

Aspects of the biology of the Grey Falcon *Falco hypoleucos* in the Pilbara region of Western Australia

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The diet and breeding biology of two pairs of Grey Falcons *Falco hypoleucos* were studied in the eastern Pilbara region of arid north-western Australia during the second half of 1987, after average to above-average rainfall in the preceding six months. The two simultaneously active nests were old stick nests in riparian eucalypts, approximately 23 kilometres apart on a dry river, with a natural waterhole approximately seven kilometres from one nest and bores 5–10 kilometres from both nests. Egg-laying occurred in mid-July, hatching in late August and fledging around the end of September, giving incubation and nestling periods of approximately five weeks and six weeks, respectively. Both broods fledged three young. Two banded juveniles from one nest still associated, within one kilometre of the nest, three months after fledging. The Grey Falcons' diet at both nests consisted mainly of birds, particularly Galah *Eolophus roseicapillus*, Australian Ringneck *Barnardius zonarius*, Budgerigar *Melopsittacus undulatus* and others (?kingfisher, small passerine), and some insects (beetles Coleoptera, grasshoppers Acridoidea).

INTRODUCTION

The endemic Grey Falcon *Falco hypoleucos* is the rarest Australian falcon, and one of the least common and least studied of raptors. It normally occurs in the arid and semi-arid zones (Marchant and Higgins 1993) and is classified nationally as *near threatened*, with likely amendment to *vulnerable* if a decline in its population is detected (Garnett and Crowley 2000). It is listed as *endangered* (upgraded from *vulnerable*) in New South Wales, *endangered* in Victoria, and *rare* in Queensland and South Australia. It is not listed in Western Australia, although it has been assessed as qualifying for '*rare*' (Garnett 1992a).

Little is known of the Grey Falcon's general ecology, with little quantified information published on its diet or breeding biology. Further information since the summary in Marchant and Higgins (1993) was largely anecdotal (Slater 1997; Debus and Rose 2000; Harrison 2000; Martin and Royal 2001), until Aumann (2001a-d) quantified aspects of the foraging ecology and breeding biology of two pairs in arid central Australia. Subsequent information has also been anecdotal (Stewart and Gynther 2003; McLaren 2005; Morris 2005; Schrader 2005; Wright 2005; Debus *et al.* 2006; Silcocks 2007; Dennett and Abbotts 2008; Rogers 2008; Ashton 2009).

Debus (1998) and Garnett and Crowley (2000) identified the need for population survey and monitoring, and research into the Grey Falcon's biology and ecology, including details of its nesting habitat. Olsen (1998) identified targeted research, to identify key conservation areas and requirements for this species, as a high priority. Olsen *et al.* (2000) additionally recommended life-history studies, limiting-factor management, habitat management, and, when more is known of the Falcon's life history and habitat needs, population and habitat viability analysis. A decade or so later, most of these recommendations

remain unfulfilled (Debus 2008), although the first comprehensive study is being attempted (notably, an independent self-funded project, rather than government- or NGO-sponsored initiative: Schoenjahrn 2009).

This paper reports aspects of the ecology of the Grey Falcon, including diet and breeding biology, in the Pilbara region in the arid north-west of Western Australia in 1987; some findings were briefly summarised by Johnstone and Storr (1998). Storr (1984) characterised the Grey Falcon as a scarce visitor to the region, mostly to the coastal plains between the De Grey and Ashburton rivers. The Falcons in this study bred in the most inland (south-eastern) part of the Pilbara, on the Fortescue River.

STUDY AREAS AND METHODS

The environment of the Pilbara, in terms of physiography, rainfall and vegetation, has been described by Storr (1984) and Johnstone and Storr (1998). The main study area was that part of the region within 100 kilometres radius of Newman (23°21'S, 119°43'E), in the Ophthalmia Range off the eastern Hamersley Range. The area is part of the subregion characterised by Storr (1984) as the moderately elevated interior sector of peniplains and rugged hills, with vegetation of eucalypt woodland and Mulga *Acacia aneura* communities.

Grey Falcons were searched for around Newman by means of road transects according to the methods of the RAOU Bird of Prey Watch Scheme (Baker-Gabb and Steele 1999). Two routes were followed, once per month usually on the same day each month, during 1987 and 1988, chosen to sample a wide range of habitats and vegetation types: one in a north-easterly direction from Newman (85 km) to the Fortescue floodplain, and one in a southerly direction (70 km) into Mulga country. Each transect took approximately 1.25 hours, at approximately 70 kilometres

per hour, and started at 07:00 hours. Nest searches were also conducted around Newman in the 1987 and 1988 breeding seasons.

Additional field trips, outside the main study area and including the coast, were conducted to search for Grey Falcons over the period 1986–88. Maps were used to identify habitat considered potentially suitable, e.g. moderately wide, dry riverbeds. The two study nests were found on the upper Fortescue River, on a river channel in flat, sparsely vegetated floodplain terrain. At the time of this study, the landscape around the Grey Falcon nest sites was open and heavily grazed. Seasonal conditions preceding and during the study period were below-average rainfall for the years 1986 and 1987 overall, but average or above-average rainfall during four of the six months in the first half of 1987; and below-average rainfall for four of the six months in the first half of 1988 (notably January–February) and throughout June–November (Bureau of Meteorology data). The Fortescue River did not flow during the study period 1986–88. In addition to a natural waterhole in the river approximately seven kilometres from Nest 2, there was surface water available at bores approximately 10 kilometres from each nest and approximately five kilometres from Nest 2.

Six nestling Grey Falcons, in these two nests, were banded with metal leg-bands (supplied by the Australian Bird and Bat Banding Scheme). Breeding chronology, and hence appropriate age for banding, was determined by approximately weekly observations of adult behaviour at Nest 1 since its discovery in the prelaying phase in May, with inspection (by climbing to the nest) at the laying and hatching stages. The chicks were measured according to standard ABBBS methods, using calipers or rule as applicable. Size 11 bands were selected on the basis of trial and error, being the size apparently most suitable (when closed) for almost fully-grown nestlings, because there was no official ABBBS band size for this species at that time. [Tarsus lengths did differ slightly (see Table 1), but tarsus widths were not measured at the time; the sexes may require different band sizes, reflected in the ABBBS scheduled size of '27 (11 male), varies geographically'.] Nest heights were measured from the climber's rope plumbed vertically from the nest.

Pellets and prey remains were collected from these two Grey Falcon nests in September 1987 and sent to the Western Australian Museum for analysis.

RESULTS

Breeding biology

Two Grey Falcon nests were located in riparian eucalypts, on a dry river bed: Nest 1 in the canopy of a live (non-emergent) Coolibah *Eucalyptus coolabah* 14 metres above the bank and 17 metres above the river bed, and Nest 2 in the top of an emergent live River Red Gum *E. camaldulensis*, 25 metres above the ground, within the river channel (Figures 1 and 2). Both were disused stick nests apparently of corvids, probably Torresian Crow *Corvus orru*. These two simultaneously active nests were approximately 23 kilometres apart on the same river. During the study period Grey Falcons were also observed on the Oakover River and at a nearby bore, approximately 100 kilometres north-east of the Fortescue site, but were not found breeding. A third active Grey Falcon nest (an old stick nest in an unidentified



Figure 1. (a) Grey Falcon nest site and nest (Nest 2) with adult defending as tree is climbed to band young. (b) Grey Falcon Nest 2 with adult watching on 20 September 1987.



Figure 2. Close-up of Grey Falcon Nest 2, with chick. 20 September 1987.

eucalypt) was found late in the year (about November) in the early 1990s, in sandy scrub within two kilometres of the Pilbara coast (between Eighty Mile Beach and the Great Northern Highway, approximately 400 km from Newman).

When first inspected on 25 May 1987, Nest 1 was empty, but an adult flew from it, returning approximately 10 minutes later to defend it by stooping at the climber for about three minutes



Figure 3. Adult Grey Falcon defending Nest 2. 20 September 1987.



Figure 4. Two of the Grey Falcon nestlings from Nest 2, with natal down remaining on their heads. Putative male (390 g) on left, suspected female (488 g) on right. 20 September 1987.

TABLE 1

Morphometrics (mm, g for lengths and weights respectively) of six Grey Falcon nestlings (two broods of three siblings), Pilbara, Western Australia, 20 September 1987 when approximately one month old. M? = putative male, F? = putative female; bill = exposed culmen including cere.

Sex	Wing	Tail	Tarsus	Bill	Head-bill	Weight
<i>Brood 1:</i>						
M?	209	91.7	51.9	20.8	–	409
F?	210	84.6	58.5	15.4	–	476
F?	190	92.6	57.6	14.2	–	433
<i>Brood 2:</i>						
F?	192	92.5	56.9	15	61.5	488
M?	177	81.4	50.1	14.8	58.7	413
M?	170	60.3	55.1	15.1	58.9	390

before departing again. At Nests 1 and 2, both adults defended the nest by stooping at the climber when the chicks were banded (Figure 3). The adults appeared, flying, from unknown locations when the climber was within approximately 10 metres of the nest. It was not recorded whether the adults vocalised during defence, nor were their calls (if any) described.

At Nest 1, the first egg was laid on or about 19 July when the nest was inspected, and the three young were about 2–4 days old when inspected on 25 August, giving an approximate incubation period of five weeks (~35 days). Young in both nests were almost fully grown and feathered, at optimal banding age but too young to fledge prematurely (i.e. ~1 week before natural fledging age), when weighed and banded on 20 September. Laying was thus in mid-July, and the young in Nest 2, with down remaining on the crown at approximately 28–30 days (Figure 4), give an approximate fledging age of just under six weeks. Three fledglings were seen approximately one kilometre east of Nest 2 on 30 September 1987, 10 days after banding, thus confirming that they were close to fledging when banded.

Both broods were of three young, which could not be sexed positively (see Figure 4, Table 1). It is likely that the three heaviest birds (433–488 g), with the longest tarsi (56.9–58.5 mm), were females, and the other three birds (390–413 g), with shorter tarsi (50.1–55.1 mm), were males. In further support of this diagnosis, in Nest 2 the heaviest bird had a larger head-bill than the two lighter birds, which had full crops (Table 1). Head-bill measurements were not taken at Nest 1, and there was no bimodal cluster, within and between broods, in bill lengths (Table 1). The disparity in tail lengths within broods suggests that, in each case, the youngest chick may have hatched at least one or two days after the others.

Two banded juveniles were observed by chance, during one of the regular monthly road transects, on 31 December 1987, approximately one kilometre from Nest 1, suggesting that juveniles remain in the nest area, and associate as siblings, for at least three months after fledging. Although repeat visits were made to the nest sites in 1988, Grey Falcons were not found nesting in 1988, a dry year with deficient rainfall in most months.

However, adults were observed near Nest 1 during the breeding season, and a brood of two fledglings was seen approximately one kilometre from Nest 2 on 26 October 1988. The Falcons did not reuse their 1987 nest in 1988.

On a return visit to the Grey Falcons' nests in December 2009, after a reduction of grazing pressure, the country had 'thickened up' with scrubby regrowth. No Grey Falcons and few other birds, other than several Whistling Kites *Haliastur sphenurus* and Nankeen Kestrels *Falco cenchroides*, could be found. A nest was in the same site as former Nest 1 (Coolibah, which was by then noticeably taller), apparently (re)built or enlarged by an accipitrid, which had left pellets underneath it. The nest stand of Nest 2 could not be located, owing to the difficulty of navigating and finding landmarks (e.g. the particular river gums) in the changed landscape.

Diet

At Nest 1 were the remains of two bird nestlings or chicks (one possible kingfisher and one possible parrot), and among at least 23 pellets, three measured (mm) (a) 45 × 25, (b) 35 × 22, and (c) 35 × 18. The pellets contained feathers of Galah *Eolophus roseicapillus* (plus a Galah foot), Australian Ringneck *Barnardius zonarius* and Budgerigar *Melopsittacus undulatus*, bone fragments, and remains of grasshoppers (Acridoidea) and beetles (Coleoptera: ?longicorn, Cerambycidae). Pellets also contained the claw of a crustacean (possibly the gut contents of the kingfisher) and seeds. Some pellets contained small stones (up to 2 × 3 mm) and leaves.

At Nest 2, among at least 42 pellets, three measured (mm) (a) 45 × 20, (b) 40 × 12, and (c) 40 × 30. The pellets contained feathers of Galah, Australian Ringneck and Budgerigar (plus a Budgerigar bill, trachea and foot), the leg of a small passerine, bones, and remains of a grasshopper, as well as seeds, leaves, twigs, bark, stones and sand.

In the pellets from both nests (mean 40 × 21.2 mm for the six pellets), the seeds were probably crop contents of the parrots, and the stones and sand were either 'rangle' (falcon gizzard stones) or the stomach grit of granivorous prey or perhaps even of the prior nest occupants (e.g. corvids). Vegetative material, and possibly even some of the stones, were perhaps ingested accidentally with food, or during investigation of nest material by the Grey Falcon chicks.

DISCUSSION

Breeding biology

The results of this study are similar to those of previous studies on the Grey Falcon, with respect to breeding distribution in the Pilbara, breeding habitat, nest-site characteristics, laying dates, adult behaviour (nest defence), and the duration of the incubation, nestling and post-fledging periods (cf. Olsen and Olsen 1980, 1986; Marchant and Higgins 1993; Olsen and Marples 1993; Harrison 2000; Aumann 2001d). Some aspects, e.g. incubation and nestling periods, apparent hatching sequence, are closely similar to those of the Peregrine Falcon *Falco peregrinus* (cf. Marchant and Higgins 1993). The few data on inter-nest distances suggest that breeding density is variable but usually very low in this species; it is noted here that '16 km' (Garnett 1992b) is a misquote, as only the two neighbouring nests (23 km apart) were found in the study area.

Laying dates and breeding events in relation to rainfall (Aumann 2001d; this study) suggest that above-average rainfall in the first half of the year may encourage breeding in the Grey Falcon, perhaps because summer rainfall triggers seeding and hence population increase of its seed-eating prey, at least in the northern arid zone. Conversely, below-average rainfall, particularly in the preceding summer–autumn, may discourage breeding by the Falcon or result in smaller broods, although sample sizes were small.

The Grey Falcon nestlings' wing and tail lengths represent 'snapshots' on a single day in their respective growth curves, at about one month old. Breeding productivity in the Pilbara (two broods of three) was at the high end of the previously recorded range for Grey Falcons (usually two, cf. Marchant and Higgins 1993; Aumann 2001d). In addition to juvenile morphological characters previously described (Marchant and Higgins 1993), the advanced nestlings in this study had dull yellow gape flanges (Figure 4), a character not previously noted. An upper range for the nestling period of 49–52 days (Marchant and Higgins 1993) seems excessive for a medium-sized falcon, and raises the possibility of unobserved fledging, with fledglings returning to the nest to feed or roost over the next few days (cf. another record of 41 days: Marchant and Higgins 1993).

Diet

The diet of the Grey Falcons in the Pilbara, i.e. predominantly birds and mainly parrots, was similar to that recorded in the few previous studies (cf. Olsen and Olsen 1986; Marchant and Higgins 1993; Slater 1997; Debus and Rose 2000; Harrison 2000; Aumann 2001b). For instance, Aumann (2001b) reported 93 percent birds (62% Budgerigar, 69% parrots), seven per cent insects, mean prey weight 29 grams, and found the Falcon to be a bird specialist, and these other recent authors agree with respect to specialisation on birds. The Grey Falcon's prey spectrum appears to be intermediate in size between that of the Australian Hobby *Falco longipennis* and the Peregrine *F. peregrinus* and Black Falcon *F. subniger*, as might be expected from its intermediate body size (cf. Marchant and Higgins 1993; Debus *et al.* 2005; Olsen *et al.* 2006). The claim (based on gut contents) that the Grey Falcon 'feeds on seed, earthworms...' (Saunders and Ingram 1995) is misleading, as those items may have been in the gut of prey species rather than actively foraged by the Falcon.

Conservation implications

From this and other recent studies, the Grey Falcon can be characterised as a falcon that, at least as a breeding species, occupies riparian and other productive 'oases' in the arid zone, though not necessarily nesting immediately adjacent to waterholes, and preys mainly on flocking, ground-foraging, seed-eating birds. It requires the old stick nests of corvids and other birds in tall trees (including riparian eucalypts, though watercourses may be dry), and its breeding may be encouraged by above-average rainfall in the preceding summer/autumn, or discouraged (or reduced) by below-average rainfall. However, the assumptions (e.g. about riparian zones) and search method in this study may have biased the results on breeding habitat and nest sites, and Grey Falcons may use other types of nesting habitats and sites as well. For instance, in the Kimberley they use Whistling Kite nests in Baobab trees *Adansonia gregorii* (Slater 1978), and they

have recently been found using corvid nests in the tops of tall telecommunications towers (Schoenjahn 2009).

The Grey Falcon is apparently not a true desert falcon of sandy, stony or otherwise waterless deserts, although it may at times forage out into such habitats (but such habitats are rarely searched for this species). One stronghold appears to be the Channel Country of south-western Queensland, and other rivers of the Lake Eyre Drainage (Marchant and Higgins 1993; Harrison 2000; Aumann 2001a–d); another may be the Pilbara (Olsen and Olsen 1986; this study), and perhaps also the southern Kimberley of Western Australia (cf. Slater 1997). The Murray-Darling Basin (in the <500 mm rainfall zone) was formerly a more important part of its range, and a drought refuge (Olsen and Olsen 1986).

This study, and that by Aumann (2001a–d), go some way towards documenting the Grey Falcon's biology and ecology, including its nesting habitat, and identifying important conservation areas and the Falcon's requirements. It remains for the process to be completed more comprehensively, with extensive targeted research, in order to understand the factors that may be limiting the Grey Falcon's population, and thus to manage its habitat to facilitate its recovery in the semi-arid zone and particularly in the Murray-Darling Basin.

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