Efficacy of intervention to relieve nest box competition for orange-bellied parrots *Neophema chrysogaster*.

Summary

We use an experimental approach to evaluate the effectiveness of removing nests of a dominant competitor to create vacant nest boxes for a critically endangered parrot. We compared the number of times that tree martins (*Petrochelidon nigricans* – the dominant competitor at nest boxes) perched at or entered nest boxes intended for orange-bellied parrots (*Neophema chrysogaster* – the subordinate nest competitor) over three time periods (before, immediately after and one week after experimental nest destruction). In the before period, rates of nest attendance by martins treatment and control nests were not explained by treatment group. After experimental nest destruction, total attendance at boxes by tree martins rose to a mean of 6.1 visits over three five minute surveys in the treatment group, compared to 3.3 visits at control boxes. Within individual surveys, tree martins visited treatment boxes 4.4 times per survey one week after nest destruction, compared to only 1.6 visits in the control group. Tree martins in the treatment group rapidly rebuilt their nests and laid replacement clutches, and within a week all boxes were reoccupied. Nest destruction did not increase nesting opportunities for orange-bellied parrots, and increased vigilance of the dominant competitor may in fact reduce nesting opportunities in nearby boxes.

Key words

Tree cavity, hollow, nest box, competition, tree martin *Petrochelidon nigricans*, conservation management, orange-bellied parrot *Neophema chrysogaster*

Introduction

Tree cavity abundance can limit the populations of cavity dependent fauna (Newton 1994) and in some forests, cavities suitable for wildlife are rare (Stojanovic*, et al.* 2012). In such cases, competition among cavity-dependent species may be intense (Pearce*, et al.* 2011). If subordinate hollow competitors (i.e. those that lose competitive interactions) are of conservation concern, exclusion from cavities by dominant competitors may be a threat. Nest boxes are commonly deployed to overcome cavity limitation (Lindenmayer*, et al.* 2016), but if these are also occupied by dominant competitors, management may actually be creating new problems (e.g. if dominant species population sizes are inflated by additional nesting opportunities). Additional interventions to control dominant competitors (Stojanovic*, et al.* 2018c) may be necessary to protect threatened subordinate species, but the efficacy of these techniques may vary among species and study systems.

We evaluate whether removing nests of a competitor from nest boxes benefits orange-bellied parrots *Neophema chrysogaster* (hereafter: parrot). Arguably the rarest parrot in the world (Stojanovic*, et al.* 2018), the species currently depends on nest boxes (Department of Environment 2016). Anecdotal observations indicate parrots are subordinate to tree martins *Petrochelidon nigricans* (hereafter: martin) at nest boxes (Department of Environment 2016). Martins are cavity nesting aerial insectivores, and although smaller (18g vs 45g), they can aggressively swoop at parrots until they are driven away from boxes (Department of Environment 2016). Martins can also usurp parrot nests by covering-over their eggs with nests of leaves, or by using mud to shrink the nest box entrance hole. On an ad hoc basis, conservation managers remove martin nests by cleaning nest boxes to alleviate competition, but whether this increases the availability of vacant boxes is unknown. We test this experimentally and evaluate whether nest attendance by martins (as a proxy for the intensity of box defence) changes after nest removal.

Methods

Orange-bellied parrots are managed by the Tasmanian Government by provision of nest boxes and supplementary food at Melaleuca, Tasmania (Troy and Kuechler 2018). Nest boxes have internal dimensions of 55 cm length × 15 cm height × 14 cm width with a 5 cm entrance hole, and 38 boxes are deployed on trees or wooden poles in the study area (more are deployed >1.5 km away). Most trees support two boxes, but poles have only one box each. In December 2018, when most parrots were either prospecting for nests or incubating eggs, we randomly assigned 21 martin occupied nest boxes to either a treatment or control group (10 treatment, 11 control). Tree martins begin building their nests early in the orange-bellied parrot breeding season, but timing of egg laying can vary mid spring to late summer (D.S. personal observation). Occupancy was confirmed by climbing trees and checking for martin nest cups in boxes. The treatment was implemented after the commencement of incubation and involved removal of nest material from boxes and destruction of eggs. We recorded data over three observation periods, timed around the day of the implementation of the treatment: (i) day before/morning of, (ii) day of/morning after, and (iii) one week after. All nests were climbed once during each observation period to confirm martin nest occupancy. Treatment nests were destroyed during the second climb. During each observation period, we conducted three repeated randomly-timed five-minute surveys of each nest box (total nine surveys per box). During surveys, we tallied the number of times martins landed on the entrance perch or entered a nest box. Observers were blind to the treatment applied at each box. We did not attempt to distinguish among individual birds. Surveys were conducted in the morning or afternoon.

Analytical Approach. We calculated (i) the total number of times martins perched at/entered boxes cumulatively over the three survey periods, and (ii) the maximum number of times martins perched at/entered boxes during an individual observation per survey period.

We used these values as response variables in generalised linear models and fitted the following fixed effects: (i) treatment group, (ii) survey period and (iii) an interactive effect of treatment group × survey period.

We evaluated nest box vacancy by checking martin occupancy of boxes one week after treatment implementation. Nest success (successful nests produced at least one fledgling) was compared among treatment groups using a binomially distributed generalised linear model. This model was compared against a null. We compared models using ΔAICc >2, and all analyses were undertaken in R (R Development Core Team 2017).

Results

All nests contained eggs at the start of the experiment and 4/11 control nests contained chicks at the end. None of the treatment group nests contained chicks during the experiment.

The best model for the total number of times that tree martins perched at/entered nest boxes cumulatively over the survey period contained an interaction between treatment group and survey period (Table 1). Based on that model, the total number of times martins visited boxes increased with each successive survey period in the treatment group, but was constant in the control (Table 2). The best model for the maximum number of times martins perched at/entered boxes during individual surveys in each period also contained an interaction between treatment and survey period (Table 1). Based on that model, the maximum number of times martins visited boxes increased with each successive survey period in the treatment group, but was constant in the control (Table 2).

Within a week of nest destruction, all martins in the treatment group had reconstructed nests and 8/10 had laid replacement clutches. The model including treatment group fit the data better than the null (ΔAIC 2.562) and nest success in the treatment group was 0.5 ± 0.2 (LCI: 0.2, UCI: 0.8) compared to 0.9 ± 0.1 (LCI: 0.5, UCI: 1) in the control group.

Discussion

Deployment of nest boxes for orange-bellied parrot is an important conservation action but competition with tree martins could be an important limitation to the effectiveness of this approach. Removing martin nests and eggs did not contribute to the management aim of increasing the number of vacant boxes potentially available to parrots. Martins in the treatment group perched at/entered boxes more often than controls. All treatment nest boxes were reoccupied, and nests were rebuilt within a week. Nest survival in the treatment group was lower, but these nest boxes were unavailable to parrots anyway because (i) vigilant martins harass parrots, and (ii) martin nests make boxes less attractive to parrots. Other approaches should be explored to relieve competition for parrots. Where nesting success of parrots is at risk, trapping and removal of tree martins may be necessary.

If suitable nesting sites are rare, interspecific competition may become problematic if subordinate competitors are denied breeding opportunities. However, management efforts to correct this problem should be evaluated for efficacy. Further study of martin behaviour is warranted to evaluate whether nest destruction could have a perverse impact on parrots via increased defence of nearby nest boxes. Removal of adult martins or oiling eggs should also be tested to identify management actions that maximise availability of vacant, undefended boxes for parrots.

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Tables

Table 1. Competing models ranked by AIC for the maximum and total number of times tree martins perched at the entrances of nest boxes. * indicates the preferred models from which estimates were calculated.

Response variable	model	AIC	d.f.
Maximum	Treatment × survey period*	238.4996	6
	Survey period	255.9475	3
	Treatment	263.8930	2
	Null	272.0333	1
Total	Treatment × survey period*	296.1150	6
	Survey period	317.2550	3
	Treatment	345.2134	2
	Null	353.5634	1

Table 2. Modelled estimates on the original scale ± standard error (lower confidence interval – upper confidence interval) from the best fitting models for the total and maximum number times tree martins perched at/entered nest boxes in the study. C = control group, T = treatment group.

Response	Group	Day before/morning of	Day of/morning after	Week after

Total number	C	1.9 ± 0.4 (1.2 – 2.9)	1.7 ± 0.4 (1.1 – 2.9)	3.3 ± 0.5 (2.4 – 4.5)
	T	0.7 ± 0.3 (0.3 – 1.4)	4.3 ± 0.7 (3.1 – 5.7)	6.1 ± 0.8 (4.7 – 7.8)

Maximum number	C	1.5 ± 0.4 (0.9 – 2.4)	1.5 ± 0.4 (0.9 – 2.4)	1.6 ± 0.4 (1.0 – 2.6)
	T	0.6 ± 2.4 (0.3 – 1.3)	3.0 ± 0.5 (2.1 – 4.3)	4.4 ± 0.6 (3.2 – 5.9)

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