Some aspects of the biology of the Black Falcon \textit{Falco subniger}

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Aspects of the biology of the Black Falcon \textit{Falco subniger} were studied in South Australia in the 1970s, and the data on breeding biology not published elsewhere are presented here. Recent body-mass and associated data, and banding and recovery data, were sourced from museums, raptor rehabilitators and the Australian Bird and Bat Banding Schemes. Brood size (young per successful nest) in the 1970s averaged 2.5 (range 1–4, \(n = 6\)). Free-flying male Falcons averaged 582 grams (481–650 g, \(n = 11\)), and females 833 grams (710–950 g, \(n = 18\)). Prey remains in Falcon nests included mainly parrots (e.g. Little Corella \textit{Cacatua sanguinea}, Galah \textit{Eolophus roseicapillus} (~40% by number), Australian Ringneck \textit{Barnardius zonarius}, Crested Pigeon \textit{Ocyphaps lophotes} and Australian Magpie \textit{Cracticus tibicen}. The only banded nestling recovered was found 346 kilometres away, 11 years 7 months later. Common causes of injury and mortality were vehicle collisions.

\section*{INTRODUCTION}

The Black Falcon \textit{Falco subniger} is Australia’s representative of the ‘great’ or ‘desert’ falcons (subgenus \textit{Hierofalco}), i.e. the Gyrfalcon \textit{F. rusticolus}, Saker \textit{F. cherrug}, Lanner \textit{F. biarmicus} and Laggar \textit{F. jugger}. Ecologically and morphologically it is closest to the Laggar Falcon of India (Olsen 1974; J. Olsen in Czechura and Debus 1985), and this apparent relationship was later confirmed genetically (Wink \textit{et al.} 2004). \textit{Contra Olsen \textit{et al.} (1989)} and Marchant and Higgins (1993), it is not related to the hobbies or the Brown Falcon \textit{F. berigora} (Wink \textit{et al.} 2004).

The Black Falcon must be Australia’s most under-studied falcon, given its accessibility to ornithologists and birdwatchers in the eastern sheep–wheat belt, notably in the Adelaide region (e.g. Debus 2005a, 2007). There have been only three studies of the Black Falcon’s biology, all with small sample sizes of nests (Baker-Gabb 1984, \(n = 3\); Debus \textit{et al.} 2005, \(n = 1\); Falkenberg \textit{et al.} 2000, \(n = 7\)), and two observational/photographic studies (Cupper and Cupper 1981; Hollands 1984). Otherwise, information since the summary by Marchant and Higgins (1993) and review by Debus \textit{et al.} (2005) has been anecdotal (Whelan 1992; Dark 2005; Debus 2005b, 2009a; Jolly 2005; McCrie 2005; Moorhead 2005; Ashton 2009). Furthermore, much of the historical information on the Black Falcon is suspect, because of confusion with the dark morph of the Brown Falcon (Olsen 1975; Czechura and Debus 1985; Marchant and Higgins 1993). For instance, until the 1970s books and field guides incorrectly showed the Black Falcon’s legs and other bare parts as yellow (Olsen 1975), whereas older adult Brown Falcons (especially males) can have dull yellow bare parts (e.g. McDonald 2003).

Although the Black Falcon was considered of no national conservation concern in the 1990s (e.g. Marchant and Higgins 1993; P. Olsen \textit{et al.} 1993, 2000), it is poorly known and research into its ecology was recommended as a high priority (Debus 1998). Other recommendations included survey, monitoring, life-history studies, and limiting-factor research (Olsen \textit{et al.} 2000). A decade or so later, most of these recommendations remain unfulfilled. The Black Falcon may now meet criteria for nationally vulnerable, given its recent 38 percent decline in index of abundance (atlas reporting rate) in just two generations, when the IUCN criterion is more than 30 percent decline in three generations. This decline is centred in heavily human-populated south-eastern Australia, i.e. the Murray-Darling Basin and eastern sheep–wheat belt (Debus 2009b,c).

This paper presents some of the basis for the information in Marchant and Higgins (1993) cited as ‘J. Olsen’ (hereafter JO), and for the anecdotal accounts of Black Falcons in P. Olsen \textit{et al.} (1993) and Olsen (1994). It also presents recent body-mass data on the Black Falcon, to supplement and compare with the limited sample in Marchant and Higgins (1993), and ancillary data derived from museum specimens, rehabilitated birds and band recoveries that shed some light on the Falcon’s ecology, movements and causes of mortality. We present this compilation in the absence of detailed dietary or other studies, by other researchers, on the Black Falcon (and indeed most other raptors) in a major part of its heartland, South Australia.

\section*{METHODS}

During a study of the Peregrine Falcon \textit{Falco peregrinus} in South Australia in the early 1970s, JO inspected seven Black Falcon nests, six of which contained nestlings, in the Port Augusta–Wilmington area (Olsen and Olsen 1980; Olsen 1994). These nests were visited 1–6 times each, depending on their stage and the research activities in progress (e.g. collection of prey remains, banding at appropriate chick age). Supplementary information on Black Falcons was supplied by local farmers, notably the late Tom Brandon (of Wilmington), who studied nests and particularly eggs. Data on clutch sizes in historical egg collections were incorporated in the study by Olsen and
Marples (1993), and the residual, hitherto unpublished data on Black Falcon biology are presented here. It is emphasised that the notes taken on Black Falcons at the time were mainly for comparison with the Peregrine, on which the study was focussed.

Body-mass data for Black Falcons (excluding emaciated birds) and related data were sourced from those museums that held recent (post-1990) specimens (Australian Museum, Museum Victoria, South Australian Museum; n = 10), and from a raptor rehabilitator in South Australia (Anita Turton, SA Birds of Prey Centre; n = 8). The excluded emaciated/dehydrated birds were those with a body-condition score of 1 (i.e. close to death, where 5 = well-rounded sternum) in Turton’s care, and a museum specimen that had died in care: males of 456, 500 and 512 grams, and a female of 600 grams. Live-weights were also sourced from the Australian Bird and Bat Banding Scheme (n = 6, variously banded by D. Baker-Gabb, G. and A. Cam, P. Driscoll and W. Klau). These weights are here combined with live-weights of adults trapped or weighed for banding and/or rehabilitation by JO (n = 10). Recovery data for Black Falcons (n = 4) were also sourced from the Australian Bird and Bat Banding Schemes (ABBBS). The Birds Australia Nest Record Scheme was interrogated for recent (post-1990) data, but despite 11 breeding records for Black Falcons in the second national bird atlas (Barrett et al. 2003), no further nest records have been added since the analysis by Marchant and Higgins (1993) (G. Ehmk pers. comm.).

RESULTS AND DISCUSSION

Breeding biology

All seven Black Falcon nests in South Australia (Port Augusta region) were located in flat terrain, often near saltbush (Atriplex) flats or wheat fields, in contrast with Peregrine nests that were on cliffs in the nearby Flinders Ranges (see also Olsen 1994). The Black Falcon nests were all old raven Corvus sp. nests, usually in the top of riparian River Red Gums Eucalyptus camaldulensis on creeklines (see also Olsen 1994), with one near the top of a 30-metre power pylon. (Other areas were searched, and other raptors did nest in low trees and bushes, but these Black Falcons used the only tall trees available, which were on creeklines.) Black Falcons used old raven nests for several years running, without refurbishment by the ravens each year, but when nests started to deteriorate they chose another (JO).

All Black Falcon nests were exposed, open to sun, wind and rain, suggesting that the Black Falcon, in contrast with the cliff-nesting Peregrine, is tolerant of sunlight and heat. Black Falcons are said to sometimes nest on low bushes in the inland (Marchant and Higgins 1993; Ferguson-Lees and Christie 2001), which we regard as highly unlikely and probably referable to Brown Falcons using low corvid or eagle nests. In our experience Black Falcons select the highest nests in the tallest trees available (Debus et al. 2005; JO pers. obs.; SD pers. obs.) and to date there is no reliable evidence to the contrary, given the confounding effect of misidentified Brown Falcons.

Average brood size of the Black Falcon in southern South Australia was given as about three (from Brandon’s historical data from the Wilmington district), compared with the Peregrine’s average of two (Olsen 1994). However, brood size in the six Black Falcon nests inspected by JO in the same region averaged 2.5 nestlings (range 1–4): B/1 x 2, B/3 x 3, B/4 x 1.

Sakers, Laggars and other ‘great’ falcons use cliff nests often, as well as stick nests (Ferguson-Lees and Christie 2001). However, the Black Falcon does not use cliffs, thus limiting its breeding opportunities compared with Australian Peregrines. The latter, unlike elsewhere in the world, have cliffs largely to themselves, free of other eagle and competing falcon species (further discussion by Olsen et al. 2006). Disregarding the smaller Nankeen Kestrel Falco cenchroides, exceptions are some localised Eastern Osprey Pandion cristatus and White-bellied Sea-Eagle Haliaeetus leucogaster nests on coastal cliffs (mainly in SA: Marchant and Higgins 1993). The other medium–large Australian falcons (Grey F. hypoleucus and Brown) are also restricted to using stick nests, typically high, fresh corvid nests (Marchant and Higgins 1993; M’Donald et al. 2003), thus raising the possibility of interspecific competition between Black, Grey and the abundant Brown Falcon for nest sites (especially where many trees have been removed from the landscape or are dying, i.e. the sheep–wheat belt). Nest sites may be a limiting resource for Black Falcons in some areas.

Vocalisations

The Black Falcon’s commonest call at the nest is said to be a harsh scream (Ferguson-Lees and Christie 2001), based on Hollands (1984) who added ‘lower pitched than Peregrine with more the crowing character of the Brown Falcon’. Hollands appears to have used ‘scream’ as a catch-all term for the various cackling and whining calls of the Black and Peregrine Falcons. The Black Falcon does utter a harsh gaaaar or kaaaar (Marchant and Higgins 1993), somewhat like the call of a White-faced Heron Egretta novaehollandiae (JO). However, in our experience the commonest calls around the nest are a gutturral cackle and the female’s begging whine or wail (Debus et al. 2005). The Black Falcon’s cackling call is a deep chug-chug…, more like that of the Saker and Gyrfalcon (i.e. other ‘great’ falcons) than the Peregrine (JO). This similarity is reinforced by sonagrams of the respective calls of the Gyrfalcon and Black Falcon (cf. Clum and Cade 1994; Jurisevic 1998).

Marchant and Higgins (1993) repeated the claim that Black Falcons sometimes scream or cackle when attacking prey, but in our experience Black Falcons are silent when attacking, and most (if not all) such claims are probably based on Brown Falcons (Czechura and Debus 1985).

Prey

Olsen et al. (1979) noted that, in the flat parts of their study area in South Australia, Black Falcons compete directly with Peregrines for prey (meaning they take the same prey species). P. Olsen et al. (1993) and Olsen (1974, 1994) described and compared anecdotally the hunting methods, flight performance and some prey items of both species in that area, including the methods used by Black Falcons to catch Galahs Eolophus roseicapillus and various pigeon species. Black Falcons differ from Peregrines in plumage features (e.g. more flexible flight-feathers), manoeuvrability and hunting methods (e.g. greater use of tactics such as mediated flushing and kleptoparasitism;
Further discussion by Czechura and Debus 1985 and Olsen 1974, 1994). Additional to the descriptions of Black Falcon hunting methods published elsewhere (Marchant and Higgins 1993; Olsen 1994), Olsen (1974) also noted that the Falcon catches Galahs by flying over the treetops and taking them by surprise (a frequent, but unquantified, observation). SD has also observed such treetop-hugging foraging flights, sometimes by a pair of Black Falcons (once at a foraging Musk Lorikeet Glossopsitta concinna in the canopy). In South Australia, Black Falcons have been observed taking Stubble Quail Coturnix pectoralis, Little Button-quail Turnix velox, Horsfield’s Bushlarks Mirafra javanica, Australasian Pipits Anthus novaeseelandiae and a Zebra Finch Taeniopygia guttata flushed by farm machinery, vehicles or mobs of sheep; the finch, and House Mice Mus musculus and Plague Locusts Chortoicetes terminifera, were eaten in flight (L. Pedler pers. comm.).

Prey remains in Black Falcon nests in South Australia included Crested Pigeon Ocyphaps lophotes, Little Corella Cacatua sanguinea, Galah, Australian Ringneck Barnardius zonarius, Blue Bonnet Northiella haematogaster, Budgerigar Melopsittacus undulatus, honeyeaters (Meliphagidae), Australian Magpie Cracticustibicen, Fairy Martin Petrochelidon ariel and Common Starling Sturnus vulgaris, with Galahs contributing about 40 percent of vertebrate prey by number. J. Jolly (pers. comm.) reported Starlings taking refuge amongst and under mobs of sheep to escape hunting Black Falcons, and the Falcons trying to flush them out. The proportion of Galah, by number, is greater than that recorded by Baker-Gabb (1984) and Debus et al. (2005) (18% and 19% of vertebrate prey, respectively), but Galahs were superabundant in JO’s study area.

In contrast, immature Rabbit Oryctolagus cuniculus was the Black Falcon’s dominant prey in arid South Australia and Victoria in the 1970s, i.e. pre-calicivirus (Cupper and Cupper 1981; Hollands 1984; Baker-Gabb 1984). The Black Falcon also preys on plaguing Long-haired Rats Rattus villosissimus in the arid zone (Hollands 1984). Limited recent data from arid South Australia concern the remains of three rabbits and one Galah at two Black Falcon nests in 1995, as the calicivirus was arriving in the region (Falkenberg et al. 2000). Perhaps Black Falcons behave like Sakers or Lanners, taking many small ground mammals when they are superabundant (cf. Ferguson-Lees and Christie 2001). This was not so in three examples recorded by JO (a pair and a juvenile; Figure 1a, Figure 2). These birds, and another pair observed by J. Jolly (pers. comm., also in SA), had a smoky-grey wash on the mantle, a grey cast to the remiges and rectrices and a hint of dorsal barring on the tail, but were little different from normal Black Falcons (see Figure 4). Similarly, other observers with extensive experience of Black Falcons in South Australia have not observed a ‘grey’ form distinguishable from a weathered adult (T. Dennis and L. Pedler pers. comm.). Serventy and Whitell (1976) noted that the Black Falcon has a ‘greyish-blue bloom’ to the plumage, which may reach the extreme of individual variation in the bird illustrated herein (Figures 3, 4). Thus, we suspect that a ‘grey’ morph does not exist, and that such plumages are attributable to a grey wash or bloom, feather wear and perhaps lighting effects. A ‘grey’ form is not admitted by the standard Australian bird field-guides, although Slater et al. (2009) aptly described the [normal] Black Falcon as ‘dark slaty-brown’.

As many juvenile Brown Falcons are very dark, with some buff mainly on the collar, throat and belly/crissum (Marchant and Higgins 1993), there is much risk of confusion with Black Falcon nestlings; some early banding records of ‘Black Falcon’ nestlings may have been Brown Falcons (JO). False data may inflate Black Falcon population and productivity figures and thus create an overly optimistic impression, and perhaps have contaminated the Nest Record Scheme analysis in Marchant and Higgins (1993), and indeed probably atlas and other databases. However, the only two weighed Black Falcon nestlings in the ABBS were correctly identified (see below).

Black Falcon prey records in this study are a subset of Peregrine prey from the same area (cf. J. Olsen et al. 1993). In the arid zone, there is much dietary overlap between the Black Falcon and Grey Falcon (cf. Marchant and Higgins 1993; Falkenberg 2011; Sutton 2011). The Brown Falcon, whose range encompasses that of the Black Falcon, also overlaps with the latter in vertebrate food (birds, small mammals and some carrion, cf. Marchant and Higgins 1993; M’Donald et al. 2003; Debus et al. 2005; M’Donald and Baker-Gabb 2006).

Plumage

The Black Falcon’s plumages are poorly understood, and readily confused with those of dark Brown Falcons. Breeding adult Black Falcons tend to be lighter-coloured (browner) than juveniles, with an evident malar stripe, whereas in the darker juveniles the malar stripe blends with the overall colouration (Figure 1a, Figure 2). Most feathered nestling Black Falcons examined by JO were typically dark (e.g. Marchant and Higgins 1993). However, one was light in colour, with a clear malar stripe: pale edging on its back feathers and some barring under its wings and tail, resembling what might be called an adult (Figure 1b). Other juvenile characters are discussed by Debus et al. (2005).

A rare sooty-grey (i.e. dark grey) colour form of the Black Falcon is alleged to exist (e.g. P. Olsen et al. 1993); its upperparts are said to be slate-grey as in the Australian Hobby Falco longipennis (Marchant and Higgins 1993; Ferguson-Lees and Christie 2001). This was not so in three examples recorded by JO (a pair and a juvenile; Figure 3a,b). These birds, and another pair observed by J. Jolly (pers. comm., also in SA), had a smoky-grey wash on the mantle, a grey cast to the remiges and rectrices and a hint of dorsal barring on the tail, but were little different from normal Black Falcons (see Figure 4). Similarly, other observers with extensive experience of Black Falcons in South Australia have not observed a ‘grey’ form distinguishable from a weathered adult (T. Dennis and L. Pedler pers. comm.). Serventy and Whitell (1976) noted that the Black Falcon has a ‘greyish-blue bloom’ to the plumage, which may reach the extreme of individual variation in the bird illustrated herein (Figures 3, 4). Thus, we suspect that a ‘grey’ morph does not exist, and that such plumages are attributable to a grey wash or bloom, feather wear and perhaps lighting effects. A ‘grey’ form is not admitted by the standard Australian bird field-guides, although Slater et al. (2009) aptly described the [normal] Black Falcon as ‘dark slaty-brown’.
Body weights

For free-flying Black Falcons aged 1+ or older, sexed by dissection (the recent museum specimens) or by experienced raptor biologists and rehabilitators (n = 29 in total), males averaged 582 grams (range 481–650 g, s.d. = 59.8, n = 11) and females averaged 833 grams (range 710–960 g, s.d. = 90.3, n = 18). In addition, two advanced female nestlings at banding age weighed 810 and 840 grams, and two unsexed free-flying birds aged 1 and 1+ weighed 640 and 647 grams (ABBBS data), i.e. probably males on the above basis. Inclusion of these last two would amend the male mean to 592 grams (s.d. = 59.2, n = 13), which may be more realistic for healthy wild birds. (We note here that of 154 Black Falcons in the ABBBS, half of which were free-flying, i.e. age 1+, only six had been weighed.)

The Black Falcon is strongly sexually size-dimorphic in body mass, and the data herein raise the possibility that a few of the old museum specimens (used for body weights in Marchant and Higgins 1993) may have been mis-sexed. For example, the 610-gram ‘female’ museum specimen in Marchant and Higgins (1993) and Ferguson-Lees and Christie (2001) is likely to have been mis-sexed, sick or desiccated. As a further caution against underweight (sick) birds, a rescued nestling that was assumed male on the basis of live-weight (495 g), and died of trichomoniasis, was found to be female on dissection (AM O.71022: Debus et al. 2005; data per W. Boles).

Specimens, band recoveries and other data

For the museum specimens, five birds from South Australia (all females) were noted as road kill (two), hit by car (two), and found injured (one); one of the car casualties was feeding on a Fox *Vulpes vulpes* cub carcass on the road (P. Willcock pers. comm.). Two female Falcons had bird remains and probable rabbit remains in their stomachs, respectively, and a third (road kill) had chunks of meat but no other remains in its stomach, i.e. probable scavenging on a large road-kill carcass (data per P. Horton). For the Australian Museum specimens, at least two

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**Figure 1.** (a) ‘Normal’ (dark) juvenile Black Falcon, ~10 months old, and (b) light juvenile Black Falcon, seven weeks old, showing atypical (for juveniles) light face and clear malar stripe; both from South Australia. Photos: Jerry Olsen.

**Figure 2.** The same ‘normal’ (dark) juvenile Black Falcon as in Fig. 1a, at 8–10 weeks old. Photos: Jerry Olsen.
of four (a male and a female) originated from main roadways, i.e. probable road kills (data per W. Boles; stomach contents given by Debus et al. 2005). At least two of the road-killed females were adults, with convoluted oviducts (i.e. had bred), which suggests that not only juveniles scavenge road kill (cf. Debus et al. 2005). These incidents support the view that the Black Falcon feeds on carrion more frequently than do most other Australian falcons, though less so than the Brown Falcon (cf. Marchant and Higgins 1993; Ferguson-Lees and Christie 2001). For instance, SD has observed a pair of Black Falcons feeding on a road-killed macropod in central Queensland.

One specimen (Australian Museum) consisted of Black Falcon bones found in a Wedge-tailed Eagle nest near Broken Hill (western NSW), and male Black Falcon remains were found in a Peregrine cliff nest at 1000 metres elevation near Canberra (J. Olsen, A. B. Rose and W. Boles unpubl. data). That Peregrine pair commonly took Australian and Little Ravens Corvus coronoides and C. mellori (Olsen et al. 2004).

Among 12 Black Falcons received by the South Australian Birds of Prey Centre, 2002–2009, were: six hit by cars (one juvenile and two adult females, one juvenile and one adult male); two gunshot victims (one 1+ female, one juvenile male); two unspecified collision victims (adult female, adult male); one nestling taken illegally from a nest (but confiscated and taken into care); and one nestling that was in unspecified difficulty (rescued and taken into care).

Details of the four banded Black Falcons recovered (a 3% recovery rate, of 154 banded) are as follows. The Mallala birds were trapped in a pigeon-fancier’s pigeon barn (using padded leg-hold rabbit traps that sometimes accidentally injured the Falcons and caused ethical issues with the authorities; see Olsen 1994).
Mallala (SA), 9 March 1990, age 1+, sex unknown: recaptured in cage trap at banding place on 5 April 1996 after 72 months, released alive with band.

Mallala (SA), 2 February 1994, age 1+, sex unknown: recaptured by hand/hand-held net at banding place on 5 April 1997 after 38 months, released alive with band.

Mallala (SA), 8 December 1994, age 1+, sex unknown: found sick or injured at Two Wells (SA) on 5 April 1995 three months later, 14 km south-east (rehabilitated in captivity).

Pirlta (Victoria), 20 September 1980, nestling, sex unknown: found fatally injured (mercy killed) on highway near Port Wakefield (SA) on 4 May 1992 139 months later, 346 kilometres west.

The Mallala birds were all trapped in summer/autumn and all five birds were recovered in that region in autumn: a season when the Black Falcon was locally noted as a visitor to the wheat fields of the district, with up to 13–14 gathering at local gluts of prey such as locusts (M. Waterman pers. comm.). Similarly, on the South Australian coast at Encounter Bay, Black Falcons are seen annually in late summer/autumn, apparently attracted to the large numbers of feral Rock Doves Columba livia and Common Starlings roosting on near-shore islands (T. Dennis pers. comm.). Conversely, Black Falcons leave the Adelaide region in winter (P. Willcock pers. comm.).

The Pirlta to Port Wakefield recovery represents a longevity (11 years 7 months) and distance record for a wild Black Falcon. These few birds (not aged or sexed) illustrate a wide variation in occurrence and movements, from being present at a given locality after 3–6 years (no implication about their movements or locations in the interim), to moving 14 kilometres from that locality in three months, to juvenile dispersal of ~350 kilometres to that same locality (a post-breeding destination?). A pair of Black Falcons appeared to maintain a temporary summer (post-breeding) territory at Werribee (coastal Victoria), where the two birds regularly roosted together but did not breed (P. McDonald pers. comm.).

Black Falcons used to be seen fairly often around Canberra (Olsen 1975), but are rarely if ever seen there nowadays (JO pers. obs.). This trend is supported by the annual bird reports of the Canberra Ornithologists Group, published in Canberra Bird Notes. In these, the Falcon went from a reportedly uncommon breeding summer migrant, with records in most years (~5 per year) in the 1980s, to a rare visitor in the 1990s (~2 records per year in the few years with records) and 2000s (occasional in autumn, notably in the drought years of the mid-2000s).

However, more systematic study is needed, as the Black Falcon has never been confirmed to breed near Canberra (JO). This trend in sightings may reflect the Black Falcon’s recent population trend, and perhaps breeding success, in the Murray-Darling Basin (cf. Debus 2009b, c). Similarly, at high elevation (>1000 m asl) on the Northern Tablelands of New South Wales, the few Black Falcon sightings (1–2 per year) over the past 20 years fall in summer–autumn (SD), with the nearest known breeding population at much lower elevation (~400 m asl) in a valley of the North-west Slopes (Debus et al. 2005).

How much of the foregoing regional decline represents an Australia-wide shift in the Black Falcon population (e.g. more frequent and prolonged occurrences in the drier coastal valleys of south-east Qld: G. Czechura pers. comm.), or perhaps a response to changing fire regimes, is unclear pending further data.

CONCLUSIONS

There are few other data with which to compare the Black Falcon’s breeding productivity in South Australia. Baker-Gabb (1984) recorded 12 young raised in six pair-years (mean = two young per attempt) in a climatically similar area in Victoria. Falkenberg et al. (2000) recorded a mean of two young per pair over eight pair-years pre-calicivirus, and one per pair (n = two pairs) in the first year post-calicivirus, with breeding failure (i.e. no pairs at that study site) in the next two years, in the South Australian arid zone (a non-significant difference, given the sample sizes). However, with such a small sample size and short interval in the 1990s, a climatic effect rather than an effect of rabbit decline cannot be ruled out, and researchers may not have found or searched for alternative nests. For instance, Black Falcons, which do not refurbish nests, moved several kilometres to alternative (newer) raven nests, used by ravens in the previous year, in South Australia (JO).

Post-calicivirus, populations of rabbit-eating raptors showed no significant change in relation to rabbit abundance (Steele and Baker-Gabb 2009). Clearly, there is a need for contemporary data on nest occupancy and breeding productivity from sample locations around the country, over several years, to complement atlas survey data, in order to elucidate the Black Falcon’s conservation status and population trends (e.g. Olsen et al. 2009). The need for studies of breeding pairs is crucial because atlas surveys of raptors, as opposed to smaller bird species, can misrepresent breeding numbers (Sergio et al. 2008; Olsen et al. 2009). For instance, Black Falcons are still frequently seen at food sources in parts of southern South Australia (e.g. up to eight around an abattoir near Adelaide), although nests are not found (J. Jolly and P. Willcock pers. comm.), whereas Olsen (1994) noted the loss of some Black Falcon and other raptor breeding pairs following the destruction of riparian woodland in his South Australian study area. These are non-systematic observations, and may not reflect the true status of the Black Falcon in South Australia. Furthermore, Olsen et al. (2009) showed that even systematic surveys of raptor sightings can mask a species’ decline: breeding Little Eagles Hieraaetus morphnoides in the Australian Capital Territory had declined dramatically, but data from annual bird surveys suggested that numbers were stable.

Limited data on the Black Falcon’s breeding diet in South Australia confirm that it is largely a bird hunter, and that its avian diet overlaps almost completely with that of the Peregrine, although Black Falcons take more mammals and carrion. Black Falcon prey records in this study are a subset of the Black Falcon’s breeding diet elsewhere (cf. Baker-Gabb 1984; Marchant and Higgins 1993; Debus et al. 2005). Although generally not rabbit-dependent, the Black Falcon may be a facultative opportunist on abundant mammals, and on abundant flying insects (e.g. locusts); it may also take larger prey when
feeding young (e.g. Olsen and Tucker 2003; Debus et al. 2005). In the study by Falkenberg et al. (2000), Black Falcons may have responded to a post-calicivirus shortage of rabbits by switching prey or by not breeding (cf. Olsen et al. 2010), and thus were not attached to nests until conditions (e.g. ground cover, avian prey) improved.

The Black Falcon’s plumage is variable, such that banders and observers should exercise caution in assigning age classes to birds in the field on the basis of plumage alone, and include other cues such as plumage wear and moult, the plumage condition and behaviour of associating individuals (e.g. adults with dependent juveniles), and bare-part colouration (see Debus et al. 2005).

The body-mass data confirm the strong sexual size dimorphism in this species, and its similarity in body size to the Peregrine Falcon (male 600 g, female 825 g, cf. Marchant and Higgins 1993). Banding, recovery and rehabilitation data highlight the need for further investigation of the Black Falcon’s movements and causes of mortality. Recovery and rehabilitation data suggest that road kill and other collisions with human structures are a common cause of non-normal (human-caused) mortality in this species in the sheep–wheat belt. If Black Falcon breeding territories are not held year-round and the Falcons range widely in the non-breeding season, or hold regular non-breeding territories, this may have implications for management of the species.

Ecological information on the Black Falcon remains scanty, but increasingly necessary for conservation and management purposes if the Falcon is declining in south-eastern Australia. The research needs identified (Debus 1998; Olsen et al. 2000) are now more pressing, and the Falcon’s conservation status warrants review not only in southern Australia, but more widely. For instance, the heart of its global distribution appears to be South Australia, western New South Wales and inland Queensland, and its conservation therefore lies mainly with these respective governments. Conversely, it appears to be rare in Victoria, central Australia and Western Australia. For instance, Aumann (2001) found none breeding in his study area in the south-western Northern Territory, and, during much work in remote deserts (Queensland, Northern Territory, South Australia, Western Australia), M. Schulz (pers. comm.) has not seen one, despite several Grey Falcon sightings, especially in the eastern deserts (e.g. Tirari, Strzelecki and Simpson). Thus, the Black Falcon may be a ‘steppe’ falcon rather than a true desert species.

Comparison of the Black Falcon’s ecology (e.g. prey, hunting behaviour, flight performance) with that of the well-known Peregrine has been anecdotal and based partly on birds trained for pest-control trials (Olsen 1994). More rigorous and quantitative comparisons, as made with Peregrine and Lanner Falcons in Africa, would be fruitful (cf. Jenkins 2000a,b,c and his earlier work cited therein). Furthermore, comparison between Peregrine and Black Falcons could provide models for more relevant sympatric falcons, i.e. the Brown Falcon and Grey Falcon, given that (a) the Peregrine increased in reporting rate in New South Wales between the two atlas periods (Barrett et al. 2007), and is of lesser conservation concern; (b) the Grey Falcon is rare and/or threatened in some states (see Sutton 2011); and (c) the abundant Brown Falcon may be the most relevant in terms of overlapping nest-site requirements and locations, and diet.

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