

# RECRUITMENT OF THE BLACK-CHINNED HONEYEATER *Melithreptus gularis gularis* IN A FRAGMENTED LANDSCAPE IN NORTHERN NEW SOUTH WALES, AUSTRALIA

G. W. LOLLBACK<sup>1</sup>, H. A. FORD and S. C. CAIRNS

Department of Zoology, University of New England, Armidale, NSW 2351, Australia.

<sup>1</sup>Corresponding author. Email: glollbac@une.edu.au

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The Black-chinned Honeyeater *Melithreptus gularis gularis* is an uncommon species that may be declining in numbers in New South Wales. One possible reason for this decline may be a low fledgling rate and lack of recruitment of juveniles into the population. This study examined the production of young by this species in the fragmented woodlands of the Bundarra-Barraba region of northern New South Wales. At the end of the 2003–2004 and 2004–2005 breeding seasons, 46 per cent and 47 per cent of groups contained independent young, respectively and contained an average of 0.7 young per group. The finite rate of increase of the population was estimated using the recruitment data and varying levels of adult and juvenile annual survival. For the local Black-chinned Honeyeater population to remain at least stable, minimum adult annual survival was estimated at 0.7 and minimum juvenile survival was estimated at 0.6. Based on values for similarly sized Australian passerines, the former value is possible but the latter is unlikely to be the case. There was no evidence that recruitment was poorer in smaller patches of native vegetation, in comparison with large patches.

## INTRODUCTION

Many species of woodland birds have declined in numbers across southern Australia in recent decades (Ford *et al.* 2001). The Black-chinned Honeyeater *Melithreptus g. gularis* is one species that has apparently declined (Reid 1999), and is now regarded as *threatened* in New South Wales (NSW Scientific Committee 2001). Although the underlying reasons for these declines include habitat loss, fragmentation and degradation, the ecological processes that have caused the declines are poorly understood. The annual survival of woodland birds is high, but breeding success is often low (Rowley and Russell 1991; Ford *et al.* 2001). The major cause of nest failure is predation. There is evidence that habitat fragmentation may lead to an increase in the rate of nest predation, because generalist predators are more common at woodland edges (Kurki *et al.* 2000; Cantrell *et al.* 2001) and predators from open habitat may also encroach into remnant edges (Gardner 1998; Zantede and Jenkins 2000). However, the evidence of increased predation at woodland edges in Australia is equivocal. Boulton and Clarke (2003), for instance, found that Yellow-faced Honeyeater *Lichenostomus chrysops* nests close to the edge suffered less predation than those in the centre of a patch, even though more nest predators were found at the edge. Piper *et al.* (2002) demonstrated that predation of artificial nests was no greater at habitat edges than it was within core habitat. Zantede and Jenkins (2000), and Taylor and Ford (1998) found that predation rates did not differ consistently amongst patches of different sizes.

This study examined whether there was adequate recruitment of Black-chinned Honeyeaters in the Bundarra-Barraba region of New South Wales to sustain the population. Although woodlands and open forests in the region are

fragmented, there is still more native vegetation than in most parts of south-eastern Australia (Oliver *et al.* 1999). The mean number of young recruited per group of Black-chinned Honeyeaters over two seasons was calculated. Because there are no data on annual survival of adult or juvenile Black-chinned Honeyeaters, the survival rates that would be required for the estimated recruitment to be sufficient to maintain the population of Black-chinned Honeyeaters were calculated. We also tested whether patch size and isolation influenced recruitment in Black-chinned Honeyeater groups.

## METHODS

### Study site

The study took place at a number of sites on the western edge of the Northern Tablelands bioregion (NSW National Parks and Wildlife Service 2003), in an area bounded by the towns and hamlets of Bundarra (30°10'S, 151°04'E), Yarrowyck (30°28'S, 151°22'E) and Kingstown (30°30'S, 151°06'E). All sites were in box-ironbark woodland as described by Oliver *et al.* (1999). The region has retained 43 per cent of its original woodland (Oliver *et al.* 1999).

### Study species

Adult Black-chinned Honeyeaters have a short, slightly down-curved, all black bill (Higgins *et al.* 2001), while juveniles are distinguished from adults by a brown (rather than black) head and partly orange beak (Higgins *et al.* 2001). They form tight social groups, which ranged from a pair to five individuals (mean group size = 2.68; s.d. = 0.68) in the study area. They were sedentary in the study area and occupied and defended large territories (>15 ha) over the study period (pers. obs.).

### Study design

The study was undertaken during the breeding seasons (August – February) and after these breeding seasons, from August to April of 2003–2004 and 2004–2005. Because the species defends territories against conspecifics (Chapman 1995; Willoughby 2005; pers. obs.), individual groups were easily identified. Juveniles were easy to count as they stayed close to other members of their group. Groups were initially found by systematic sampling and call playback during 2003–2004, and were revisited several times each breeding season to count the number of independent young. Once the last Black-chinned Honeyeater group had finished feeding young, searching for juveniles ceased. Birds were deemed successful at recruiting young into the population if an independent juvenile remained part of a group at the end of the breeding season. The number of young produced by each group was recorded.

### Analysis

For a general indication of whether juvenile recruitment was adequate to maintain the local Black-chinned Honeyeater population, the finite rate of increase ( $\lambda$ ) was calculated using the formula used by Zanette (2000):

$$\lambda = S_f + N_i \times J_i \quad (1)$$

where:  $S_f$  = annual survival of breeding females;  $N_i$  = number of independent female young per female per year;  $J_i$  = annual survival of juveniles. A population is sustainable when  $\lambda$  is greater than or equal to one. Because there is no information on the survival rates of Black-chinned Honeyeaters, the finite rate of increase was calculated for a range of both juvenile female survival and adult female survival. This formula was used because it is easy to calculate and apply to other data, and relies on relatively few unknown variables. Formula (1) assumes that females are capable of reproduction in the breeding season following their birth, which is a sound assumption for the Black-chinned Honeyeater.

A logistic regression with a binomial error term was used to model the probability of a group producing at least one independent juvenile in relation to certain landscape parameters. The parameters included were: the size of the patch in which the group bred (if a group occupied more than one patch, the size of the patches was cumulated), the edge ratio of the patch (the ratio of perimeter to area), and whether or not the home range extended to the edge of the patch. The response variable, recruitment success, was binary by nature (1 = success, 0 = failure). Recruitment data for both years were pooled for the analysis.

The models were chosen *a priori* and were based on information found in the literature on avian ecology. Model selection was undertaken using a modified Akaike's Information Criterion ( $AIC_c$ ) because the sample size was low (Burnham and Anderson 2002). The criterion is expressed by the formula:

$$AIC_c = -2 \log \left[ L \left( \hat{\theta} | y \right) \right] + 2K + \frac{2K(K+1)}{(n-K-1)} \quad (2)$$

where:  $L \left( \hat{\theta} | y \right)$  is the likelihood function of the model

parameters ( $\theta$ ) given the data  $y$ .  $K$  is the number of parameters in the model. The  $AIC_c$  difference ( $\Delta_i$ ; the  $AIC_c$  value for model  $i$ , minus the lowest  $AIC_c$  value from the suite of models) was determined for each model. The larger the  $AIC_c$  difference, the less plausible it was that a particular model was the 'best' of the suite of models considered in an analysis. Models with an  $\Delta_i$  greater than two are unlikely to qualify as the model that best explains the data (Burnham and Anderson 2002). An Akaike weight:

$$w_i = \frac{\exp(-1/2\Delta_i)}{\sum_{j=1}^R \exp(-1/2\Delta_j)} \quad (3)$$

provide a relative weight of evidence for each model as part of the model assessment process. For further explanation of the use of AIC, see Burnham and Anderson (2002).

## RESULTS

Approximately half of the groups produced young each year, with groups producing an average of 0.70 young per year (Table 1). The proportion of groups that produced young was similar for both years. The difference in the number of adults sampled between the two years resulted from sampling of different groups each year.

Assuming that half the juveniles were female, an estimated 0.33 female young were produced per group in 2003–2004, 0.37 in 2004–2005, and 0.35 on average, across both years.

Assuming a 1:1 sex ratio in the young produced,  $N_{2003/2004} = 0.33$  and  $N_{2004/2005} = 0.37$ . A range of  $\lambda$  values was calculated for a range of juvenile and adult survival rates. Once the annual adult survival was below 0.7, even with juvenile survival at 0.8, the population would be in decline (Table 2). If the survival rates for adult females and juvenile females exceeded 0.75, the population would be at least maintained. However, if the adult survival rates were less than or equal to 0.8 and juvenile survival rates were less than 0.6, the Black-chinned Honeyeater population in the study area would decline assuming the population is closed. The formula in the Methods and Table 2 shows that  $\lambda$  is more sensitive to the survival rate of adult females than to the survival rate of juveniles.

There was no outstanding model based on the landscape variables that explained recruitment success (Table 3). Three of the four models had similar weights;  $\Delta_i$  less than two, suggesting that any of the top three models could be considered the best in relation to explaining the relationship between landscape features and recruitment (Burnham and Anderson 2002). There was a negative relationship between recruitment success and patch area, and a positive relationship between recruitment success and proximity to edge habitat. That is, territories adjoining edge and in smaller patches may have had better recruitment. This appears to be contradictory to the expectation that habitat fragmentation has a negative impact on recruitment. Considering that most models shared very similar weights and that the relationship between some parameters and recruitment success was contrary to those found in other studies (Cooper *et al.* 2002; Luck 2003), it is unlikely that edge-related effects are influencing Black-chinned Honeyeater recruitment success in the Bundarra-Barraba region of New South Wales.

TABLE 1

The annual production of juveniles by Black-chinned Honeyeater groups for the two breeding seasons. The number of groups and the total number of adults is also shown. The proportion of groups that produced independent young, and the number of independent young per group are shown in brackets.

Year	2003/2004	2004/2005
Number of groups	24	19
Number (proportion) of groups that produced independent young	11 (0.46)	9 (0.47)
Number of independent young (number per group)	16 (0.67)	14 (0.74)
Number of adults	63	51
Adults per group	2.63	2.68

TABLE 2

$\lambda$  matrix for 2003/2004 and 2004/2005 given differing values of adult female and juvenile female survival (in bold).  $n = 0.35$  is used and is an average number of young per female for both breeding seasons.

		Juvenile survival						
		<b>0.9</b>	<b>0.8</b>	<b>0.7</b>	<b>0.6</b>	<b>0.5</b>	<b>0.4</b>	<b>0.3</b>
Adult survival	<b>0.9</b>	1.22	1.18	1.15	1.11	1.08	1.04	1.01
	<b>0.8</b>	1.12	1.08	1.05	1.01	0.98	0.94	0.91
	<b>0.7</b>	1.02	0.98	0.95	0.91	0.88	0.84	0.81
	<b>0.6</b>	0.92	0.88	0.85	0.81	0.78	0.74	0.71
	<b>0.5</b>	0.82	0.78	0.75	0.71	0.68	0.64	0.61
	<b>0.4</b>	0.72	0.68	0.65	0.61	0.58	0.54	0.51

## DISCUSSION

This study recorded the recruitment of Black-chinned Honeyeaters and modelled the population to determine if it is sustainable in the Bundarra region of New South Wales. The relationship between habitat size and edge parameters and recruitment was also examined.

Groups of Black-chinned Honeyeaters produced an average of 0.70 independent young per year over two years. Mean recruitment for Black-chinned Honeyeaters fell into the mid-range of values for productivity of similarly sized passerines in eucalypt woodlands, which span almost an order of magnitude (Table 4). However, in a few cases only numbers of fledglings were presented in the original papers. In many studies, adult survival was also given and, in a few studies, survival of independent young to the following breeding season was given. For one species of honeyeater, the Yellow-faced Honeyeater, studied in coastal open forest in Victoria, productivity averaged 2.55 fledglings per pair per year (Clarke *et al.* 2003) but the number of independent young recruited into the population is likely to be lower than this value.

TABLE 3

Black-chinned Honeyeater recruitment models that includes the number of parameters ( $K$ ), the AIC value, AIC difference ( $\Delta_i$ ) and Akaike weight ( $w_i$ ). The influence (positive or negative) of a variable on recruitment success is shown in brackets.

Model	$K$	AIC	$\Delta_i$	$w_i$
(-) Patch size	3	63.08	0	0.33
(+) Proximity to edge	3	63.17	0.14	0.31
(-) Edge ratio	3	63.4	0.37	0.27
(-) Patch size* (-) edge ratio	5	65.71	2.68	0.09

No data are available on adult survival rates of Black-chinned Honeyeaters. However, data are available for adult survival of Australian passerines. Mean adult survival from seven studies in Table 4 was 0.75 and mean juvenile survival was 0.41 from six studies. Rowley and Russell (1991) summarised estimates of survival for Australian passerines from resighting of individually marked birds, for which almost all species (20 out of 22) had adult survival rates of over 0.6. In a larger study, Russell *et al.* (2004) calculated a mean adult survival rate of 0.73 for 32 Australian and New Zealand passerines. In contrast, Yom-Tov *et al.* (1992) estimated survival rates of a range of Australian passerines from recapture of banded birds. Brown-headed Honeyeaters *Melithreptus brevirostris*, a smaller congener of the Black-chinned Honeyeater, had an estimated survival rate of 0.42. Yom-Tov *et al.* (1992) also derived a general relationship equating survival rates to body mass:

$$\text{Survival} = 0.36 + 0.065 (\text{Ln } x \text{ body-mass}) \quad (4)$$

Applying Yom-Tov's formula to the species listed in Table 4 consistently underestimates survival rates based on detailed studies.

TABLE 4

Productivity (fledglings/pair or group/year), adult survival rate and survival rates of independent young to the following breeding season, for a range of passerines in eucalypt woodlands. Unless otherwise stated, studies were from the New England Tablelands; CWS = Central Western Slopes of NSW, WAW = Western Australian Wheatbelt. Adult survival calculated from the survival estimate formula provided by Yom-Tov *et al.* (1992) is also shown.

Species	Productivity	Adult Survival	Young Survival	Estimate from equation by (Yom-Tov <i>et al.</i> 1992)	Reference
Rufous Treecreeper <i>Climacteris rufa</i>	2.1	?	0.41	0.57	Luck (2003) (WAW) Fragmented landscape
Eastern Yellow Robin <i>Eopsaltria australis</i>	1.29	0.72	0.36	0.56	Zanette (2000)
Brown Treecreeper <i>Climacteris picumnus</i>	1.15	0.79	?	0.59	Cooper <i>et al.</i> (2002)
Rufous Treecreeper	1.05	?	0.22	0.57	Luck (2003) (WAW) Fragmented landscape
Rufous Whistler <i>Pachycephala rufiventris</i>	0.74	0.84	?	0.59	Bridges (1994a); Bridges (1994b)
Eastern Yellow Robin	0.73	0.71	0.58	0.56	Debus (2006)
Black-chinned Honeyeater <i>Melithreptus gularis</i>	0.7	?	?	0.56	This study
Brown Treecreeper	0.61	0.74	0.54	0.59	Doerr and Doerr (2006) (CWS)
White-throated Treecreeper <i>Cormobates leucophaea</i>	0.36	0.84	?	0.56	Doerr and Doerr (2006) (CWS)
Scarlet Robin <i>Petroica boodang</i>	0.2	0.58	0.33	0.53	Debus (2006)

Two studies have calculated annual survival rates of honeyeaters from colour-banded birds. Clarke *et al.* (2003) gave values for Yellow-faced Honeyeaters of 0.43 for females and 0.51 for males. However, this species is migratory and adults may not return to the same location in successive years. At the other extreme, the much larger, but also migratory, Noisy Friarbird *Philemon corniculatus* showed an annual adult survival of 0.89 near Armidale (Ford 1998). Hence, it seems likely that an annual adult survival rate of 0.75 for Black-chinned Honeyeaters would be reasonable to sustain the population.

Given an adult survival rate of 0.75 and a recruitment rate of 0.7 young per group, the survival rate of independent young to the following breeding season would need to be at least 0.70 (Table 2) to sustain the population. There are few data on the survival rate of young Australian passerines from independence to the following breeding season, but these are likely to be lower than for adult survival (Johnston *et al.* 1997). Six studies on four species shown in Table 4 give an average of 0.45. Russell *et al.* (2004) found that only 0.29 of fledgling White-breasted Robins *Eopsaltria georgiana* survived until the next breeding season. Although it is possible that survival of yearling birds is underestimated because many disperse rather than die, it would seem unlikely that independent young Black-chinned Honeyeaters have a better than 50 per cent chance of surviving to the following breeding season.

Hence, it would appear that the population of Black-chinned Honeyeaters in the Bundarra region of New South Wales is not sustainable, unless adult and juvenile survival rates are higher than we have estimated from comparable species. However, productivity was only calculated over two years in this study and it is possible that in some years the species may produce more young. A number of other studies has also found that small passerine populations in fragmented woodlands do not appear to have sustainable populations, e.g. Eastern Yellow Robins *Eopsaltria australis* (Zanette 2000; Debus 2006), Scarlet Robins *Petroica boodang* (Debus 2006) and Brown Treecreeper *Climacteris picumnus* (Doerr and Doerr 2006). In addition, a number of species, such as Brown Treecreeper and Hooded Robin *Melanodryas cucullata* have shown local extinctions and range contractions over recent decades (H. Ford, S. Debus pers. obs.).

This study found no evidence that recruitment was poorer in smaller patches of native vegetation, in comparison with large patches. Because the landscape in this study has 43 per cent of its original cover, it might be that there is enough habitat left so that fragmentation effects do not heavily influence a bird like the Black-chinned Honeyeater. It has been suggested that fragmentation effects influence species population size when there was 10–30 per cent of suitable habitat left in the landscape (Andren 1994; Fahrig 1997). Radford *et al.* (2005) found that

woodland-dependent bird species richness declined markedly in Victorian landscapes with less than ten per cent tree cover, suggesting that more than just habitat loss impacted on species richness in landscapes below this level. In a landscape such as the Mount Lofty Ranges in South Australia, where only five per cent of native vegetation remains, habitat loss and fragmentation appears to have caused a dramatic decline in the Black-chinned Honeyeater population (Chapman 1995).

It is of concern that the Black-chinned Honeyeater populations may not be sustainable, even in regions that are regarded as strongholds. Clearly, it would be highly desirable to record long-term, reliable values for annual survival rates for the species, as well as additional years of data on recruitment to assess the likelihood of a population decline. Data on adult and juvenile survival of Black-chinned Honeyeaters in sites of varying patch size and different landscapes would be ideal to further assess the influence of these parameters on populations. Genetic sampling and radio-tracking would also give a better idea of movement between local populations, providing data on metapopulation dynamics and which populations are sources or sinks for migration (Hanski 1999).

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