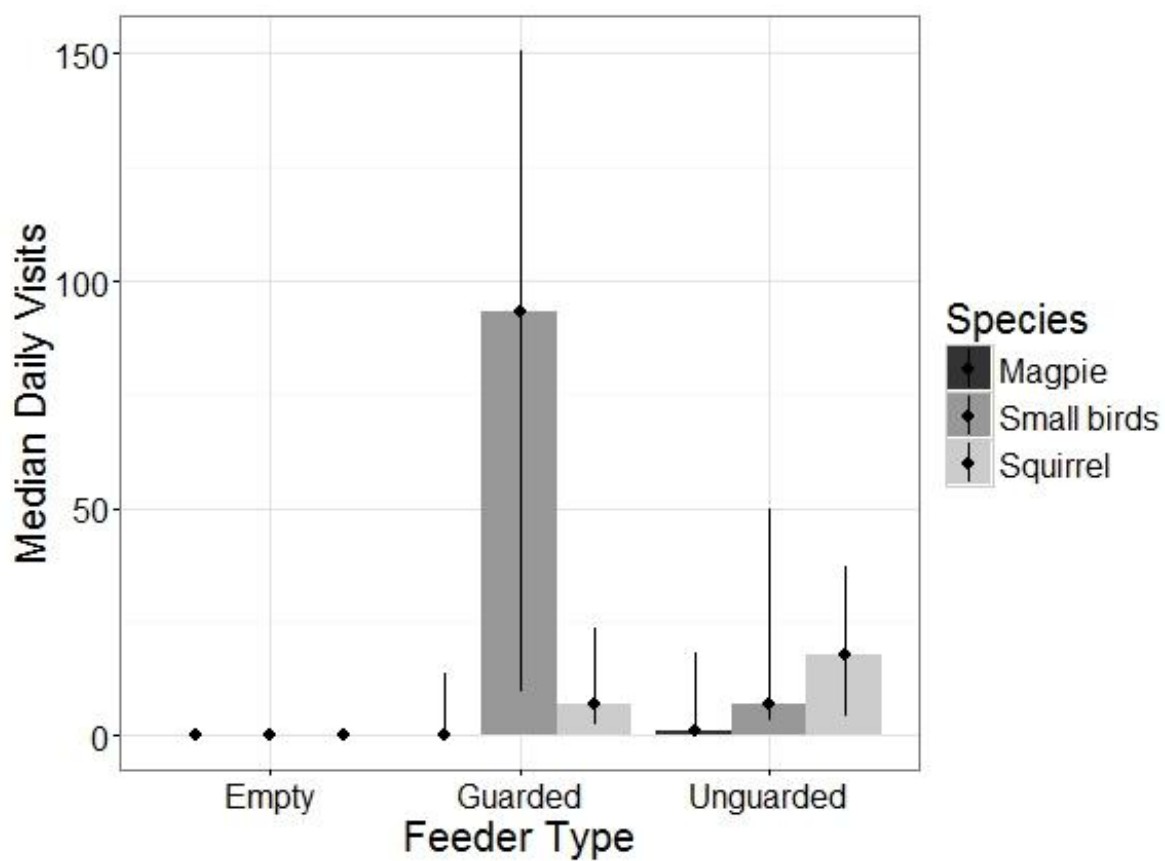


Figure 1. Median (+/-IQR) daily animal visits to each feeder treatment by species/grouping. Only species that visited at least two individual bird feeders are included. Small bird species are Great Tit *Parus major*, Blue Tit *Cyanistes caeruleus*, Nuthatch *Sitta europaea* and Robin *Erithacus rubecula*.

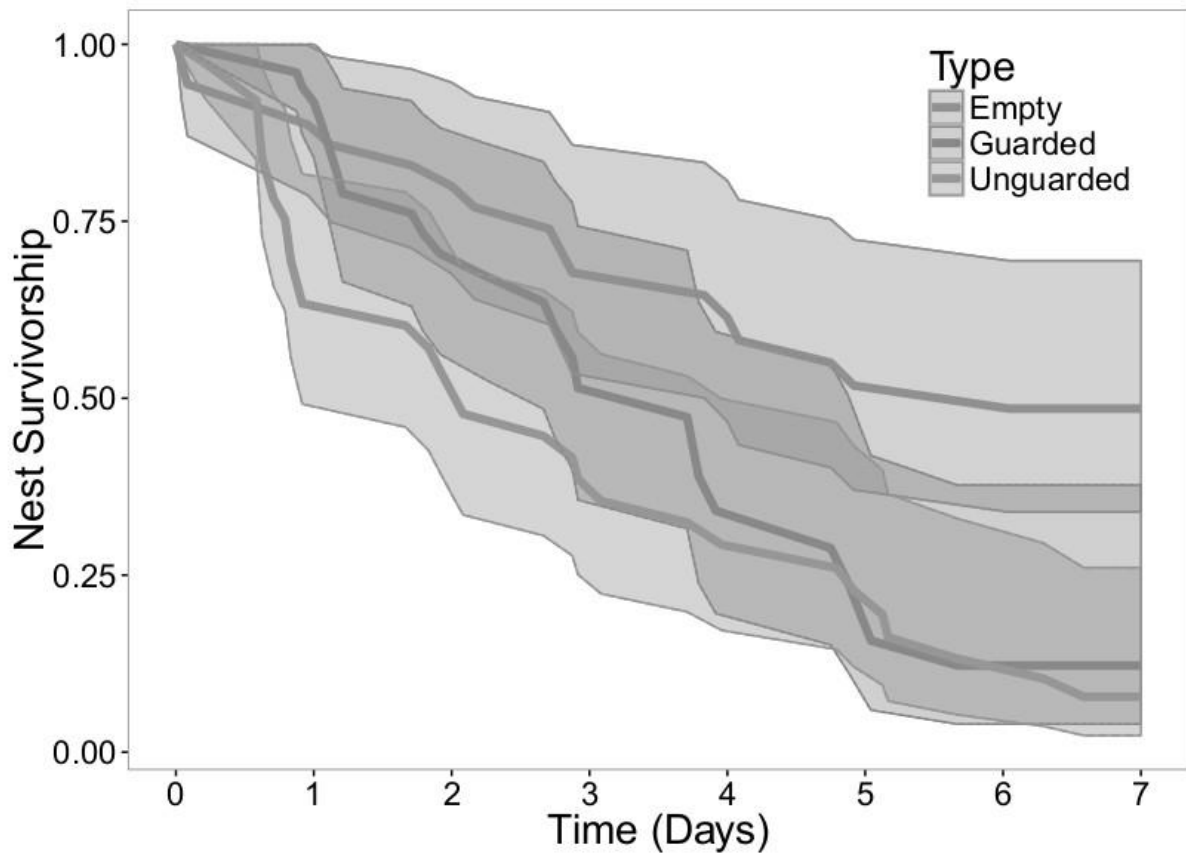


Figure 2. Predicted Cox's proportional hazard survival distribution by feeder nest type over the course of a mean experimental week (bold lines) with individual 95% confidence intervals (shaded). Final predicted survival rates were 0.49, 0.12 and 0.08 for empty, guarded and unguarded feeder nests respectively.

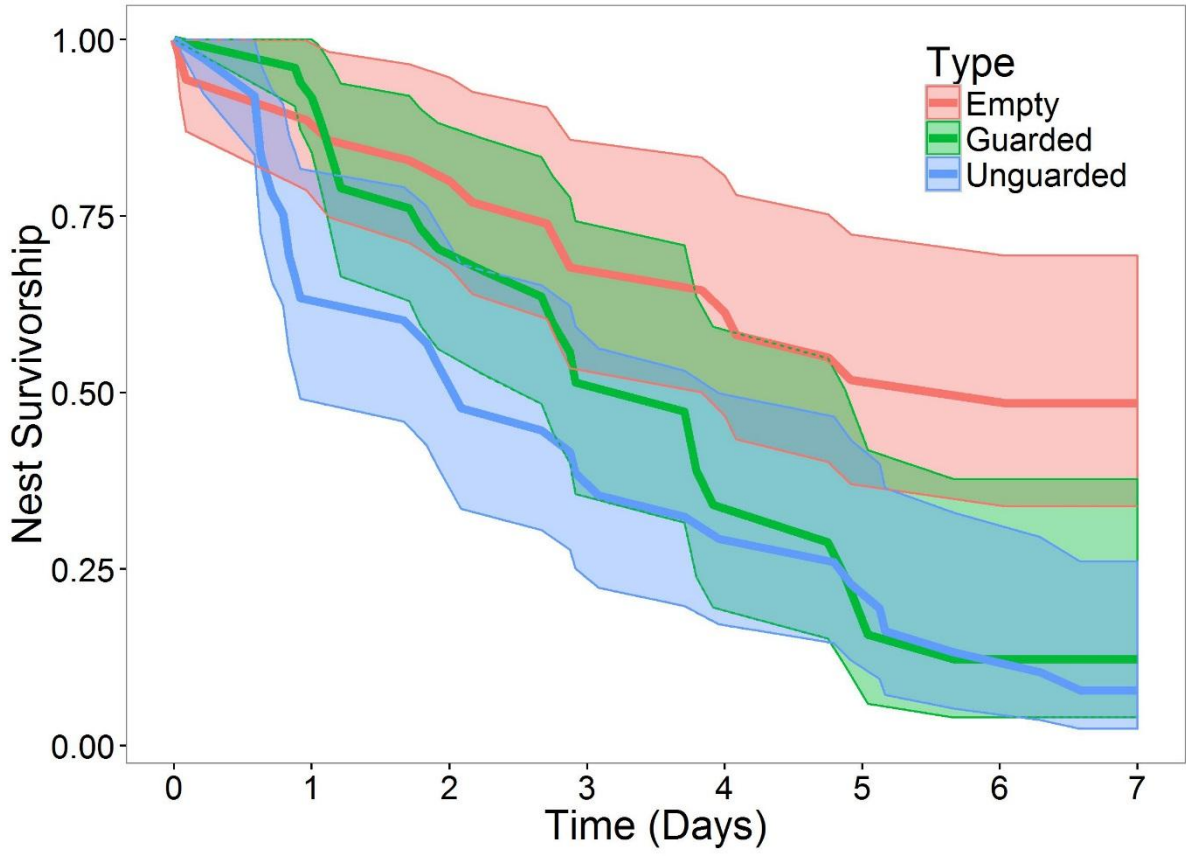


Table 1. Median daily species visits and Kruskal-Wallis tests by feeder type (all $df = 2$). Only common species that visited at least two individual bird feeders are included.

Species	Empty median	Guarded median	Unguarded median	Kruskal-Wallis Chi-squared	<i>P</i>	Number of feeders where species was recorded
Grey Squirrel	0.0	6.9	17.86	23.02	<0.001	26
Magpie	0.0	0.0	0.9	6.88	0.032	13
Great Tit	0.0	47.7	4.1	25.59	<0.001	27
Blue Tit	0.0	24.6	1.6	18.18	<0.001	21
Nuthatch	0.0	4.9	0.0	13.76	0.001	14
Robin	0.0	0.3	0.0	8.12	0.017	14

Table 2. Hazard ratios (relative predation risk; +/- CI) and *P*-values for covariates in the global model where h = 1 is the control (empty) feeder hazard ratio (df = 6.42, AICc = 600.4, model weight = 0.210). After the removal of distance from the AICc selected model (df = 5.43, AICc = 598.5, model weight = 0.672) the hazard ratios, CI and *P* values were identical after rounding.

Covariate	Hazard ratio (h)	Lower 95% CI	Upper 95% CI	<i>P</i>
Guarded	2.14	1.14	3.99	0.017
Unguarded	3.09	1.67	5.73	<0.001
Week (random effect)	1.00	0.58	1.73	0.010
<i>Distance</i> (removed in AICc selected model)	<i>1.08</i>	<i>0.68</i>	<i>1.71</i>	<i>0.740</i>

Table 3. Binomial generalised linear mixed effect models of predation against daily visitors with model AICc values and weights. The grouped predator models consider all predator visits together while the individual predator models consider them separately. The null model includes only the intercept and study week random effect. *indicates significance at the 95% level.

Predator variables	Model	Visit Coefficients	Estimate (95% CIs)	SE	<i>P</i>	Model AICc	Model weight
Grouped predators	Null	Intercept only	0.751 (-0.263 – 2.061)	0.4533	0.0976	84.1	0.024
	Global	All predators	0.079 (0.022 – 0.155)	0.033	0.016*	79.4	0.255
		All small birds	0.004 (-0.012 – 0.021)	0.008	0.620		
	AICc selected	All predators	0.068 (0.025 – 0.157)	0.029	0.019*	77.3	0.705
Individual predators	Null	Intercept only	0.751 (-0.263 – 2.061)	0.4533	0.0976	84.1	0.024
	Global	Squirrel	0.068 (-0.004 – 0.141)	0.037	0.066	81.5	0.095
		Magpie	0.131 (-0.081 – 0.342)	0.108	0.225		
	Model 2	All small birds	0.004 (-0.012 – 0.020)	0.008	0.645	81.2	0.108
		Magpie	0.178 (0.0197 – 0.414)	0.097	0.068		
		Squirrel	0.084 (0.017 – 0.174)	0.039	0.029*		
	Model 3	All small birds	0.005 (-0.010 – 0.219)	0.008	0.519	80.9	0.124
Model 4	Squirrel	0.070 (0.003 – 0.158)	0.038	0.063	79.3	0.277	

	Magpie	0.061 (-0.045 – 0.391)	0.084	0.469		
AICc selected	Squirrel	0.090 (0.022 – 0.179)	0.039	0.021*	79.1	0.314
