

Morphometric data from recent specimens and live individuals of the Grey Falcon *Falco hypoleucos*

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Received: 11 May 2010

Morphometric data are presented for eight specimens of the Grey Falcon *Falco hypoleucos* acquired since 1990 by Australian wildlife collections and wildlife care facilities, and for the first three wild-caught adult individuals of the species. Morphological characteristics are analysed and compared with other published material. It is suggested that adult and juvenile Grey Falcons can be sexed by wing-length and tail-length: females have wing-length greater than 305 millimetres and tail-length greater than 150 millimetres, and males have wing-length less than 300 millimetres and tail-length less than 150 millimetres. Disregarding severely emaciated or dehydrated specimens, six females averaged 559 grams (486–624 g) and four males averaged 388 grams (range 362–419 g). Contrary to the ABBBS recommended band size of '27(M11) (varies geographically)', it is suggested that size 27 is inappropriate for males and probably for many or most females, size 11 being more suitable, and that for this species the tarsus diameter should be measured before bands are applied.

INTRODUCTION

The Grey Falcon *Falco hypoleucos* is the rarest and least known of the six members of its genus in Australia (Marchant and Higgins 1993). To date the species has not been the subject of a specific study, although several field projects have dealt with single aspects of the species' ecology and biology (Debus and Rose 2000) or have included the species as part of a broader investigation of raptor communities (Aumann 2001a,b,c; Falkenberg 2011; Sutton 2011).

Marchant and Higgins (1993) summarised morphometric data for the Grey Falcon from measurements and labels of a limited number of specimens in museum collections. Since then, three specimens of Grey Falcon were added to museum holdings in Australia by passive collection (i.e. found dead or injured, rather than actively collected by museum staff). Further, Eagles Heritage, a raptor rehabilitation facility at Margaret River, Western Australia, took five injured birds into care, three of which remained alive in early 2010. As well, during a current study on wild Grey Falcons conducted since 2004, three adult birds have been captured and released thus far.

The relevant problem to date is that there are few morphometric data for determining sexing criteria and dimorphism indices for the Grey Falcon, and very few known body weights for elucidating, for instance, its size class with respect to the other bird-eating falcons. New data from wild adults and recent specimens, in addition to previously published material, are used to refine sexing criteria, examine body weights, and evaluate the recommended band sizes for this species. Results from the only Grey Falcons banded before this study, a total of eight nestlings, are discussed elsewhere in this issue by other authors (Sutton 2011; Falkenberg 2011).

SPECIMENS AND METHODS

The most recent Grey Falcon specimen received by the South Australian Museum (SAM) was in 1998 ('adult female', registration number B49016: Tables 1 and 2). Originating from north-eastern South Australia, it had a broken wing from collision with a power-line (per SAM records), received veterinary treatment in Adelaide and was cared for by the late Jim Robinson (N. Jarvis *in litt.* 2006). Before it could be returned to its original location, a storm damaged its aviary and it escaped; it was later found dead on a beach. The unknown period between the bird's death and its last meal, combined with its not having eaten well in captivity, may explain its low weight. It is indeed a female by measurements (see 'Sexing', below, and Table 2), probably severely emaciated, and an adult based on photos provided by N. Jarvis (Figure 1).

An adult male, found with a broken wing on a roadside east of White Cliffs (NSW) in June 2007, was lodged with the Australian Museum (AM) in November 2007 (reg. no. O.72018). While in care at Broken Hill (NSW) it was apathetic, ate little, and died a few days after arrival (B. Deans *in litt.* 2007). Its frozen corpse weighed 381 grams, which may be below the normal weight range of that individual.

In late 2007, the Western Australian Museum (WAM) received a fledgling Grey Falcon (accession number A37044), which originated from a brood in the Chichester Range, Pilbara (WA). Stewart Ford (SF) and George Swann (GS) had discovered the nest containing three young. On 14 October 2007, on the ground below the nest they found one young falcon dead and another exhausted, unable to fly. This particular day was very hot with temperatures above 50 degrees Celsius and a strong wind was blowing. The three young either fledged on or just before that day, or had left the nest or been blown out

TABLE 1

The most recent acquisitions of Grey Falcons by wildlife collections in Australia. AM = Australian Museum; ANWC = Australian National Wildlife Collection (CSIRO, Canberra); MM = Macleay Museum, Sydney University; MV, incl. HLW = Museum Victoria, including the H.L. White Collection; QM = Queensland Museum; SAM = South Australian Museum; WAM = Western Australian Museum.S

Wildlife collection	Skins held in 2009	Most recent acquisition	Accession no.	2nd most recent acquisition	Accession no.
AM	11	2007	O.72018	1949	O.38715
ANWC	1	1954	No. 2	–	–
MM	1	1880s	B3025	–	–
MV, incl. HLW	8	1936	B.282	1919	HLW.6505
QM	2	1979	QMO 17728	1928	QMO 3585
SAM	8	1998	B49016	1984	B49000
WAM	2	2007	A37044	pre-1980	A31552

TABLE 2

Morphometric data for Grey Falcon specimens, rehabilitated birds or live-caught wild birds obtained since 1990 (n = 11; see text). Measurements as on museum tags, as provided by museum staff, or as measured in the field. Weights in grams, measurements in mm. The five birds at Eagles Heritage were measured by the author on 24/03/2010; some of the frozen corpses could not be measured, owing to the unsuitable position of legs, wings or head. Weights probably affected by emaciation or captivity are in parentheses. Wild birds captured during this study are identified by the serial number of their respective ABBBS band. All measurements taken according to Marchant and Higgins (1990), except those marked (*), indicating that method and precision are assumed to be standard. a = wing amputated; g = growing; vw = very worn; w = worn.

	Sex	Weight	Wing	Tail	Bill (C)	Bill (F)	Tarsus
AM O.72018	♂	(381)	283	137	16.5	20.8	36.4
SAM B49016	♀	(365.7)	309*	155*	19.7	25.2	44*
WAM A37044	♂ ?	(220.7)	242g	137(g?)	14.2g	17.6g	44.6
EH 1999 (corpse)	♀	–	–	–	(broken)	–	–
EH 2001 (live)	♀	(620)	326	171	20.1	25.7	44.8
EH 2003 (corpse)	♂	(362)	278	–	17.9	23.6	–
EH 2007 (live)	♀	(543)	335	171	20.4	27.4	44.7
EH 2009 (live)	♂	(371)a	284	141	18.1	24.0	41.5
Bird 111-03731	♂	419	284	132	15.6	21.1	–
Bird 111-03742	♀	486	320	161w	20.2	25.7	–
Bird 111-03732	♂	391	280	140vw	17.9	23.7	–

TABLE 3

Grey Falcon weights reported in Marchant and Higgins (1993). Weights considered emaciated are set in parentheses. A further mentioned 'unaged female' of 562 grams is assumed to be identical with QMO 17728; see text. * = data on label state '1 lb 6 oz', precision is not known.

Specimen	Sex	Age	Weight (g)	Emaciated	Circumstances
NHM Tring 1965.43.6	♂	adult	(335)	yes	(see text)
QMO 17728	♀	?	(568)	yes	found shot
ANWC No. 2	♀	adult	624*	no	active collection
SAM B40000	♀	sub-adult	(515)	yes	road-kill



Figure 1. Adult female Grey Falcon specimen SAM B49016 while still alive, undergoing rehabilitation in Jim Robinson's care, 1998 (see text).

Photo: the late Jim Robinson (courtesy Neil Jarvis).

of it prematurely. The exhausted and dehydrated falcon (here referred to as EH 2007: Table 2), apparently after being locally treated and stabilised, was sent to Eagles Heritage.

A few days after the incident, SF and GS observed the third sibling at the Chichester Range territory being fed by a parent near the nest (S. Ford *in litt.* 2007). During a visit there in May 2008 (i.e. seven months after the fledging date), I observed two adults and one young Grey Falcon roosting regularly for the night close to the nest. On a visit in August that year I found the nest destroyed (presumably by wind), and no Grey Falcons were seen.

The following information concerning sex, weight and circumstances for the first three acquisitions of Eagles Heritage, i.e. EH 1999, EH 2001 and EH 2003, was provided by P. Pain, owner of the facility.

EH 1999 originated from Telfer, Pilbara (WA) and was an adult when found (cause of injury unknown), sex allegedly female. Before being transferred to Eagles Heritage it had its left wing amputated near the carpal joint. The bird died in 2005 when it fell off a six-metre high perch in its aviary. Due to a range of weights being recorded (all minus one wing below the carpal joint), its weight is omitted in Table 2.

EH 2001, a female by measurements, was found entangled in a barb-wired fence in 2001 near Wagga Wagga (NSW). At that time it was young (P. Pain pers. comm.), presumably hatched in spring 2000. Apparently, a second youngster, possibly a male, was found dead near the injured female. Its fate or current location is unknown.

EH 2003 was a male, allegedly adult when found, and originated from near Mt Magnet (WA). It had a damaged sciatic nerve in its left leg (cause of injury unknown), which severely handicapped it, and it was euthanised in 2005. Its corpse differs from a typical adult in the lighter yellow colour of its legs and toes and in its darker plumage.

EH 2009 was found on 28 June 2009 on the side of the Great Northern Highway approximately 20 kilometres east of Port Hedland, Pilbara (WA) (F. Grierson *in litt.* 2009). The location was along a well-timbered and then-dry creek-bed, 10 kilometres inland from the coastline. It is a male on measurements, and was, by plumage, within its first year, having hatched in spring 2008. Before being sent to Eagles Heritage, it had its left wing amputated at the humerus, the injury probably caused by collision with a vehicle. Its weight (371 g) is invalid for the purpose of this paper, as it is an amputee missing most of one wing, but nevertheless suggests that its true weight might have been around 400 grams.

Wild bird, band no. 111-03731 (bands supplied by the ABBBS), was captured by the author on 28 July 2007 in central South Australia. It was the male of a pair, both birds being in adult plumage according to the description by Marchant and Higgins (1993). The pair showed interest in, and copulated near, the highest of three nests (apparently built by corvids) in a cluster of approximately 12 coolibahs (~12 metres tall), along the edge of a broad and shallow creek-bed. The falcons subsequently left the area, but whether capturing one deterred the pair from using the nest in that year is uncertain (though considered unlikely, from the author's experience with other pairs).

Wild bird, band no. 111-03742 was an adult female (by measurements) captured by the author on 19 September 2009 in the Northern Territory. On 27 July 2003 a pair was found roosting at the top of a telecommunications tower approximately 70 metres tall, near remnants of a stick-nest. In 2008, a pair of Grey Falcons bred on that tower and successfully raised one young, in a nest at the top that appeared to be the old nest of Torresian Crows *Corvus orru*. A pair of crows successfully bred in 2008 at the same time as the Grey Falcons, in a nest half way up the tower, i.e. approximately 35 metres below the falcons. In 2009, however, a pair of Australian Hobbies *Falco longipennis* bred in the nest at the top, and the nest halfway up the tower was not in use.

When captured, the female Grey Falcon appeared to be unpaired. She regularly roosted halfway up the tower near the disused crows' nest of 2008, and she repeatedly stood in that nest or sat in it. Her weight (486 g) was lower than expected from available data (Table 3), but she may simply have been a small individual and not, for example, temporarily undernourished. When observed in 2008, the female of the pair that bred at the location, most probably 111-03742, appeared to be of nearly equal size to the male when perched. Only when flying close to each other did the size difference become obvious, mainly owing to the difference in wing-length. Typically, females can be separated from males by their larger size when the sexes are together for direct comparison (see Schoenjahn 2010a, Plate 9). Further, on observing the individual for six days before and two days after capture, she appeared healthy and fit. The measurements of 111-03742 were all within the respective ranges for females given by Marchant and Higgins (1993). On the day after her capture, 111-03742 was in the company of a yearling Grey Falcon by its plumage, presumably her offspring from the previous year.

Wild bird, band no. 111-03732, was the adult male of a breeding pair in central Queensland, captured by the author on 11 October 2009. In that year, the pair successfully raised four young. In 2008, a pair had raised one young successfully in that same nest.

Measurements

Methods of measurements and precision used in this paper are in accordance with Marchant and Higgins (1990), unless stated otherwise. Bill (C) = bill chord from front edge of cere; bill (F) = bill chord from forehead feathers (i.e. exposed culmen; Marchant and Higgins 1993).

RESULTS AND DISCUSSION

Sexing

Because no molecular sexing has been conducted on the Grey Falcon, sexing has to rely on morphometric data. The presumption that the Grey Falcon, as most other Falconiformes, exhibits reversed sexual size dimorphism (RSD) (Newton 1979) is undisputed (Baker-Gabb 1984; Cade 1982; Marchant and Higgins 1993) but has not been explicitly demonstrated to be true. In the following that deficit is rectified.

From museum specimens and their labels, Marchant and Higgins (1993) found two size-groups of adult Grey Falcons: the smaller ones sexed as males, the larger ones as females (Table 4). The ranges of measurements of the two groups do not, or only slightly, overlap. For most measurements (for $n > 3$ specimens of each sex), notably wing-length and tail-length, females were significantly ($P < 0.01$) larger than males, the only exceptions being 'toe' (not significant) and 'tarsus' ($n = 3$ females only).

New data (Table 4) extend only slightly the ranges of measurements, and do not change the quality regarding overlap or lack thereof. Further, the sexes of the following specimens are certain. 111-03731 and 111-03732 are male by direct observation such as copulation or as observed within the family group; NHM Tring 1965.43.6 (see below; measurements taken by H. van Grouw: wing 295 mm, tail 130.5 mm, tarsus 42.15 mm, bill (C) 17.8 mm, bill (F) 22.4 mm) is a male on gonads (data on label); and ANWC No. 2 is a female on gonads (data on label). Wing and tail of those three adult males fall within the set of smaller measurements in Marchant and Higgins (1993), and the adult female specimen has wing and tail within the set of larger measurements.

The measurements bill (C) and bill (F) of those four 'new' birds of known sex are either inside or marginally outside the respective ranges for the relevant group. Hence, the sex of any adult specimen discussed above is defined by either wing-length or tail-length alone. However, 'a single measurement taken to represent individual size... is not sufficient for careful studies' (Winker 1998, p. 26). For Grey Falcons, the data suggest that the sex of an adult individual may be determined by using the two commonly taken measurements, wing-length and tail-length, and the ranges as provided by Marchant and Higgins (1993, p. 297 row (1) adults; see Table 3). Thus, a wing-length less than 300 millimetres and tail-length less than 150 millimetres

denotes male, and a wing-length more than 305 millimetres and tail-length more than 150 millimetres denotes female.

The RSD of the Grey Falcon is also verified in the field by observations of copulation and other behaviour of breeding pairs of Grey Falcon, such that with familiarity, members of a pair are readily sexed by size (i.e. female always larger than male: Cupper and Cupper 1980; Hollands 1984; Schoenjahn 2010a; pers. obs.).

It is suggested that fully grown juveniles be sexed in the same way as adults, using the same ranges of measurements. Measurements of juveniles may lie only marginally outside the respective ranges for adults.

With very limited meaningful data available to date, the differences in the weight of male and female Grey Falcon are not yet understood well enough to be used for sexing. As expected, the ranges of the weights of adults, however, seem to be disjunct (see below).

The bill of juvenile EH 2007

Measured on 24 March 2010, bill (C) of EH 2007 was 20.4 millimetres and bill (F) was 27.4 millimetres. Both measurements are larger than the respective measurements given by Marchant and Higgins (1993) for juvenile and adult females. Just over two years earlier, on 8 January 2008 about three months after it had fledged, the bill (C) of EH 2007 was measured as 19.3 millimetres. Whether the increase (from 19.3 mm to 20.4 mm) represents a longer bill, or is within the margin of measurement error, or was, for example, caused by a slight change in the demarcation of the cere, cannot be said. However, when first examined, both mandibles were pink near the base, suggesting that the bill was still growing; the pink was not present on 1 April 2008. In a little over two years, since this bird was approximately 4.5 months old, its bill (C) had apparently increased by approximately five percent.

The sex of WAM A37044

The data on the label of specimen WAM A37044 indicate female on gonad examination, the gonads being depicted by the preparer on the label. However, even direct gonadal examination can be subject to error (Winker 1998). Sexing by dissection can be difficult when a bird is not in breeding condition, as the size and development of the reproductive organs are influenced by the bird's readiness to reproduce (Keast and Marshall 1954; Marchant and Higgins 1993). The weight, presumably of the frozen corpse of WAM A37044, is given as a very low 220.7 grams (even for a male): probably the result of starvation and pre- and post-mortem dehydration. Bill (C), at 14.2 millimetres, is smaller than the lower margins of the ranges for adult and juvenile males in Marchant and Higgins (1993). It appeared that the hook at the tip of the upper mandible had not yet grown to its full length. The presence of pink in both mandibles (see also above, EH 2007) suggests that the bill was still growing. It seems unlikely, however, that its bill (C) would have increased 25 percent to reach the lower margin given by Marchant and Higgins (1993) for adult and juvenile females (17.7 mm). In comparison, bill (C) of EH 2007 had increased by only five percent in the two years following fledging, albeit in captivity.

TABLE 4

Ranges of measurements in mm, of adult birds. 'HANZAB' refers to Marchant and Higgins (1993, p. 297 row (1) adults), 'COMBINED' refers to the latter combined with the adult specimens presented in Table 2. All measurements taken according to Marchant and Higgins (1990), except that marked (*), indicating that method and precision are assumed to be standard.

HANZAB	Wing	8th p	Tail	Tarsus	Bill (C)	Bill (F)
Male	276–297	184–210	131–146	41.2–43.6	15.6–17.7	20.5–23.9
Female	313–337	216–236	154–176	44.6–47.8	17.7–20.1	23.5–25.3
overlap	no	no	no	no	0	0.4
COMBINED						
Male	276–297	–	131–146	36.4–43.6	15.6–18.1	20.5–24.0
Female	309*–337	–	154–176	44.0–47.8	17.7–20.4	23.5–27.4
overlap	no	–	no	no	0.4	0.5

Similar growth would increase bill (C) of WAM A30744 to 14.9 millimetres, which is still below the lower margin for males (15.6 mm). The tail-length of WAM A37044 is within the range for adult and juvenile males and much smaller than the range for females of any age. Tarsus-length is greater than the range for males (ages combined) and equal to the lowest of three figures given for females (Marchant and Higgins 1993). Considering the small sample of tarsus lengths, the morphometric data strongly suggest that WAM A37044 is a male.

On 13–18 May 2008, I visited the location of the nest where both EH 2007 and WAM A37044 originated, where I observed an adult pair and a juvenile Grey Falcon roosting regularly for the night next to the nest. That juvenile was sexed as male by comparing its size with the adult birds, which were likely to be the pair that bred at that site the previous year. Thus, the juvenile was probably the sibling of EH 2007 and WAM A37044, which would mean that the 2007 brood consisted of at least one individual of either sex, and most probably consisted of one female and two males.

Band size selection

To date, 11 Grey Falcons have been banded (C. Hunt, ABBBS, pers. comm.): two nestlings in 1984 by M. Waterman (*in litt.* 2003), six nestlings in 1987 by Sutton (2011), and, since 2007, three adults by the author. The 1984 sibs were sexed as a male and a female, and were both banded with size 27 bands (ABBBS banding data). Sutton's six birds, weighing between 390 and 488 grams, were all banded with size 11 (Sutton 2011), and the three adult birds captured were also banded with this size. Before attaching the bands I measured the right leg of each bird: the minimum of the antero-posterior diameter of the tarsometatarsus near the middle point (see Baldwin *et al.* 1931) and the minimum of the lateral diameter (Table 5). Each bird was fitted with one metal band on each tarsometatarsus, using a colour code for future individual identification. When selecting band size for the two males, size 10 (internal diameter 9.5 mm) appeared visually and numerically too small, considering that the minima of the antero-posterior diameter of the tarsometatarsus were measured as 8.2 millimetres and 8.3

TABLE 5

Minimum tarsometatarsus diameters (to the nearest 0.1 mm) of live Grey Falcons captured from the wild, taken near the middle point (see text) of the right leg, utilizing vernier calipers.

Wild Grey Falcon	Sex	Antero-posterior	Lateral
111-03731	♂	8.2 mm	–
111-03742	♀	9.0 mm	6.4 mm
111-03732	♂	8.3 mm	5.9 mm

millimetres, notwithstanding that bands are closed to a slight ellipse rather than a perfect circle. In both males the band size 11 fitted well, with bands moving freely along the tarsometatarsi without slipping onto the adjacent joints. The female 111-03742 was first fitted with a band size 27, internal diameter 12.5 millimetres, but the band was too large and in danger of slipping onto the upper and lower joints. It was removed and replaced with a size 11 band, nominal internal diameter 11.0 millimetres, which fitted very well.

Weight

Passively collected individuals are likely to be emaciated, owing to a loss of body fluids from injury, dehydration and/or starvation. Even under the rare circumstance that the time of weighing is known, the degree of emaciation is typically unknown. Also, the weight of an animal kept and fed in captivity must be treated with care; it can be below or above the normal range for that individual in the wild. The eight examples presented in Table 2 that were not captured from the wild are affected in this way. The weights of better-studied species of the genus *Falco* show greater variability when captive compared with in the wild, e.g. Australian Peregrine Falcons *Falco peregrinus* (Marchant and Higgins 1993).

For male Grey Falcons, all previously published weights derive from one specimen obtained near Warburton (WA), and now held at the Natural History Museum, Tring, UK (accession number 1965.43.6; H. van Grouw *in litt.* 2010). Children of the Warburton Mission had given the bird to ornithologists (Hall 1974). Its weight, as stated on the label and given by Hall (1974), was 335 grams; sex is male by gonadal examination (data on label) and by measurements. The age was adult by plumage, from photos provided by H. van Grouw. Serventy and Whittell (1967) first published that weight, albeit at 12 oz (~340 g), later repeated (in grams) by others (e.g. Cade 1982; Czechura and Debus 1985; Marchant and Higgins (1993). It is likely from the circumstances of acquisition that the corpse was emaciated or dehydrated. Consequently, 111-03731 and 111-03732 provide the only known weights of non-emaciated adult male Grey Falcons.

The weights for both sexes provided by Marchant and Higgins (1993) are listed and commented on in Table 3. The bird listed as 'Unaged female, 562 [grams] (P. D. Olsen; J. Olsen; S. J. S. Debus)' is most likely QMO 17728 adult female of weight 568 grams (S. Debus pers. comm.; H. Janetzki *in litt.* 2010). The latter was sexed as female by gonadal examination, and was in good condition, though found shot beside a road (G. Czechura pers. comm.); it thus may have been dehydrated. The weight ranges for adults of the two sexes still do not overlap, even with the new data available.

From Tables 2 and 3, ignoring the two severely emaciated birds (SAM female 366 g, WAM male 221 g), five male Grey Falcons average 378 grams (335–419 g), and six females average 559 grams (486–624 g). If the 335-gram male is also treated as an emaciated outlier, the mean for four males becomes 388 grams (362–419 g).

The measurement 'Tarsus'

Sutton's (2011) measurements of the tarsi of Grey Falcon nestlings are consistently much greater than those discussed here. The discrepancy cannot be explained as measurements of the anterior or posterior side of the tarsometatarsal bone (see Baldwin *et al.* 1931), nor can it be explained as difference between 'Tarsus length (TR)' and 'Tarsus length with foot (TZ)' after Lowe (1989). Consequently, Sutton's set of tarsal measurements cannot be compared with those discussed here.

Age characters

The colours of Grey Falcon bare parts change from juvenile to adult (Marchant and Higgins 1993), and the bright yellow-orange colour of the cere, base of bill and orbital ring of the adult may not be acquired at the same time (Schoenjahn 2010b). Two fledglings had pink at the base of the bill (see above). Juvenile EH 2007 had dull yellow gape flanges in January and April 2008, i.e. about three and six months after fledging; WAM A30744 also shows yellow at the gape flanges. Sutton (2011) noted that feature on the nestlings he examined. A more extensive study of the age-related variation in bare-part colouration and plumage will be presented elsewhere.

CONCLUSIONS

The morphometric data presented extend the respective ranges for the Grey Falcon given by Marchant and Higgins (1993). Notably, the weights of the birds captured from the wild were outside the known range for the respective sexes. Both males were heavier than the only male mentioned by Marchant and Higgins (1993), and it is suggested that the latter was emaciated. The female captured from the wild was lighter than any of the three examples mentioned. Although these weights differ substantially from the literature, the non-emaciated weights of both sexes presented here coincide with the weights taken by Sutton (2011) for nestlings approaching fledging age. Considering the very low sample size before this study, and still today, the typical, healthy weight ranges remain to be clarified.

The ranges of measurements and weights provided by Marchant and Higgins (1993) for Grey Falcon males and females exhibit little overlap, and the data gained since have not changed that situation. Although the body weights presented herein probably include dehydrated and/or emaciated birds, they at least provide some comparison with a presumably similarly affected sample of museum weights of other falcon species (e.g. Peregrine Falcon, Black Falcon *Falco subniger*) in Marchant and Higgins (1993). These data suggest that male Grey Falcons are intermediate in weight between the female Australian Hobby and male Peregrine and Black Falcons, and female Grey Falcons approach male Black and Peregrine Falcons in weight. Healthy wild adults of all these species are likely to be heavier than passively collected museum specimens.

Given the problems with weights for Grey Falcons, the data suggest that the sex of an adult individual may best be determined by tail-length and wing-length: males' tail-length being less than 150 millimetres and females' more than 150 millimetres, and less than 300 millimetres or more than 305 millimetres for wing-length, for males and females respectively. Sutton's (2011) three lighter nestlings, possibly males, weighed 390, 409 and 413 grams; the adult males captured from the wild were 391 and 419 grams. Sutton's two heaviest nestlings, possibly females, were 476 and 488 grams, close to the 486 grams of the only adult female captured. The fact, however, that no data are available to determine the sex of nestlings makes it difficult to draw further conclusions about juveniles. Nevertheless, on the basis of size and potential growth of its bill, a fledgling in the Western Australian Museum (WAM A37044) most probably is a male, despite direct gonadal examination suggesting otherwise.

When the ABBBS published the 'Recommended Band Size List' (2000), the recommendation for Grey Falcon was, based on the very limited data available, '27(11M)*', i.e. size 27 in general; the bracketed size 11 may be used for males only if size 27 proves unsuitable, the asterisk meaning 'varies geographically'. However, the uncertainty deriving from the very small sample size has been pointed out (D. Drynan pers. comm.). Size 27 for a male Grey Falcon as used by Waterman seems inappropriate (see also Falkenberg 2011), and may be so for some or most females as well. For comparison, male Peregrines (which are much more robust than male Grey Falcons, and slightly more so

than female Grey Falcons) take a size 11, as do both sexes of the Peregrine-sized Black Falcon, whereas size 27 is appropriate for some *female* Peregrines (ABBBS 2000).

Band sizes in this study were carefully chosen on the basis of measurements only, and independently of sex and published recommendations. For female 111-03742, the choice was made against the recommendation by ABBBS (2000). All adult birds of both sexes banded in this study were banded with size 11. It is strongly suggested that individually measuring the diameter of the tarsometatarsus should be carried out before choosing the band size for Grey Falcons. Choosing band sizes for Grey Falcon pulli requires utmost scrutiny and consideration.

ACKNOWLEDGEMENTS

My sincere thanks to Philip Pain of Eagles Heritage for providing access to the live and dead birds in his possession whenever I requested, and for sharing his extensive and intimate knowledge with me. I thank Stephen Debus, two initial reviewers, and Penny Olsen and another (anonymous) referee for valuable comments on drafts. I thank Ben Allen, David Baker-Gabb, Rose Best, Felicity Bettesworth, Walter Boles, Gregory Czechura, Beris Deans, Stephen Debus, David Drynan, Stewart Ford, Fiona Grierson, Hein van Grouw (Natural History Museum at Tring, UK), Philippa Horton, Catherine Hunt, Heather Janetzki, Neil Jarvis, Elizabeth Jefferys, Ron Johnstone, Jon and Anne King, Geoff Lodge, Bob McGowan, Mike McGrady, Discovery Team of the Museum Victoria, Jerry Olsen, Samuel Orr, Palatitz Péter, Trevor Quedsted and Tony Webster. Field work for this ongoing study is undertaken under ABBBS banding authority 2484 (including colour-marking approval), and under all relevant licenses, permits, animal ethics approvals and deeds required for New South Wales, the Northern Territory, Queensland, South Australia and Western Australia, all held since 2004. Bands and banding pliers were supplied by the ABBBS.

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