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RESULTS FROM A BANDING STUDY OF PEREGRINE FALCON CHICKS IN VICTORIA, 1972–1997

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Since 1972, 807 Peregrine Falcon chicks have been banded in Victoria and 66 of these have been either recovered or resighted. There was a slight but significant ($P < 0.05$) female-bias in the sex ratios of both the nestlings banded and the subsequent band recoveries. Most (69.7%) recoveries were made more than 4 km from banding (nest) sites. Of the 66 recoveries, 60 were of either dead or injured birds, with the main determinable cause being flying accidents, particularly collisions with vehicles and overhead or fence wires. Females dispersed further, may have settled and bred further from their natal sites, and lived longer than did males. A large portion of the recoveries of banded birds were made within one year of their leaving the nests. Most recoveries of banded birds less than one year old were made within the first six months (December–May) of their leaving the nests, whereas recoveries of those birds which survived the first year were most often made during the four main breeding months of August–November.

INTRODUCTION

The Peregrine Falcon *Falco peregrinus* is widespread in Victoria (Emison *et al.* 1987) and we know the locations of nearly 200 nest sites (Emison *et al.* 1997). The Fisheries and Wildlife Division (now Department of Natural Resources and Environment) began banding Peregrine Falcon chicks in 1972 and by 1984, when we temporarily ceased banding, 410 had been banded. In 1991 we resumed banding and by the end of the 1996 season, 397 more chicks had been banded.

The last time we analysed the returns from our banding programme was in 1980 (Emison and Bren 1981) when we had only banded 207 chicks (an additional five chicks had been banded by others prior to the start of our programme in 1972). At the time of those analyses, there had been only 12 recoveries of banded chicks, so we could draw only a few general conclusions about the dispersal and survival of chicks after leaving the nest. The present number of recoveries is over five times greater than that in 1980. This amount of data allows us to examine in more depth the dispersal and survival patterns of chicks in general and to determine whether there are differences in these patterns between male and female chicks.

METHODS

Before 1975, banding of Peregrine Falcon chicks had been done opportunistically, resulting in the banding of 18 chicks. After 1975, chick banding was done in conjunction with Peregrine nesting site surveys which were conducted throughout Victoria from 1975 to 1984 and from 1991 to 1996. All known nests were usually visited once during the incubation period and at least once during the late nesting stage when the young were banded with stainless steel bands supplied by the Australian Bird and Bat Banding Scheme (ABBBS). For the purposes of this paper, the ages of recovered or resighted birds have been calculated as the number of months elapsed between the month of banding and the month of recovery or resighting.

The sex of the chicks was determined by body size, and bands placed on females were slightly larger than those placed on males in compliance with ABBBS guidelines. Starting in 1992, a two-colour anodised aluminium band was placed on the tarsus opposite the one with the usual band issued by the ABBBS. Recoveries of birds with only ABBBS bands were made both by personnel involved with this project (often on subsequent trips to eyries) and by the general public. All of these recovered birds were either dead or injured. Observations by spotting scope of the two-colour aluminium bands allow identification of healthy individuals without having to trap them. Five such identifications of colour-banded chicks have thus far been made.

Methods of data analysis consisted mainly of summarizing data in terms of totals, percentages and means. Chi-square tests were done to determine whether various differences and ratios were significantly ($P < 0.05$) different.

RESULTS

Numbers banded and recovered or resighted

Since 1972, a total of 807 Peregrine Falcon chicks have been banded during the project. Sex was determined for 776 of these banded chicks: 417 (53.7%) were classed as female and 359 (46.3%) as male. The difference between the numbers of females and males banded was significant ($X^2 = 4.3$, d.f. = 1, $P < 0.05$).

Of the 807 banded peregrines, 66 (8.2%) have been recovered or resighted as of October 1997. The sexes of 63 of these recovered birds were: 37 (58.7%) females and 26 (41.3%) males. The sex ratios of birds recovered did not significantly differ from those of birds banded.

Location of recoveries and resightings

Of the 66 recoveries and resightings, 20 (30.3%) were at or near the sites (nests) where they were banded. The rest (46, 69.7%) were 4 kilometres or more away from the banding sites. Of the 20 recoveries at the banding sites, 11 were females, 7 were males and 2 were unsexed,

TABLE 1

Suspected causes of death, injury or band loss of 20 banded Peregrine Falcon *Falco peregrinus* chicks recovered at or within four kilometres of their banding (nest) sites, 1972–1997.

Sex of banded chick	REMAINS OR BAND ONLY IN NEST		REMAINS WITHIN 4 KM OF NEST				
	Remains in nest. Cause of death unknown	Band only in nest. Suspect it fell off of tarsus	Cause of death unknown	Flying accident	Shot	Storm related	Unknown predator
Female	2	0	4	3	1	0	1
Male	0	0	2	4	0	1	0
Unsexed	0	1	1	0	0	0	0
Total	2(10)	1(5)	7(35)	7(35)	1(5)	1(5)	1(5)

( ) = % of the 20 recoveries.

TABLE 2

Resightings of five colour-banded Peregrine Falcon *Falco peregrinus* chicks and suspected causes of death or injury of another 41 banded Peregrine Falcon chicks, all of which were recorded more than four kilometres from their banding (nest) sites, 1972–1997.

Sex of banded chick	RESIGHTINGS	CAUSE OF DEATH OR INJURY					
	colour-bands	unknown	flying accident	shot	starved	rabbit trap	other raptor
Female	2	11	6	4	1	1	1
Male	3	4	8	2	2	0	0
Unsexed	0	1	0	0	0	0	0
Total	5(11)	16(35)	14(30)	6(13)	3(7)	1(2)	1(2)

( ) = % of the 46 resightings/recoveries.

and of the 46 recoveries made away from the banding sites, 26 were females, 19 were males and 1 was unsexed.

Details of band recoveries and resightings

Death or injury of banded birds were the main sources of band recoveries, accounting for 60 of the 66 recoveries. The other six recoveries were attributable to band loss (1) and resightings of colour-banded birds (5).

Of the 19 chicks and 1 band loss which were recorded in or within 4 kilometres of the banding (nest) sites, the causes of death or injury were mainly unknown (35%) or were suspected to be flying accidents (35%) (Table 1). Of the seven suspected flying accidents, four were associated with overhead or fence wires, two with natural rock features and one with a building window. The main causes of death or injury (unknown, 35% and flying accidents, 30%) of the 46 chicks which were recorded more than 4 kilometres from the banding sites were similar to those of the 19 chicks recovered at or near their nest sites (Table 2). However, the flying accidents of the 46 chicks that dispersed from their natal sites involved collisions more often with moving vehicles (8 of the 14 accidents) than with overhead wires (5), building windows (1) or natural rock features (none).

Direction of dispersal

Although more of the 46 recoveries and resightings, which were made away from the banding sites, were in a northerly direction than in any other direction, the differences were not statistically significant (Table 3).

Distance from banding (nest) sites

The 26 recoveries or resightings of females which had dispersed, were made at an average of 68 kilometres (median, 56 km; range, 4–295 km) from the banding sites. The 19 recoveries or resightings of males which had dispersed, were made at an average of 53 kilometres (median, 25 km; range, 5–315 km) from the banding sites. There was also one recovery of an unsexed bird which had moved 120 kilometres from its banding site.

TABLE 3

Recoveries and resightings of 46 banded Peregrine Falcon *Falco peregrinus* chicks in relation to the directions from their banding (nest) sites, 1972–1997.

Direction*	Females N = 26	Males N = 19	Unsexed N = 1	Combined
Westerly	13	9	1	23
Northerly	15	9	0	24
Easterly	12	7	0	19
Southerly	8	5	1	14

The differences between directions are not significant (females: $X^2 = 2.2$, d.f. = 3, $P > 0.05$ and males: $X^2 = 1.5$, d.f. = 3, $P > 0.05$).

*Most recoveries have two directions (e.g. a NNE recovery has both a northerly and an easterly direction); only due W, N, E or S have single directions.

Annual mortality

A life table (Table 4) based on 57 recoveries of dead or terminally injured birds banded as nestlings, was constructed following the method in Olsen and Olsen

(1988). It shows a 64 per cent mortality during the first year (age, 0–1) and an average of 5.8 per cent for each of the subsequent five years (ages, 1–6).

TABLE 4

Life table for Peregrine Falcons *Falco peregrinus* in Victoria based on 57 recoveries of dead or terminally injured birds banded as nestlings, 1972–1997. Nine other recoveries not used in this table were: five resightings of colour-banded birds; one band loss; and three banded birds which were not terminally injured.

Age interval (years)	Number of recoveries (R)	Number available* (A)	Ratio (R/A x 100)	Annual mortality (%)
0–1	43	807	5.33	64
1–2	4	664	0.60	7
2–3	0	565	0.00	0
3–4	4	475	0.84	10
4–5	2	413	0.48	6
5–6	2	371	0.54	6
6–7	0	355	0.00	0
7–8	1	355	0.28	3
8–9	0	354	0.00	0
9–10	0	354	0.00	0
10–11	1	354	0.28	3

*Because not enough time has elapsed since banding for all recoveries to have been made, the figures are corrected to allow for this bias.

Age at recovery

Of the 66 recoveries or resightings of banded peregrines, 48 (72.7%) were made within one year of the chicks leaving the nest and the other 18 (27.3%) were made after one year. These figures, when broken down by sex, show that of 37 recoveries of banded females, 25 (67.6%) were within the first year and 12 (32.4%) were after the first year. In contrast, for the 26 male recoveries, 21 (80.8%) were within the first year and only 5 (19.2%) were after the first year. However, the differences between the female and male recoveries were not significant. Of the 3 recoveries of unsexed birds, 2 were in the first year and 1 was after the first year.

The average age at recovery or resighting of the 26 females which had dispersed, was 27 months (2 years and 3 months) with the median being 10 months and the oldest being 131 months (10 years and 11 months). The average age at recovery or resighting of the 19 males which had dispersed, was 16 months (1 year and 4 months) with the median being 6 months and the oldest (still alive and breeding in October, 1996) being 59 months (4 years and 11 months).

The months of recovery were reported for 54 of the 60 banded birds which were found either dead or injured. Of these 54 recoveries (the majority of which were made by the public), 41 were of birds less than one year of age and the rest (13) were older than one year. The majority (80.5%) of the 41 recoveries of birds less than one year old were made within the first six months (December–May) after the young had left the nest. In contrast, the majority (69.2%) of the 13 recoveries of birds more than one year old were made during the four main months (August–November) of the breeding season.

Of the six records not involving either dead or injured birds, one was of an apparent band loss in the nest and the other five were resightings (by researchers) of colour-banded birds. Four of the colour-banded birds were resighted at eyries as breeding adults. Two of these were females (ages, 3 and 4 years) and two were males (ages, 3 and 5 years); the age (5 years) of the oldest breeding male represents its last resighting (and the age used in all calculations in this paper) although it was first seen as a breeding bird at 3 years of age. The two colour-banded females were breeding at eyries located 26 and 30 kilometres from their birth sites whereas the two males were breeding 7 and 14 kilometres from their birth sites. The other resighting of a colour-banded bird was a 5 month old male seen 315 kilometres east of its banding (nest) site.

DISCUSSION

The sex ratio of peregrine nestlings in Australia appears to be slightly female-biased. Olsen and Cockburn (1991) found that a sample of 1 040 nestling peregrines from south-eastern Australia was composed of 545 (52.4%) females and 495 (47.6%) males.

During our Victorian study, the percentage of female chicks banded (53.7%) was larger than that of males (46.3%). These results are similar to those of Olsen and Cockburn (1991) and to those obtained by Mooney and Brothers (1993) during their banding study of Peregrine Falcon chicks in Tasmania. Mooney and Brothers (1993) suggested that this small departure from a 1:1 sex ratio was, in part, because of male chicks flying earlier than the females. We suggest that an additional factor in our study may have been a slight tendency for banders to class chicks in single-sex broods (i.e. no size differences in the nestlings) as females. This was probably related to a bias favouring the use of the larger-sized female bands when there was some uncertainty about the sex of chicks. Hickey (1942) also suggested that there might be as much as a 10 to 20 per cent error when sexing peregrine nestlings by size only.

After leaving the nest, young peregrines in Victoria remain with their parents in the vicinity of the eyrie for two months or longer (Sherrod 1983). During this time, the young acquire the flying and hunting skills essential for survival once they become independent. About 30 per cent of our band recoveries were made near nest sites and most of the banded birds probably perished or were injured during this dependency period, although at least three of them either died or lost their band before leaving the nest. The single largest determinable cause of mortality or injury near the nest sites appeared to be flying accidents, particularly those associated with overhead or fence wires and natural cliffs. It is likely that some of these flying accidents occurred shortly after the young birds left the nest.

The other nearly 70 per cent of band recoveries or resightings were made more than 4 kilometres from the nest sites after the young were independent. Of these recoveries (excluding the five resightings), the single largest determinable cause of death or injury was also flying accidents. However, the objects (mainly moving vehicles and, to a lesser extent, overhead or fence wires)

with which these birds collided differed from those (mainly overhead or fence wires and natural rock features) with which the birds near eyries collided. The collisions with stationary objects around the nests sites were probably caused by misjudgment or lack of agility of inexperienced fledglings, whereas the collisions with moving vehicles by the older experienced birds, who had survived the dependency period, probably occurred while they were intent on pursuing or carrying prey over roads.

Death attributable to persecution (shooting) by humans in our study was detected in only one (5%) of the recoveries made near nest sites and in six (13%) of the recoveries made over 4 kilometres from the nest sites. Although one bird was also caught in a rabbit trap, it did not appear that the trap had been set to catch a raptor.

A high incidence of mortality or injury caused by collisions has also been reported for Tasmanian peregrines (Mooney and Brothers 1993). However, Mooney and Brothers also reported a 50 per cent incidence of death or injury caused by human persecution, which was much higher than the 5–13 per cent detected in our study. Perhaps the importance of human persecution in our study is understated because of the large number of recoveries for which the cause of death or injury was either unreported or reported as unknown.

Despite there being a small tendency for banded birds in this study to disperse in a northerly direction, statistically the direction of dispersion was random. This is consistent with results reported by Mooney and Brothers (1993) for Tasmanian peregrines as well as those of an earlier examination of recoveries from Victoria (Emison and Bren 1981). A lack of southerly dispersal across Bass Strait is indicated by the absence of recoveries in Tasmania (despite an active Peregrine Falcon monitoring programme there) of any of the 807 Peregrine Falcon chicks banded in Victoria. Similarly, a long-term banding study of Tasmanian Peregrine Falcon has not recorded any northerly dispersion across Bass Strait (Mooney, pers. comm.).

The tendency of females to disperse more widely than males (as found in this study), has been previously reported for Peregrine Falcon populations in south-eastern Australia (Olsen and Olsen 1988; Mooney and Brothers 1993) as well as elsewhere in the world (Mearns and Newton 1984; Ambrose and Riddle 1988; Newton and Mearns 1988). However, the difference in distance dispersed between males and females was much greater (101 km) for the Tasmanian Peregrine Falcon (Mooney and Brothers 1993) than it was (15 km) for the Victorian Peregrine Falcon. This large difference between the two populations may be related to a difference in recovery methods between the two studies. In the Tasmanian study, Mooney and Brothers (1993) relied heavily on their own resightings of colour-banded birds, often around eyries. In contrast, most of the band recoveries of birds that had successfully fledged in our Victorian study came from either dead or injured birds found by the public. Newton and Mearns (1988) reported dispersal distances being different for both of the sexes when they analysed the results from two different recovery methods used within their own study in south Scotland, although both methods still indicated that females dispersed farther than males.

A life table by Olsen and Olsen (1988) for Peregrine Falcons in south-eastern Australia, based on recoveries of 46 dead birds banded as nestlings, showed a 55 per cent mortality rate during the first year of life, this being lower than the 64 per cent first year mortality found in our Victorian study. The mortalities for the subsequent five years (ages, 1–6) in the two studies, were 5 per cent per year in Olsen and Olsen (1988) and 5.8 per cent per year in our Victorian study. Thus, these Victorian results, although a little higher, still compare favourably with those of Olsen and Olsen (1988) for Peregrine Falcons in south-eastern Australia. However, comparisons with results obtained in other studies (e.g. Enderson 1969), which use a different method to construct their life tables, are not valid.

The maximum age attained by a banded bird in this Victorian study was 10 years and 11 months; in comparison, the known maximum age reached by an Australian Peregrine Falcon in the wild is 15 years and 3 months (Baker *et al.* 1995). The ages of the banded Peregrine Falcons also appear to be a factor influencing the time of the year that recoveries are made. Most (80.5%) of the birds recovered within the first year of leaving the nest are found during the six months of December–May, which comprise the dependency period and the very early months of independence. In contrast, those banded birds which survive their first year appear to be most susceptible to mortality during the four months of (August–November) which is the period when most nesting occurs (Olsen 1995).

To date, only four (two males and two females) Peregrine Falcons, which were colour-banded as chicks, have been resighted as breeding adults. These preliminary data show that some members of both sexes begin breeding at three years of age. However, the minimum breeding age of females may be less than three years because Mooney and Brothers (1993) found that three out of five known-age females in Tasmania began breeding at two years of age.

In our study, the average distance that the two colour-banded, breeding females had moved from their natal sites was 28 km, nearly three times farther than the average distance (10.5 km) moved by the two colour-banded, breeding males. It is emphasized that such results from our colour-banding of chicks are just starting to emerge and will be a major focus of future work on this species in Victoria.

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BOOK REVIEW

John Gould in Australia: letters and drawings.

Ann Datta, 1997. Melbourne University Press, Carlton South. RRP $80.00.

The 19th Century was a time of great European activity, expanding colonies, trade and exploration was at its greatest. One man seemed to exceed allcomers with his zeal and apparent penchant for expansion, trade and exploration in the field of wildlife; that man was John Gould. Very few have equalled this, and few have approached it. In essence his input into the discovery and introduction of new and exciting animals in Australia is unsurpassed.

Ann Datta's current book looks not only at these achievements, but also at the man himself. The Natural History Museum holds a wealth of information on this account and, as seen among the book's pages, a fine series of previously unpublished illustrations. The book is separated into parts, the first dealing with John Gould the man, the second a seemingly unending listing of the paperwork and correspondence held in the Natural History Museum Library. The book is well researched, and written in a straight-forward way allowing the reader to be engrossed in its character. I found both parts very informative and in many cases useful to my demands with a penchant for Australian ornithological history.

The whole episode of Gould's life is interwoven by the author with interesting snippets or detailed descriptions. It becomes swiftly apparent that Gould was not a 'one-man show'; a multitude of collaborators assisted him. The 'squattocracy' allowed him freedom of movement throughout his Australian travels, while aristocracy smoothed out other potential problems. His dealings with both are condensed in the second part of the book.

The book's production, illustration selection, and subject matter are good. Although not primarily an ornithological text it does fill such a vacancy. It delves not only into the interests of Gould but also gives us an insight into the times and places and Gould's associates. The book contains a wealth of data on the man, his dreams, and his achievements. That one man succeeded in this penchant for expansion, trade and exploration in wildlife is wonderful. Ann Datta's book on Gould is well worth its cost.

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