The role of intense nest predation in the decline of Scarlet Robins and Eastern Yellow Robins in remnant woodland near Armidale, New South Wales

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A study of open-nesting Eastern Yellow Robins *Eopsaltria australis* and Scarlet Robins *Petroica multicolor*, on the New England Tablelands of New South Wales in 2000–02, found low breeding success typical of eucalypt woodland birds. The role of intense nest predation in the loss of birds from woodland fragments was investigated by means of predator-exclusion cages at robin nests, culling of Pied Currawongs *Strepera graculina*, and monitoring of fledging and recruitment in the robins. Nest-cages significantly improved nest success (86% vs 20%) and fledging rate (1.6 vs 0.3 fledglings per attempt) for both robin species combined (*n* = 7 caged, 20 uncaged). For both robin species combined, culling of currawongs produced a twofold difference in nest success (33% vs 14%), a higher fledging rate (0.5 vs 0.3 per attempt), and a five-day difference in mean nest survival (18 vs 13 days) (*n* = 62 nests), although sample sizes for nests in the cull treatment (*n* = 18) were small and nest predation continued. Although the robin breeding population had not increased one year after the cull, the pool of Yellow Robin recruits in 2001–03, after enhanced fledging success, produced two emigrants to a patch where Yellow Robins had become extinct. Management to assist the conservation of open-nesting woodland birds should address control of currawongs.

Key words: Woodland birds, Habitat fragmentation, Nest predation, Predator exclusion, Predator removal.

INTRODUCTION

INCREASED nest predation in fragmented and degraded eucalypt woodlands was one of the specific mechanisms hypothesized by Ford *et al.* (2001) for the loss and decline of bird species from woodland in southern Australia. Many open-nesting small passerines, including robins (Petroicidae), flycatchers (Dicruridae), whistlers (Pachycephalidae) and honeyeaters (Meliphagidae), experience poor nesting success in remnant vegetation in the region, with young fledging from about 20% of nests (reviewed by Ford *et al.* 2001; Higgins *et al.* 2001; Fitri and Ford 2003; Higgins and Peter 2003; Debus and Lollback 2005). Poor nest success and high rates of nest predation are characteristic of the life histories of small passerines in southeastern Australia (Woinarski 1985; Yom-Tov 1987; Robinson 1990), but it is unclear whether this feature is natural or whether nest success has declined in recent decades with changes in land use.

Many experiments on artificial nests have tested whether predation differed between remnants of different sizes, or at edges versus woodland interior; that is, whether predation is linked to fragmentation (Gardner 1998; Taylor and Ford 1998; Major *et al.* 1999; Matthews *et al.* 1999; Zanette and Jenkins 2000; Fulton and Ford 2001a; Berry 2002; Piper *et al.* 2002; Zanette 2002). These results have been equivocal, with at best modest evidence for higher predation on edges or in smaller remnants. Instead, it appears that high nest predation occurs across the rural landscape generally, including the woodland interior, by predators that occur in woodland rather than edge or open country.

The Pied Currawong *Strepera graculina* is a nest predator whose population has increased in eastern Australia, probably owing to the inclusion of exotic fruits and other novel (human-provided) foods in its diet, its wide dispersal of invasive plants via regurgitated seeds, and its transition to an urban wintering and breeding bird (Bass 1989, 1990, 1995; Major *et al.* 1996; Wood 1998, 2000; Rose 1999; Bayly and Blumstein 2001; Fulton and Ford 2001b). For robins and other woodland passerines predation is the main cause of nest failure, and the currawong is believed to be the main nest predator (Robinson 1990; Major *et al.* 1996; Zanette and Jenkins 2000; Ford *et al.* 2001; Berry 2001, 2002). However, the presumed role of the currawong in reducing bird populations and causing local declines is controversial (Bayly and Blumstein 2001), and has been tested (and proven) only on a seabird nesting on an offshore island, where habitat degradation had also exposed nests to predation (Priddel and Carlile 1995). The currawong may now impose sufficiently high predation on nests of small woodland birds so that there are too few fledglings to replace adult mortality and allow emigration among remnants.

Although culling of currawongs led to a significant decline in the predation rate on

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artificial nests with real eggs (Fulton and Ford 2001a), there was still a high predation rate on eggs, suggesting that other predators (as well as remaining currawongs on the cull site) were also involved. There is a need for controlled experimental studies to elucidate what role the currawong plays in reducing fledging rates and recruitment, and consequent decline of woodland passerines (Bayly and Blumstein 2001; Fulton and Ford 2001a). Currawongs appear to be most predatory during their own breeding season (September–December), often taking and caching vertebrate prey for feeding to their mates or young (Cooper and Cooper 1981; Prawiradilaga 1994; Wood 1998, 2000).

The Scarlet Robin *Petroica multicolor* and Eastern Yellow Robin *Eopsaltria australis* (hereafter Yellow Robin) build open, cup-shaped nests in the tree and shrub canopy of temperate woodlands. They have low nest success (10–40%: Marchant 1984, 1985; Robinson 1990; Debus 2006) and the Scarlet Robin is declining in most of its range, although the evidence for a decline in Yellow Robins is contradictory, with increases in some regions but declines in others, including New England (Barrett and Silcocks 2002; Barrett *et al.* 2003). An important question is whether currawongs limit nest success, recruitment and hence the breeding population of robins in remnants. The aim of this study was to determine whether protection from, and culling of, currawongs leads to reduced nest predation, and in particular to more juvenile robins reaching independence, and whether these offspring join the local breeding population and hence increase the subpopulation.

The present study addressed the currawong nest-predation hypothesis by protecting nests from predators by means of (a) predator-exclusion cages around some nests of Scarlet Robins and Yellow Robins in 2001 and (b) removing the currawongs from half of a 270 ha woodland patch in spring 2002, and monitoring fledging success at protected and unprotected robin nests and recruitment of juveniles into the breeding population.

STUDY AREA AND METHODS

Study site

The study site was Imbota Nature Reserve (formerly Eastwood State Forest), 10 km south-east of Armidale (30°30'S, 151°40'E) on the New England Tablelands of New South Wales. This woodland patch of about 270 ha, including contiguous intact woodland on private land, has been described by Ford *et al.* (1986), NPWS (2002) and Hunter (2003), with details summarized by Debus (2006). The study period culminated in the dry year of 2002 (see Debus 2006). In 2000–2002 the reserve supported 10–12 pairs of Scarlet Robins, distributed fairly evenly throughout, and 8–10 pairs of Yellow Robins, distributed patchily though with similar numbers in the northern and southern halves of the reserve (Debus 2006).

Normally, the reserve supports 10–12 breeding pairs of currawongs, distributed fairly evenly throughout (pers. obs.; Fulton and Ford 2001a). Other known or suspected nest predators included at least five adult pairs of Grey Butcherbirds *Cracticus torquatus*, kookaburras *Dacelo*, honeyeaters, Grey Shrike-thrush *Colluricincla harmonica*, Olive-backed Oriole *Oriolus sagittatus*, Black-faced Cuckoo-shrike *Coracina novaehollandiae*, three corvid species, and Common Brushtail Possums *Trichosurus vulpecula* (Fulton and Ford 2001a; Debus 2006).

Monitoring of robin nests

Field procedures and baseline data for 2000, a control year, are detailed elsewhere; robins were colour-banded in all years (Debus 2006). Protected and unprotected robin nests in both years of the experimental study (2001–02) were monitored daily or almost so, until success or failure. Particularly in 2002, nests were monitored from as close as possible to initiation (95% found at building, laying or start of incubation), and only those nests in which laying was confirmed were included in calculations of nest success. Results from nests found in all years of the study (2000–02) were included in assessments of nest failure and post-fledging progress.

Caging of nests

Cages were deployed in the 2001 robin breeding season. Cages were constructed of lengths of plastic garden trellis mesh 91 cm deep, of mesh size 5 × 5 cm (permitting free passage of robins, but excluding birds of Grey Shrike-thrush size and larger). Brown mesh was used for nests on dead branches, and olive-green for nests among live foliage. Cages were constructed as cylinders with the nest at the centre, and the top and bottom cut, folded in and secured by green garden-ties. The radius (27 cm), and hence circumference required (1.7 m), of the cage was calculated to place the nest beyond the reach of a currawong pushing its head through the mesh (from specimens: head–bill = 12 cm, doubled for maximal neck extension = 24 cm). Nests caged were at least 1.5 m above the ground, but limited to those within reach of a 2 m stepladder.

Acceptance of cages by parent robins was confirmed at the nestling stage, before extending the procedure to nests with eggs. The latter were caged only after incubation was fully established, several days after the clutch was complete. Seven cages were installed: one around a Scarlet Robin nest, and six around Yellow Robin nests (excluding one trial cage, that failed, for each species, after which the radius and circumference were increased to the dimensions given). Most Scarlet Robin nests were impractical to cage, being high and often on precarious dead branches (Debus 2006).

Culling of currawongs

The southern half of Imbota was chosen for culling of currawongs, being the opposite half from which nesting currawongs were culled by Fulton and Ford (2001a) in 1999. The location of resident, nest-building pairs of currawongs was established throughout Imbota in August–October 2002. The northern half of Imbota had been fully reoccupied by new pairs since the previous cull.

Currawong nesting was prevented in south Imbota for the duration of the currawong breeding season, and the latter two-thirds of the passerine breeding season, in 2002. Five adult pairs of currawongs were culled in the third week of October, before they laid eggs, and two days before the first incubating currawong was seen in the northern half. Immediate replacement currawongs ($n = 5$) were culled in the following week, then a further four in November and two in December, as soon as they were detected. Regular (almost daily or initially twice daily) patrols were maintained for currawongs until the last robin fledglings were fully grown in early February 2003.

Statistical analysis

Nest success from caged versus uncaged nests was analysed by means of two-by-two χ^2 contingency tables (caged/uncaged vs success/fail), the outcomes confirmed by Monte Carlo simulations (to check on the validity of χ^2 tests where sample sizes or expected values are small; Zaykin and Pudovkin 1993). Similarly, success of robin nests in the currawong cull area versus the non-cull area was analysed by means of χ^2 contingency tables (cull/non-cull vs success/fail), the outcomes confirmed by Monte Carlo simulations. For logistical and administrative reasons the cull could not be initiated at the start of the robin nesting season, so results were pooled for all unprotected nests: the non-cull area (entire breeding season) and the cull area before the cull started (Appendix 1). Success was defined as the proportion of nesting attempts (clutches laid) that resulted in fledged young. Mean duration of robin nest survival, from clutch initiation, in cull versus non-cull areas was analysed by means of a generalised linear model using ANOVA to test for interactions between species and treatments. For Mayfield estimates of nest survival (Mayfield 1975; Johnson 1979), standard errors and 95% confidence intervals (2 × SE) were calculated to ascertain statistical significance at $P = 0.05$ for categories being compared (caged vs uncaged in 2001, cull vs non-cull in 2002, and the three-year baseline 2000–02 vs caged or cull).

RESULTS

Baseline and control data

Only 33% and 9% of unmanipulated nests of Yellow Robins and Scarlet Robins were successful, over three breeding seasons 2000–02 inclusive (Yellow Robin: 5/11, 3/8, 5/21 nests; Scarlet Robin: 2/10, 1/12, 1/23 nests, in 2000, 2001 and 2002 respectively). Mayfield-adjusted baseline values for probability of nest survival over the three years were 0.24 and 0.08 for each species (Table 1). The overall fledging rate was 0.6 and 0.1 young per attempt for Yellow and Scarlet Robins respectively. Predation (80%) was the

Table 1. Mayfield probability of nest survival (Mayfield 1975; Johnson 1979) for Yellow Robins and Scarlet Robins. Baseline data (2000–02) and predator treatments: nest cages 2001, currawong cull 2002. 95% CI = 95% confidence interval (± 2 × SE); *$P < 0.05$ where 95% CI for compared treatments do not overlap.

Species/treatment	Nest survival	SE	95% CI
Yellow Robin:			
Baseline, all years	0.24	0.011	0.22–0.26
2001 uncaged	0.24	0.034	0.17–0.31
2001 caged	0.75	0.010	0.73–0.77*
2002 non-cull	0.19	0.015	0.16–0.22
2002 predator cull	0.37	0.014	0.34–0.40*
Scarlet Robin:			
Baseline, all years	0.08	0.016	0.05–0.11
2002 non-cull	0.07	0.017	0.04–0.10
2002 predator cull	0.22	0.018	0.18–0.26*
Both species combined:			
2001 uncaged	0.18	0.020	0.14–0.22
2001 caged	0.82	0.007	0.81–0.83*

main cause of nest failure, and currawongs were among the nest predators observed. Predation continued post-fledging, with about 30% of juveniles disappearing during the dependence period (Debus 2006).

Acceptance of nest-cages

Yellow Robins and Scarlet Robins immediately accepted cages installed around nests with chicks, returning to brood as soon as the observers had retreated. Similarly, they immediately accepted cages installed around nests with eggs once incubation was established for several days. There were no cases of nest desertion attributable to installation of cages. However, there was one case of apparently human-induced nest desertion before installation of a cage, towards completion of the clutch or at the start of incubation. During a pre-installation check, the sitting female Yellow Robin was invisible on the low (1.5 m) nest and was inadvertently flushed from a clutch of two eggs. She did not return, despite immediate retreat of the observer.

Predator exclusion

Nest success for Yellow Robins in 2001 was 83% for caged versus 38% for uncaged nests, producing 1.7 and 0.6 fledglings per attempt respectively (Table 2); in 2001 the only brood of three fledglings came from a caged nest (broods usually 1–2; $n = 8$ in 2001). The difference in success between caged and uncaged nests of Yellow Robins in 2001 was not significant, though sample size was small for caged nests ($\chi^2_1 = 2.94$, $P = 0.124$). The success rate of caged nests was significantly higher than that for unprotected nests over the three baseline years, 2000–02 (33%; $\chi^2_1 = 5.66$, $P = 0.017$). The single caged Scarlet Robin nest produced at least one fledgling from a brood of three that reached fledging age.

Predator-exclusion cages significantly increased nest success for both robin species combined in 2001 (86% vs 20%; $\chi^2_1 = 9.60$, $P = 0.001$), producing 1.6 and 0.3 fledglings per attempt respectively. This result was influenced by the small number of Scarlet Robin nests that could be caged, the large number that could not, and the high failure rate for uncaged nests of this species (Table 2). The success rate of unprotected nests over three years (20%) was also significantly lower than that of caged nests ($\chi^2_1 = 14.90$, $P = 0.000$).

The Mayfield-adjusted estimates of nest survival reveal a clear benefit from predator exclusion: nest-cages increased success threefold for Yellow Robins and fourfold for both species combined, an effect that was significant ($P < 0.05$; Table 1).

Table 2. Nest success and number of fledglings from caged and uncaged Yellow Robin and Scarlet Robin nests 2001.

Species	No. of nests	No. successful (No. of young)	No. failed (%)
Yellow Robin:			
caged	6	5 (10)	1 (17)
uncaged	8	3 (5)	5 (63)
Scarlet Robin:			
caged	1	1 (1+)^{A}	0 (0)
uncaged	12	1 (1)	11 (92)
Both species:			
caged	7	6 (11)	1 (14)
uncaged	20	4 (6)	16 (80)

^{A}Brood of three young reached fledging age; only one seen out of nest.

Predator removal

For Yellow Robins, nest success was 40% in the cull treatment versus 24% for nests not subject to currawong control in 2002; for Scarlet Robins, 25% versus 4%. Culling of currawongs did not significantly increase nest success for Yellow Robins ($\chi^2_1 = 0.86$, $P = 0.392$) or Scarlet Robins ($\chi^2_1 = 2.90$, $P = 0.15$), although the sample size for successful Scarlet Robin nests was small (Table 3). For both species combined, the cull treatment produced a twofold difference in nest success that was almost significant (33% vs 14% nest success; $\chi^2_1 = 3.18$, $P = 0.10$), with small sample sizes in the cull treatment.

The Mayfield-adjusted estimates of nest survival also reveal a positive effect from predator control: the currawong cull increased success twofold for Yellow Robins and threefold for Scarlet Robins within 2002, and by similar amounts above the three-year baseline, an effect that was significant ($P < 0.05$; Table 1).

The fledging rate was higher in the cull area for Yellow Robins (0.60 vs 0.48 fledglings per attempt respectively), Scarlet Robins (0.38 vs 0.09 fledglings) and both species combined (0.50 vs 0.27 fledglings, Table 3). The difference was particularly evident for Scarlet Robins: 23 nest attempts in the non-cull area produced one brood of two fledglings; eight attempts in the

Table 3. Nest success and number of fledglings from Yellow Robin and Scarlet Robin nests with and without currawongs culled 2002.

Species	No. of nests	No. successful (No. of young)	No. failed (%)
Yellow Robin:			
cull	10	4 (6)	6 (60)
non-cull	21	5 (10)	16 (76)
Scarlet Robin:			
cull	8	2 (3)	6 (75)
non-cull	23	1 (2)	22 (96)
Both species:			
cull	18	6 (9)	12 (67)
non-cull	44	6 (12)	38 (86)

cull area produced three fledglings (B/1, B/2). For Yellow Robins, brood sizes at fledging were similar: 1–3 young per brood ($n = 10$ broods) in the non-cull area (B/1 × 1, B/2 × 3, B/3 × 1; mean = 2.0), and 1–2 ($n = 4$ broods) in the cull area (B/1 × 2, B/2 × 2; mean = 1.5).

Yellow Robin nests survived 2–3 days longer than Scarlet Robin nests on average (Table 4), a non-significant difference (mean 16 and 13 d; $F_{1,57} = 0.76, P = 0.388$). There was no interaction between species and treatments ($F_{1,57} = 0.01$, $P = 0.925$). For both species combined, the mean duration of nest survival was five days longer in the cull area than the non-cull area (18 vs 13 d, Table 4): a difference that approached significance ($F_{1,57} = 3.14, P = 0.078$), with small sample sizes in the cull treatment.

Table 4. Duration of survival (days) for Yellow Robin and Scarlet Robin nests with and without currawongs culled in 2002, from initiation of clutch (nests excluded where initiation date uncertain).

Species	No. nests	Range	Mean	SD
Yellow Robin:				
cull	9	4–30	19.2	10.6
non-cull	18	2–28	14.3	9.6
Scarlet Robin:				
cull	8	2–29	17.0	12.0
non-cull	23	2–27	11.6	9.2
Both species:				
cull	17	2–30	18.2	11.0
non-cull	41	2–28	12.8	9.3

Recruitment

Of 10 Yellow Robins fledged from six caged nests in 2001, seven reached independence; one of these dispersed to another patch. This result compares with 14 fledglings and 12 reaching independence, from 20 uncaged nests in 2000 and 2001. Thus, protection from predators probably led to three or four additional, potential recruits. Two birds from caged nests recruited to an increased breeding population in spring 2002, but later in 2002 the robin population dropped to below the number of pairs or groups present in 2001. Hence, the extra fledglings from caged nests produced no sustained increase in the breeding population.

Of 10 juvenile Yellow Robins fledged from 21 nests in the non-cull area in 2002, eight reached independence and at least five of these remained in Imbota. Of six Yellow Robins fledged from 10 nests in the currawong cull area in 2002, three reached independence and two of these remained in Imbota (one after dispersing to another patch and returning). This outcome produced perhaps only one more recruit than would be expected without control of currawongs. Of two juvenile Scarlet Robins fledged from one of 23 non-cull nests in 2002, at independence one disappeared from and one remained in Imbota. Of three Scarlet Robins fledged from two of eight nests in the currawong cull area in 2002, two reached independence and one of these remained in Imbota. Thus, potential recruits from enhanced fledging success in 2002 served only to provide dispersers, and to partially replace populations that had declined from the 2000–01 baseline.

DISCUSSION

Success of unmanipulated nests

Eastern Yellow Robins and Scarlet Robins experience low nesting success at Imbota, with failures caused mostly by predators, including the Pied Currawong (Debus 2006). This result is consistent with other studies of nest success, fledging success and the causes of nest failure in robins of southeastern Australian temperate woodlands (see Marchant 1984, 1985; Robinson 1990; Zanette *et al.* 2000). However, nest success and productivity can be much higher, and predation rates much lower, in southwestern Australian forest (Russell *et al.* 2004) from which, notably, the Pied Currawong is absent although most of the other avian nest predators, including the Grey Currawong *Strepera versicolor*, are present (Barrett *et al.* 2003).

Protected nests

Results from caged nests, most of which were successful, confirm that predation is the major cause of nest failure. Robins also experienced higher nest survival rates in the area where currawongs had been culled, suggesting that currawongs are a major nest predator. This result accords with the artificial nest experiments of Fulton and Ford (2001a). However, at Imbota nest predation continued after the removal of currawongs, probably because of the wide range of other nest predators in the cull area.

The low sample size of caged and uncaged Yellow Robin nests in 2001, and cull versus non-cull nests in 2002, conferred low statistical power. Adopting the precautionary principle, it is likely that a significant effect occurred but was not detected. A similar caution applies to the unbalanced data set, with small sample size of nests in the cull area, for duration of nest survival (Table 4). That is, although large effects were not evident, small or medium effects are plausible and indeed the Mayfield estimates detected significant effects (Table 1).

Several factors may have confounded the results of the currawong cull. First, within-patch variation: two Yellow Robin territories in the non-cull area consistently had high breeding success over the three years 2000–02, whereas the other territories in Imbota had lower and variable success, perhaps related to habitat features. These two productive robin groups were in currawong territories, and were not in the part of Imbota that escaped predation in 1999 (cf. Fulton and Ford 2001a). These exceptional territories also had an active Little Eagle *Hieraaetus morphnoides* nest on their mutual boundary; the eagles defended the area against predators such as corvids (pers. obs.). Third, removal of resident currawongs in the experimental part of Imbota may have allowed currawong pairs from the north to extend their foraging ranges, and floaters to invade. The ongoing cull may also have lessened predation pressure in the northern non-cull area.

The results at Imbota do not demonstrate such clear-cut benefits from predator control as the results on nesting *Petroica* robins in New Zealand (Armstrong *et al.* 2000; Powlesland *et al.* 2000; Etheridge and Powlesland 2001). However, in New Zealand the main predators are introduced mammals rather than native avian predators; nest-robbing large birds (butcherbirds, currawongs or corvids) are absent from New Zealand. The results for Imbota are nevertheless consistent with those of Zanette and Jenkins (2000) on Yellow Robins: some fragments had high rates of nest predation and were demographic sinks (i.e., recruitment was less than adult mortality), whereas others had lower rates of nest predation and were potential sources (i.e., recruitment at least compensated for adult mortality).

Recruitment

Increased success of individual nests need not lead to more recruits or to increased population size, at least partly because these aspects are also influenced by the number of nesting attempts (Nagy and Holmes 2004). Predation on nestlings and fledglings may be compensatory rather than additive forms of mortality (Newton 1998, 2000), and the evidence for impact on populations, by nest predators such as corvids, is equivocal (Stoate and Thomson 1998).

Reduced nest predation, and enhanced recruitment to independence, did not result in an increase in the robin breeding population at Imbota. At best it resulted in partial replacement in 2003 of pairs lost during 2002. However, the extra recruits in 2001 and 2002 may have prevented a more serious decline of the robin populations during 2002–03. Furthermore, the pool of Yellow Robin recruits in 2001–03, after enhanced fledging success from the nest-cages and currawong cull, produced two dispersers to another patch, where Yellow Robins had become extinct but to which they had been reintroduced in 2001 (Debus and Ford, unpubl. data).

Habitat, nest predation and dispersal probably all play a role in the decline of woodland birds. Habitat quality and food supply may ultimately determine the carrying capacity of a patch, but nest predation may limit recruitment and keep local populations below carrying capacity, by limiting emigration. A lack of dispersers may increase the extinction probability for small populations. Thus, currawongs may have a role in the population dynamics of robins at the landscape scale, by influencing whether patches like Imbota can sustain or rescue other patches, and also whether smaller patches can maintain their populations despite limited immigration.

Management implications

Nest-cages could be trialled on other declining passerines that build low nests, as some other species also accept nest-cages (fairy-wrens *Malurus* and small honeyeaters: Franklin *et al.* 1995; Van Bael and Pruett-Jones 2000). However, some species may be less tolerant than robins, and ideally sites should have appropriate cover to ensure survival of fledglings. Cages are ethically preferable to culling of predators, but are labour-intensive.

This study revealed that culling of Pied Currawongs can lead to a twofold or greater increase in nest success. These results provide some support for the control of currawongs. Given the currawong's abundance and the loss of some of its main predators (e.g., large owls) from woodland fragments, control of currawongs seems a reasonable option for landholders wishing to protect passerine nests. Culled birds appear to be replaced rapidly, so that removal may need to be repeated within and between years.

In such cases of uncertainty, where currawongs may not have a large effect but probably have a small or medium effect, adopting the precautionary principle means that a precautionary measure (i.e., control of currrawongs) is justified. The issue of currawongs has parallels with the controversy over fox predation on native mammals. The proponents of fox control were criticised on statistical grounds, but precautionary measures were vindicated by long-term study (cf. Friend 1990 and Kinnear *et al.* 2002 vs Hone 1994 and Bomford *et al.* 1995).

There is likely to be an interaction between nest predation and habitat or other aspects of resource availability for small birds (Weidinger 2002; Zanette *et al.* 2003; Nagy and Holmes 2004; Debus, unpubl. data). Therefore, management should include enhancement of habitat quality (e.g., plantings of an indigenous shrub layer) in remnant woodland. Enhancement of resources and control of predators may have a synergistic benefit greater than the sum of either alone (Zanette *et al.* 2003).

Control actions should also aim to reduce resources in the matrix that sustain nest predators in fragments (Chalfoun *et al.* 2002).

Management, preferably through education and extension, should therefore be directed towards eradication of introduced berry-bearing plants (which provide abundant winter food sources for currawongs) from urban, rural and bushland areas, and their replacement with locally indigenous trees and shrubs.

ACKNOWLEDGEMENTS

This study formed part of a PhD project, supported by an Australian Postgraduate Award (administered by UNE) and by the Division of Zoology, UNE. Ben Boland, Will Buchanan, Lachlan Debus, Sandy Hamdorf, Annette and Matt Harrison, Andrew Ley, Greg Lollback, Jim Palmer, Kihoko Tokue and Paul Webber provided field assistance. Andrew Taylor and Ken Pines (NSW National Parks and Wildlife Service, Armidale) and Steve Trémont assisted with logistics of the currawong cull. Neighbours of Imbota, the Burton and Moffitt families, permitted field-work on their land. Dr Stuart Cairns (Zoology, UNE) ran the statistical tests. The project was aided financially by the Stuart Leslie Bird Research Awards (Birds Australia), the NSW Field Ornithologists Club research grants, the Joyce W. Vickery Scientific Research Fund (Linnean Society of NSW) and the NSW National Parks and Wildlife Service (Western Directorate, Dubbo), and in kind (with gratis mist-nets and colour-bands) by the Australian Bird Study Association's Fund for Avian Research. The research was conducted under UNE Animal Ethics permits AEC 2000/0081, 01/042 and 02/074, with authorisation from NSW NPWS and the Australian Bird and Bat Banding Scheme. Hugh Ford supervised the project, and he, Doug Armstrong and Shelley Hinsley critically reviewed the relevant thesis chapter. I thank Hugh Ford, Harry Recher and referees Ted Davis and Mike Calver for comments on a draft.

APPENDIX 1

Data for Yellow Robin and Scarlet Robin nests in north Imbota (currawongs not culled) and south Imbota (currawongs culled) in 2002, before and after the cull took place. N = No. of nests in each category.

Site/period	Yellow	Scarlet	Both
North:			
Pre-cull			
succeed	2	1	3
fail	3	4	7
Post-cull			
succeed	2	0	2
fail	4	4	8
South:			
Pre-cull			
Succeed	1	0	1
Fail	9	14	23
Post-cull			
Succeed	4	2	6
Fail	6	6	12

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