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ASPECTS OF POPULATION BIOLOGY OF THE EASTERN SPINEBILL *Acanthorhynchus tenuirostris* (*Meliphagidae*) IN NEW ENGLAND NATIONAL PARK, NSW

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Nearly 3 000 Eastern Spinebills have been banded in New England National Park since 1977. The number of birds caught each year was greatest in winter (April-September) when two *Banksia* species were in flower. Each year there was a number of peaks in birds captured, possibly due to successive invasions of either different spinebill populations or different parts of the same population. A total of 134 (5.2%) birds were recaptured in a subsequent year, often in the same month that they were banded. The oldest bird was at least 8 years old, and survival was estimated to be 60% per year. During the year the sex ratio of the population changed, with males outnumbering females in most months but particularly so in March, July and August.

INTRODUCTION

There have been many short-term (<5 years) studies of the populations of banded birds in Australia (Lane 1964; Wilson 1964; Wooller and Milewski 1981). Only a few have covered a longer term (Rowley 1965, 1981; Morris 1975; Kikkawa 1977; Boehm 1982; Marchant 1982). Most of these studies have been on sedentary species or breeding visitors and have examined aspects such as site fidelity, seasonal changes in population sizes and sex ratios, breeding success and mortality. Few have studied non-breeding migrant populations (Liddy 1966, Fordyce 1978). These are harder to study as individuals are generally not restricted to one locality by a breeding territory or nest and may show less site fidelity from one year to the next.

We have banded a total of 2 977 Eastern Spinebills *Acanthorhynchus tenuirostris* at New England National Park between September 1977 and September 1986. Spinebills are abundant in the park from late April to early September, when they feed on banksia nectar (Ford and Pursey 1982). We found no evidence of nesting. We use our data to examine seasonal changes in abundance and sex ratio of spinebills. We also estimate survival rates between years, the first time that this has been attempted for a non-breeding population of Australian land-bird.

STUDY SITE AND METHODS

New England National Park (30°30'S., 152° 30'E.) is on the eastern escarpment of the Great Dividing Range 60km east of Armidale. We banded spinebills in open forest with a eucalypt canopy, a shrub layer of banksias and a ground layer of grasses and ferns (details of vegetation in Williams 1982). The park has a diverse avifauna (Kikkawa, Hore-Lacy and Le Gay Brereton 1965) with honeyeaters dominating the open forest in the cooler months (McFarland 1984). The major sources of nectar are *Banksia integrifolia* (flowering March-August) and *B. spinulosa (collina)* (April-September).

Birds were caught in four to seven mist nets placed in a variety of sites in the forest within

an area of about 50 hectares. The number of hours for which nets were open was recorded each day. The most intense effort was from October 1977 to December 1979 (by HF), from June 1981 to November 1983 (by DMcF) and from April to August in both 1985 and 1986 (by HF). Few birds were banded in 1980 and 1984. Bands were provided by the Australian Bird and Bat Banding Scheme, Division of Wildlife Science, CSIRO and Australian National Parks and Wildlife Service.

A minimum estimate of survival was calculated by the percentage of birds known to be alive from one to nine years after banding. If one assumes that survival rate is constant then annual survival rates can be calculated from survival to n years after banding (s_n) by calculating $s_1 = s_n^{1/n}$ (i.e. square root of survival to two years, cube root for three year survival . . . . n root for n years). This grossly underestimates survival in the first year but probably approaches the real value in later years, though sample sizes are small beyond five years.

A range of other methods to calculate survival is available (Southwood 1966, Begon 1979). Where there has been a succession of capture attempts and a low recapture rate the Fisher-Ford method is apparently the most reliable (Begon 1979). This method assumes a constant survival rate, which should be not unreasonable for bird populations in a fairly stable habitat. The method is explained in the Appendix. We grouped all birds banded in each year together as one sample and considered birds recaptured the following year to have survived for one full year. As most birds were captured in the winter months this is not unreasonable.

RESULTS

Most spinebills were captured when the banksias were flowering (Figure 1), even though nets were set up at other times in 1977 to 79 and 1981 to 83. The numbers of spinebills showed several apparent peaks every year. A small peak usually occurred in January to February, which included many juveniles. In 3 out of 4 years there were marked peaks in April, June and August to September, consisting of mostly adult birds.

Overall there was a preponderance of males (mean ratio 1.6:1.0 males to females, n=1 755 adults). The proportion of males was significantly higher among recaptured birds (2.9:1.0, n=150, $x^2_1 = 9.6$, $p < 0.01$). In addition the sex ratio changed through the year. It was close to unity in most months but in late winter males outnumbered females by 3:1 to 6:1 (Figure 2). This trend occurred in most years.

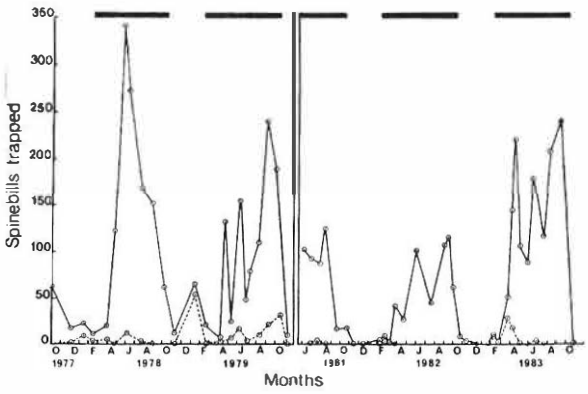

Figure 1. *Seasonal changes in the numbers of Eastern Spinebills trapped per 100 net hours. Solid line indicates all birds caught while the broken line represents only immatures and juveniles. The solid bars indicate the flowering period of the banksias (both species combined).*

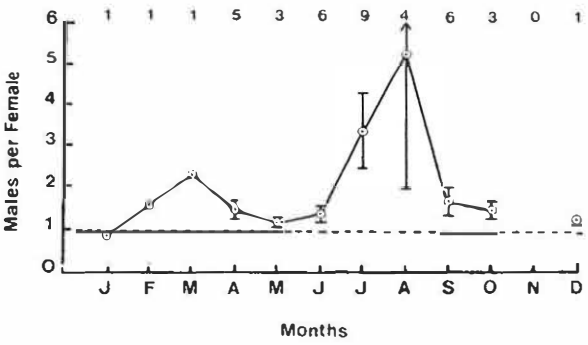

Figure 2. *Seasonal changes in the sex ratio of the Eastern Spinebill population (mean ± standard error). Number above points indicates the number of banding trips in that month where more than ten adult birds were sexed. Dotted line indicates equal sex ratio.*

A total of 229 out of 2 977 (7.7%) birds were recaptured on subsequent days with 134 individuals (5.2%) being recaptured at least once in later years (Table 1). The numbers and proportion of birds known to be alive from 1 to 9 years after banding are shown in Table 2. The oldest bird was banded as an adult female on 30 July 1978 and recaptured on 6 July 1986, 7 years and 11 months later. Annual survival rates were also calculated for each period. These are clearly underestimates initially but rise as the number of days when birds could be potentially recaptured increases. These crude estimates suggest survival is 40 to 45 per cent per year.

The results of survival rates calculated from the Fisher-Ford method are shown in the Appendix. This method gives an annual survival rate of 60 per cent.

Most birds were captured in April to September (Table 3). Not surprisingly, most birds were recaptured in later years in the same season as they were banded. However, birds banded in June to September and recaptured in later years, had a greater than 50 per cent chance of being caught within 1 month of their banding date (Table 3). Recaptures from birds banded between October and May were rarely within 1 month of their banding date. (Results up to 1983 only were used as no netting was carried out in summer in the last 3 years.) The recapture data suggest that spinebills may return to the park at similar times of the year in subsequent years.

TABLE 1

Banding and recapture data for Eastern Spinebills at New England National Park

Year	Banding effort (net-hours)	New birds banded	Recaptures from: 1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1977	140	45	1									
1978	777	577	14	22								
1979	619	429	2	28	11							
1980	126	108	0	2	2	0						
1981	405	175	0	9	7	3	4					
1982	974	304	0	4	10	9	2	9				
1983	591	466	0	1	6	0	7	19	13			
1984	12	7	0	0	0	0	0	1	0	0		
1985	372	486	0	3	1	0	1	3	7	0	19	
1986	316	380	0	1	0	1	1	3	2	0	21	31

TABLE 2

Minimum estimates of survival based on all birds known to be alive for each number of years.

Known to be alive for	Number alive	Number banded 'at risk'	Survival	Survival rate per year
1 year	134	2597	.052	5.2%
2 years	60	2111	.028	16.9%
3 years	32	2104	.015	24.8%
4 years	16	1638	.010	31.4%
5 years	8	1334	.006	35.9%
6 years	6	1159	.005	41.6%
7 years	4	1051	.004	45.1%
8 years	1	622	.002	44.7%
9 years	0	45	0	—

TABLE 3

Summary of banding and retrap data by months (1977-1983 only) for Eastern Spinebills banded in New England National Park

Month	Banding effort (net hours)	Number of birds banded	Number of retraps*	Percentage retraps caught	
				within same month but different year	in different month but same or different year
Jan.	175	47	2 (3)	0	100
Feb.	483	30	6 (9)	17	83
Mar.	304	81	2 (8)	0	100
Apr.	534	378	29 (60)	10	90
May	119	193	12 (21)	25	75
June	264	336	31 (54)	52	48
July	537	337	24 (52)	71	29
Aug.	220	219	31 (55)	58	42
Sept.	326	356	19 (35)	53	47
Oct.	268	99	21 (27)	29	71
Nov.	278	11	1 (2)	0	100
Dec.	124	17	2 (2)	0	100
Total	3632	2104	180 (328)		

*--number of banded birds that were recaptured in that month, excluding those recaptured within one month of banding. The total number of recaptures in parentheses.

DISCUSSION

Eastern Spinebills are clearly more abundant in the winter months (April-September) at the banding site, when banksias are in flower. Small numbers are present at other times in the study area or in neighbouring habitats such as temperate rainforest. Superimposed upon this crude pattern are several peaks in most years. Although chance factors such as weather may cause fluctuations in netting success or activity of the birds, it is possible that such peaks are real. The arrival of juveniles in the late summer is similar to the pattern found for Eastern Spinebills elsewhere (Wilson 1964, Liddy 1966) and for Golden Whistlers *Pachycephala pectoralis* near Armidale (Bell 1986, Ford pers. obs.), where adults arrive in late April and May to winter in eucalypt woodland. Possibly, juveniles are expelled from the parental territories soon after attaining independence. Alternatively, they may leave voluntarily, while the adults remain to moult on their territories or re-establish territorial boundaries in readiness for the next breeding season.

The three winter peaks, if indeed these are real, could represent successive waves of birds from separate populations. This is supported by the fact that occasionally in winter one experiences days when most birds trapped have already been banded, followed by days when most are unbanded. Also there is a tendency for birds to be captured on similar dates in different years. This has been noted also in Flame Robins *Petroica phoenicea* (Fordyce 1978). The timing of the peaks (April, June and August-September) could also represent passage migrants in autumn and spring as well as a separate wintering population.

Unfortunately, we have no knowledge of the breeding areas of any of the populations that winter in New England National Park. A single male banded at Byron Bay (1 July 80) was recaptured at our site (22 Mar. 82), a movement of 235km southwest. None of our birds has been recaptured elsewhere. Also spinebills are not seen obviously migrating over the study area in the way that Yellow-faced, White-naped or Scarlet Honeyeaters are observed *Lichenostomus chrysops, Melithreptus lunatus, Myzomela, sanguinolenta;* V. Fazio, pers. comm.). However, very low recapture rates are characteristic of migratory honeyeaters (Purchase 1985). The few data

TABLE 4

Distances travelled by Eastern Spinebills. Data for birds recaptured greater than 5km from original banding site. Data provided by Australian Bird and Bat Banding Scheme. (Distances in kilometres and n=sample size).

	Adult—male	Adult—female	Adult—unsexed	Juveniles & Immatures
Mean	59	13	10	13
Range	6-235	6-30	7-12	6-33
n	12	4	2	8

on movements of spinebills elsewhere indicate that they are mostly local (Table 4). Possibly, rather than displaying true migration, spinebills merely concentrate onto a rich resource from surrounding habitats. They have also been recorded increasing in winter in Canberra (Wilson 1964) and the north coast of New South Wales (Liddy 1966). They are also more common in summer than in winter in the Brindabella Range near Canberra (Lamm and Wilson 1966). Unlike the downward altitudinal movement in Canberra during winter, our autumn movement can only be upward since there is no higher ground in the New England area.

The male-biased sex ratio found in New England has been found in other wintering aggregations of Eastern Spinebills: Liddy (1966) recorded a sex ratio of 2.8:1 males to females (n=864 birds) in his north coast population. Paton (1985) found that sex ratios in a New Holland Honeyeater *Phylidonyris novaehollandiae*, population in Victoria were from 2:1 to 4:1. Dow (1973) also found 1.3 to 2.8 males to females among museum collections of eight honeyeater genera, including monochromatic species. The biases in the population could be due to the males dispersing more than females, or to the females having a greater mortality during the breeding and/or migration periods (Rowley 1965; Calder, Waser, Hiebert, Inouye and Miller 1983; Paton 1985). The very high proportions of males in mid-winter could also be because males aggressively exclude the smaller females from rich areas of nectar.

Our spinebills have an annual survival rate of about 60 per cent. This may be under-estimated if birds visit alternative wintering sites in different years. In addition most methods of estimating survival from recapture data are more reliable when data result from brief but well-spaced capture attempts. We feel that our estimate is justified though as it is based on nearly 3 000 birds captured over 9 years. A survival rate of 60 per cent is similar to those found in other small passerines in Australia, which range from 55 to 88 per cent (summarised in Ford 1985). Paton (1985) found that adult New Holland Honeyeaters showed an annual survival rate of 55 per cent (males 68%, female 42%) whereas it was only 10 to 19 per cent for juveniles. Many of these juveniles would have dispersed though rather than died. Morris (1975) calculated an annual survival rate of 57 per cent for Yellow-tufted Honeyeaters *Lichenostomus melanops*. Boehm (1978) presented data on Yellow-plumed Honeyeaters *Lichenostomus ornatus*, from which we have calculated survival rates in the region of 40 to 50 per cent per year. Bell (1982) found higher survival rates in sedentary rainforest honeyeaters in New Guinea.

Data presented by Fordyce (1978) on wintering Flame Robins indicate a survival rate of over 50 per cent in red males, but around 30 per cent in brown birds. Little information exists on long-term survival of nectarivorous birds in other continents. Calder *et al.* (1983) found that 70 per cent of females but only 27 per cent of male Broad-tailed Hummingbirds *Selasphorus platycercus* return to their breeding grounds annually in Colorado, U.S.A. Clearly only intensive and long-term banding studies of such mobile species as honeyeaters will lead to accurate estimates of survival rates.

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APPENDIX

The Fisher-Ford method is fully explained in Southwood (1966) and Begon (1979). It is probably the best method to use for capture-recapture data on birds, where recapture rates are low and there have been many attempts to capture birds.

It requires the calculation of total days or years survived by all recaptured birds. This total is then compared with estimates of total years survived which are calculated from values of number of banded birds at risk of capture each year, survival rates and average age of banded birds. Various values for the survival rates are used in this calculation and that which gives the best fit with the observed total years survived is an estimate of the annual survival rate of the population.

The total years survived by recaptured spinebills at New England National Park can be taken directly from Table 1. The first diagonal gives recaptures of birds within a year and is excluded. The second diagonal gives all birds that have survived one year (14+28+2 . . . +21=119), the third diagonal those that have survived two years (35 birds and 70 bird-years). This is repeated for all diagonals giving a full total of 338 bird years.

To calculate the estimated total years survived one needs values of:

r_i=number of newly banded birds in year *i*.

m_i=number of banded birds recaptured in year *i*,

M_i=number of previously marked birds that are still alive in year *i*,

ø=annual survival rate,

M_{i+1}=number of banded birds alive in year *i* +1 (i.e. the following year), this can be calculated from the formula:

M_{i+1}=ø ($Mi+ri$), or the survival rate multiplied by the number of old birds and new birds estimated or known to be alive in year *i*.

A_i=mean age of the previously banded birds in year *i*. This is obviously 1 for the second year of banding.

A_{i+1}=mean age of previously banded birds in year *i*+1 (i.e. the following year). This is calculated from the formula:

$$A_{i+1} = \frac{A_i M_i}{M_i + r_i} + 1$$

which is the mean age of banded birds in the previous year multiplied by the number of these birds divided by the number of old and new banded birds present in the previous year, plus one as all are now one year older.

APPENDIX TABLE

Calculation of estimated total years survived by recaptured birds, assuming a survival rate of 0.6. Values of r_i and m_i are from Table 1. M_i and A_i were calculated according to formulae in the text.

year (*i*)	r_i	m_i	M_i	A_i	$A_i m_i$
1977	45	—	—	—	—
1978	577	14	27	1	14
1979	429	30	362.4	1.045	31.35
1980	108	4	474.8	1.478	5.91
1981	175	19	349.7	2.204	41.88
1982	304	25	314.8	2.469	61.73
1983	466	33	371.3	2.256	74.45
1984	7	1	502.4	2.001	2.00
1985	486	15	305.6	2.973	44.60
1986	380	29	475.0	2.148	62.29
				ΣA_i	m_i=338.21

Total years survived calculated directly from Table 1= 338.

The Appendix table gives values for each of these variables, using a survival rate (ø) of 0.6, plus values for $A_i m_i$. If values in the last column are added this gives an estimated total years survived by 338.2. Using a survival rate of 0.5 the estimate is 299.4. The value for ø=0.6 is very close to the observed value of 338. Any further accuracy is unrealistic, so that we take the mean survival rate to be 0.6 or 60%.