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Grey Falcon – ecological insights from resightings of colour-banded and satellite-tagged individuals

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The Grey Falcon *Falco hypoleucos* is a rare Australian endemic bird of prey confined to the arid/semi-arid zone of the continent. The species is listed since 2020 as threatened under the EPBC Act 1999, category Vulnerable. Before the commencement of this ongoing research project in 2004 the species was known largely from anecdotal information and obtainments from museum specimens. The aim of this study was, therefore, to increase our knowledge about this species. During 2004–2023, and across Australia's arid/semi-arid zone, I banded 23 individuals, and fitted 11 of these with satellite-transmitters. Capture, handling and banding/tagging of the birds were subject to a strict protocol to ensure their welfare; protocol details are presented. I observed the birds before and after capture, and recorded their behaviour and circumstances. Sixteen (70%) of the 23 tagged individuals were resighted or generated, by means of satellite-telemetry, location data pertinent to this study. My observations of resighted tagged birds were complemented by those of volunteer informants. The data collated provide novel insights into the ecology of the Grey Falcon, specifically pertaining to age at first breeding, breeding preparedness, pair bond, furthest distance travelled from banding site, overcoming illness, longevity, and natural cause of death. These insights may provide crucial information for conservation considerations.

Keywords: banding ethics; bird of prey; conservation; *Falco hypoleucos*; threatened species

INTRODUCTION

The Grey Falcon *Falco hypoleucos* is a rare and elusive species endemic to Australia's arid and semi-arid zone (Schoenjahn *et al.* 2020). Before 2004, i.e., the year when the present study commenced, the Grey Falcon was known largely from anecdotal information and obtainments from museum specimens (Schoenjahn 2013). To increase our knowledge about this species in general was, and still is, the overarching aim of this ongoing Australia-wide research. Results concerning various aspects of the species' ecology and biology have since been published (including Mullin *et al*. 2020a,b; Schoenjahn 2010a,b, 2011a,b, 2013, 2018; Schoenjahn *et al*. 2020, 2022a,b,c; Schoenjahn, Mullin *et al*. 2021; Schoenjahn, Pavey *et al*. 2021). Based largely on those results, which include a population size estimate of less than 1000 mature individuals, the Grey Falcon is listed since 2020 under the Environment Protection and Biodiversity Conservation Act 1999 as a nationally threatened species, category Vulnerable (available at https://www.environment.gov.au/; Mullin *et al.* 2020a; Schoenjahn 2011b). Here I present the results of 20 years of fieldwork, involving observation data of 23 individuals, and the resightings of banded individuals. Resighting data are complemented by information pertaining to 11 individuals that were also satellite-tracked (a detailed description of the satellite-tagging together with a report and analysis of the movements of the satellite-tracked individuals will be published elsewhere). The combined banding/tagging-resighting data provide novel insights into the ecology of the Grey Falcon.

STUDY AREA AND METHODS

This study is part of an ongoing research project that commenced in 2004 and is conducted across mainland Australia. Some particulars in this section are taken from aforementioned publications that pertain to the same research project.

Study area was the arid/semi-arid zone of the Australian continent. Twenty-three individuals were banded between July 2009 and September 2021, thereof four in Northern Territory (NT), 10 in Queensland (QLD), four in South Australia (SA), and five in Western Australia (WA). Eleven of these 23 birds were also fitted with satellite-transmitters. Locations and capture methods are undisclosed to protect this threatened species.

Procedures are provided here in greater detail than usual for a banding study report. I consider this justified because the species is very rare and listed as threatened. Further, during capture and handling these birds are vulnerable to environmental hazards inherent to their extreme environment, including high heat loads and strong winds. I hope that the following details are useful in future studies.

Procedures commenced with locating a site where one or more individuals could reliably be found over the period of a few consecutive days, i.e., an active nest or a regular day-time or night-time roost. Once found, birds were observed with binoculars (Leica 10 x 42 BN, Germany) and telescope (Leica APO-Televid 77, eyepiece 32x WW) to assess their suitability for being banded and satellite-tagged. Only birds that appeared absolutely healthy and fit were considered for being captured and tagged. Free-flying birds only were considered. Nestlings were not interfered with and nests were not climbed due to concerns about the safety of these rare birds. Capture was, therefore, invariably attempted on the ground, using a variety of methods that were approved by an Animal Ethics Committee of the respective State and Territory; for permit details see Acknowledgements. Animal welfare

measures included: one trap only was used at any given time; the trap was under my uninterrupted supervision while open; traps were removed when the ambient temperature exceeded 35ºC, or was expected to exceed 35ºC during the next hour; during wind speeds exceeding about 10 m/s; at the approach of inclement weather and bush fire; and an hour before sunset. Further, capture of breeding adults was attempted only when the nestlings had been left alone by both parents for a minimum of two hours at a time. This crucial restriction ascertained that eggs were never left exposed and nestlings were old enough to thermoregulate and fend for themselves between capture of the adult and its return to the nest. Capture was also suppressed when it appeared possible that an unwanted species might get captured, e.g., Nankeen Kestrel *F. cenchroides* breeding in the immediate vicinity to the targeted Grey Falcons (as reported by Schoenjahn *et al.* 2022c).

Once captured, each bird was freed from the trap within a few minutes, often using a pair of miniature scissors (Classic SD, Victorinox, Switzerland) to quickly disentangle the bird and minimise extraction time. Secured in a PVC-pipe of suitable length and diameter and held firmly by its legs, the bird was then taken to the banding station, set up beneath the awning of my car, parked about 300 m from the nest or roost. There the bird was measured and weighed to determine sex (for details see Schoenjahn 2011a). In addition, breadth and width of the narrowest portion of the tarsometatarsus of one leg were measured to determine the appropriate band size (see Schoenjahn (2011a) for justification). A metal band was then attached to each tarsometatarsus. Bands were of stainless steel quality and colour-coated (unless used uncoloured) so that each bird could be fitted with a unique combination of coloured bands enabling future individual identification (Table 1). One band bore the ABBBS serial number. Bands and banding pliers were provided by ABBBS.

Selected birds were fitted, in addition to the colour bands, with light-weight solar-powered Doppler-shift platform transmitter terminals (PTTs, hereafter called transmitters). The weight of the transmitters ranged between, representing between 1.6% (bird No. 18) and 3.5% (bird No. 8) of the body mass of the respective individual involved, following transmitter weight recommendations for raptors, including falcons, of similar size (Steenhof *et al*. 2006). The transmitters were attached to the birds as backpacks by means of individually fabricated harnesses. These were made of tubular Teflon® tape with a flattened width of 6.35 mm (1/4 inch), provided by Bally Ribbon Mills, Bally, Pennsylvania, United States. The harness design included a weak link, which consisted of household cotton sewing thread that was used to stitch the upper and lower harness loops together. The weak link was designed to break when the cotton thread disintegrated after about two

Table 1

List of the Grey Falcons banded and, if applicable, satellite-tagged during this project to date, i.e., between July 2004 and November 2023. Age code: 2+, adult of unknown age, i.e., at least two years old; 'Flg.', fledgeling; 'Juv.', juvenile, i.e., less than one year old. Band number of the master band and colour of the bands are also provided. The master band is indicated by an asterisk (*). Dates are displayed as dd/mm/yyyy. 'PTT', platform transmitter terminal, i.e., satellite-transmitter, and its Argos identification number if applicable.

No.	Sex	Age	Band No.	Left leg	Right leg	Date tagged	State	PTT, Argos ID
1	♂	2+	111-03731	metal	metal*	28/07/2007	SA	
2	♀	2+	111-03742	black*	red	19/09/2009	NT	54142
3	♂	2+	111-03732	blue	metal*	11/10/2009	QLD	
4	♀	2+	111-03744	white	black*	11/09/2010	QLD	
5	♂	2+	111-03733	green	metal*	02/10/2010	QLD	
6	♀	2+	111-03743	black*	orange	02/10/2010	QLD	
7	♂	Flg.	111-03734	red	metal*	03/10/2010	QLD	
8	♂	2+	101-04381	metal*	blue	09/10/2010	NT	79109
9	♀	2+	111-03745	blue	orange*	19/09/2011	QLD	
10	♀	2+	111-03746	green	orange*	05/09/2012	WA	
11	♀	Juv.	111-03749	red	orange*	04/04/2014	WA	134881
12	♂	2+	111-03735	white	metal*	07/10/2014	QLD	141276
13	♀	2+	111-31009	black	blue*	13/10/2014	QLD	141628
14	♀	Flg.	111-31010	blue*	black	15/10/2014	QLD	
15	♀	2+	111-31011	black	white*	18/09/2015	SA	
16	♂	2+	111-03736	metal*	green	30/09/2015	NT	141276[1]
17	♂	2+	101-04389	orange	green*	11/10/2015	SA	
18	♀	2+	111-31051	red*	black	11/10/2015	SA	150861
19	♀	2+	111-31012	white	white*	24/05/2016	WA	150860
20	♀	2+	111-31013	white*	red	06/10/2016	NT	162913
21	?[2]	Flg.	111-31053	lime green	red*	24/09/2017	WA	
22	♀	2+	270-08252	blue	black*	08/10/2019	QLD	162915
23	♀	2+	111-31014	white*	green	10/09/2021	WA	162914

[1]This transmitter was reused after being refurbished by the manufacturer. See bird No. 12.

[2]The sex of bird No. 21 was not established because the bird was captured at around sunset, i.e., too late to be fully processed before dark. Capture was opportunistic and by hand from a low bush. See also Table 2.

years, or if, for example, the bird got entangled in vegetation. The satellite-tracking was carried out by CLS/Argos, Toulouse, France (https://www.argos-system.org). For further details see (Schoenjahn 2018).

Most banding sites were revisited in most subsequent years and predominantly during the breeding season, time and weather/road conditions permitting (Schoenjahn 2013), by either me or volunteer informants. Recorded were presence/absence of the banded individuals and their behaviour and circumstances. Resighting observation reports made available to me by volunteer informants were often accompanied by photographic evidence.

RESULTS

Twenty-three birds were colour-banded and 11 of these were also fitted with a satellite-transmitter. Sixteen (70%) of the 23 tagged individuals were resighted in the field or generated, by means of satellite-telemetry, key location data pertinent to this study. The results are listed in Tables 1, 2 and 3. To simplify cross-reference between the tables and text, a unique number is assigned to each banded individual (left column in Table 1).

All adult birds, except two, were breeding at the time of tagging. The exceptions are birds No. 2 and No. 16. Female

Table 2

Tagged Grey Falcons that were resighted and monitored remotely by satellite-tracking. Numbering as in Table 1. Also provided are date when tagged, date of subsequent observation(s), period between tagging and observation, and distance between tagging site and observation site.

No.	Date tagged	Date of subsequent observation	Period since tagged	Distance in km	Remarks	Observer or source
2	19/09/2009	28/11/2009	10 wk	~ 9	Last reliable signal; signal lost 15/01/2010	Satellite-generated data
5	02/10/2010	17/09/2011	11.5 mo	0	Resighted, breeding again with the same mate (No. 6)	JS
6	02/10/2010	17/09/2011	11.5 mo	0	Resighted, breeding again with the same mate (No. 5)	JS
8	09/10/2010	29/07/2011	10 mo	0	Resighted; photos	Freda Blakeway
		22/09/2011	11.5 mo	0	Resighted, breeding	JS
		13/04/2012	18 mo	< 1	Transmitter stationary very near nest site	Satellite-generated data
9	19/09/2011	May 2012	8 mo	0	Resighted, colour-band recognised	Jim (further details are not known)
11	14/04/2014	09/05/2016	25 mo	135	Resighted, in company of an adult male	JS
		12/06/2016	26 mo	143	Transmitter stationary. Bird found dead on 10/09/2016 (Table 3).	Satellite-generated data, and JS
12	07/10/2014	26/12/2014	12 wk	67	Transmitter stationary. Bird found dead on 25/03/2015 (Table 3)	Satellite-generated data, and JS
13	13/10/2014	31/12/2014	11 wk	0	Resighted with male partner and a juvenile; photos (Fig. 1)	William and Xavier Zuccon
		07/01/2015	3 mo	~ 0	Signal lost	Satellite-generated data
		26/03/2015	5.5 mo	0	Resighted alive without transmitter	JS
15	18/09/2015	01/10/2017	24.5 mo	0.5	Resighted with male partner; bird No. 15 on ground, appearing sick; photos	Owen Lishmund[1] and Scott Baker[1]
		13/09/2019	48 mo	0	Resighted, breeding; photos	Andrew Martin
		19/10/2019	49 mo	0	Resighted, breeding; photos	William and Xavier Zuccon, JS
		21/10/2020	61 mo	0	Resighted, breeding; photos	Peter Waanders and Michael Greenshields
16	30/09/2015	01/01/2016	3 mo	30	Transmitter stationary. Bird found dead on 08/10/2016 (Table 3)	Satellite-generated data, and JS
18	11/10/2015	05/07/2016	9 mo	4.5	Signal lost	Satellite-generated data
19	24/05/2016	04/06/2016	11 d	7.5	Transmitter stationary. Bird found dead on 13/09/2016 (Table 3)	Satellite-generated data, and JS
20	06/10/2016	10/10/2016	4 d	0	Transmitter stationary	Satellite-generated data
		28/10/2016	3 wk	0	Resighted alive without transmitter; the transmitter was found beneath the nest	Lisa and Peter Nunn
		15/04/2017	~6 mo	0	Resighted, 2 ad. and 1 juv.; photos (Fig. 2)	Lisa and Peter Nunn
		24/05/2017	7.5 mo	~ 5	Resighted; photos	Lisa and Peter Nunn
		18/02/2018	16.5 mo	0	Resighted, 2 ad. and 2 juv.; photos	Lisa and Peter Nunn
		09/04/2018	18 mo	0	Resighted; photo	Lisa and Peter Nunn
		03/12/2018	26 mo	0	Resighted; photo	Lisa and Peter Nunn
21	24/09/2017	05/10/2017	11 d	0	Resighted; photos (Fig. 3)	Bernard Hynes and Scott Brown
22	08/10/2019	12/10/2019	4 d	0	Transmitter stationary	Satellite-generated data
23	10/09/2021	02/01/2023	~16 mo	503	Transmitter stationary	Satellite-generated data

[1]Photographs available at *Macaulay Library*, Cornell Lab of Ornithology, https://www.macaulaylibrary.org

Figure 1. *The satellite-tagged female No. 13 drives away a Black Falcon* Falco subniger *that harassed her ~4-months-old young feeding on the ground. The female and her male partner were standing close to the young when the Black Falcon appeared, presumably in an attempt at kleptoparasitism.*

Photograph copyright and courtesy of William and Xavier Zuccon.

Figure 2. *Female No. 20, right, and her juvenile offspring from the breeding event during which she was banded and satellite-tagged. The transmitter is no longer on the bird. The white band on her left leg ascertains her identity.*

Photo copyright and courtesy of Lisa and Peter Nunn.

No. 2 was closely associated with a yearling male at a site that was almost certainly the natal site of the yearling. Male No. 16 was closely associated with an adult female and a yearling female, without doubt the offspring from the previous year of the adults; the tagging site was almost certainly the natal site of the yearling.

Each banded individual remained, as far as it is known, in the State and Territory in which it was banded.

The female No. 11 did not breed, according to the satellite-generated data, when one and two years old (Schoenjahn 2018). When in her third year, in May 2016, I observed that female associated with an adult male (Table 2). Five weeks thereafter, and before the commencement of the breeding season, she was killed and eaten by a Wedge-tailed Eagle *Aquila audax* (Table 2).

Figure 3. *Fledgling No. 21 approaches the nest. Eleven days earlier it was hand-captured from a low bush at that site and banded.*

Photo copyright and courtesy of Bernard Hynes.

Bird No. 15 likely had gone through a period of illness. The bird was photographed at close range on the ground at the site where it had been banded while breeding two years earlier. The behaviour of the bird, as far as it is apparent to me, and its outward appearance depicted in the photos suggest that the bird was in poor health. The two photographers involved in the observation reported also the presence of that bird's male partner, and did not mention breeding (Table 2). I assume, therefore, that the female No. 15 did not breed at that time.

The greatest distance ever recorded for a Grey Falcon from its banding site is 503 km (bird No. 23, Table 2). This bird was satellite-tagged while breeding at a location in the eastern Pilbara, WA. Satellite-tracking data show that the bird flew from the Great Sandy Desert to a location along Geegully Creek, a tributary of the Fitzroy River, Kimberley, WA, about 16 months after being tagged. There its satellite-signal became stationary. That region was affected at that time by an expansive low-pressure system (ex-tropical cyclone Ellie) that caused extensive flooding.

Four birds involved in this study were confirmed to have died (Table 3). Each of them was satellite-tracked until their satellite-signal became stationary. Date of death is presumed to coincide with the satellite-signal becoming stationary. (Note that a stationary satellite-signal *per se* does not constitute death of the individual; see Discussion.) While being tracked, three of the four individuals moved around normally compared to the

Table 3

Tagged Grey Falcons that were found dead, invariably involving satellite-tagged birds whose remains and transmitter I located in the field after their satellite-signal had become stationary. Numbering and conventions as in Table 1.

No.	Period satellite-tracked	Assumed cause of death, and justification for the assumption
11	26 mo	Killed and eaten by a Wedge-tailed Eagle *Aquila audax*. The remains of this bird and its transmitter were found at a well-used active feeding/roosting site of a Wedge-tailed Eagle.
12	12 wk	Killed and eaten by a feral cat *Felis catus*. The satellite-signal of this bird became stationary during night-time. When visiting the site three months later I found, apart from the cracked transmitter, the skull, parts of the wings and loose feathers of the bird scattered on the ground in an area of bare soil interspersed by marginal low vegetation. The bird appeared to have night-roosted on the ground, a common behaviour of this species that was revealed by satellite-tracking data (Schoenjahn 2018).
16	3 mo	Natural cause. The satellite-signal of this bird became stationary at a remote location in the western Simpson Desert, NT. On that day the maximum daytime temperature at that location was, presumably, around 25ºC (Bureau of Meteorology data for Alice Springs Airport, about 200 km away). Nine months later I visited the area, and found the complete skeleton of the bird and the transmitter lying in the sand beneath a dense, sturdy bush. The position of the individual bones indicated that the corpse had disintegrated slowly over time, the soft tissue having been consumed by, for example, ants rather than a vertebrate scavenger. The remains lay in a cave-like opening that would have been accessible to the bird only through a narrow gap between the lowest parts of the bush and the ground. These circumstances suggest that the bird had entered, on foot, that cave-like shelter, and died – possibly of old age.
19	11 d	Human interference. The bird with minor injuries had been picked up by motorists from the side of a major road in a built-up area of South Hedland, Pilbara, WA. It was transferred to a rehabilitation facility, where it spent two weeks. I released it, with a transmitter attached, in an open bushland 6 km east of where it had been found. Satellite-tracking data showed that the bird spent the next night near where it had been found injured, and one night each at two sites a few hundred metres off the Great Northern Highway, about 50 km and 55 km south of South Hedland. I found the remains of the bird and the detached transmitter at the South Hedland rubbish tip.

other satellite-tracked Grey Falcons (Schoenjahn 2018). The only exception involved bird No. 19. Human interference is suspected in connection with its death (see Table 3 for details).

DISCUSSION

The following information can be gained from the combined banding/satellite-tagging data and the details of the resighting of the individually colour-banded birds.

Grey Falcon males and females are capable of breeding in two consecutive breeding seasons (Tables 1 and 2: male No. 5, female No. 6 and male No. 8 in 2010 and 2011; female No. 15 in 2019 and 2020). Although this can be expected from a species of this size and genus, the information, evidenced here for the first time, is relevant because most Grey Falcon breeding sites were inactive during most subsequent breeding seasons. This could have led to the erroneous conclusion that pairs never breed in two consecutive years.

Grey Falcon females, once reproductively active, may breed not in every year. The female No. 2 bred in the year before being tagged and not in the year when tagged (Table 1).

Grey Falcon pairs may stay together for more than one breeding season (birds No. 5 and No. 6, Tables 1 and 2). Although expected from a species of this genus (e.g., Cade 1982), this has never before been proven for the Grey Falcon.

Grey Falcon females may breed for the first time later in life than expected for females of a *Falco* species and, generally, for a raptor of similar size to Grey Falcon. Female No. 11 did not breed at the age of one and two years, and may have commenced breeding at the age of three years. Nevertheless, female Grey Falcons may be capable of breeding successfully earlier in life. Further data are required to support either alternative.

The greatest distance ever recorded for a Grey Falcon from its banding site, 503 km (bird No. 23, Table 2), takes into account all known movements of banded and satellite-tagged individuals (Schoenjahn 2018) involved in this and other studies, i.e., including the studies conducted by M. Waterman in 1984 (for details see Schoenjahn 2011a) and A.J.G. Sutton in 1987 (Sutton 2011a,b).

Grey Falcons may recover fully after having been seriously ill; see Results. Two and three years after being obviously ill, the bird No. 15 bred again (Table 2).

The longevity record, 7+ years old, for Grey Falcon involved bird No. 15 (Recovery Round-up 2020). This female was resighted five years after having been banded when 2+ years old (Table 2). Of note, that female was recorded breeding at the age of, 2+, 6+ and 7+ years. This information is of particular interest for a threatened species such as the Grey Falcon. That is, age at reproduction is an important life-history variable that affects generation time, a demographic metric used in extinction risk assessments, for example (for an expansion of the matter, see Bird *et al.* 2020). The most recently published generation time for the Grey Falcon, 4.4 years, is an inferred estimate of low reliability, thus warranting further research (Schoenjahn, Mullin *et al*. 2021).

The methods of this study, i.e., trapping, handling, banding, satellite-transmitters and attachment method, are not known to have impacted on the wellbeing of these birds and their breeding behaviour. For example, the birds No. 5, No. 6 and No. 8 bred in the year after being banded respectively satellite-tagged (Tables 1 and 2). Further, the birds No. 8, No. 11 and No. 23 were tracked for periods of around 1.5 years and longer, apparently unhampered by their transmitter even during long-distance movements (e.g., bird No. 23).

Each of the four cases of confirmed death had a different assumed cause (Table 3), including predation by an autochthonous predator, predation by an alien predator, old age, and anthropogenic activity unrelated to this study.

A stationary satellite-signal per se does not constitute death of the individual (see Results). Examples are birds No. 13 and No. 20 (Fig. 2). Birds may actively remove the harness and transmitter, and this was presumedly the case of bird No. 20; its harness and transmitter were later recovered intact. Bird No. 22 may, perhaps, be a further example. The satellite-signal from bird No. 22 became stationary four days after the bird was tagged, the same period after which bird No. 20 lost its transmitter. Alternatively, the unit might have fallen off without the bird's active involvement and rather because the weak link incorporated in the harness broke.

The aforementioned behaviour of the young of this species of remaining closely associated with one or both parents until about one year of age is unique among the genus Falco and other birds of prey of similar size (for details and explanation see Schoenjahn et al. 2022a).

The low number of Grey Falcons captured and banded during this project, despite considerable effort spanning two decades and involving many volunteer informants, is due partly to the scarcity of the species, occurring at very low density across a vast and predominantly remote area, and the difficulty of capturing these birds once found. The latter difficulty stems from the unusual behaviour of these birds compared to congeners, in that Grey Falcons keep physical activity levels low even when most active, thus reducing capture opportunities (Schoenjahn et al. 2022b). In addition, complying with the aforementioned stringent animal welfare-related standards further reduced capture opportunities.

In summary, the banding-resighting observation data presented here provide novel and valuable insights into the species' ecology and these may be crucial for conservation considerations for this threatened species.

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The following Animal Ethics Committee (AEC) approvals, permits and licences were required for the Australian States and Territory concerned, as per November 2023. All items were held since 2004. **NT**: AEC approval No. A12018 (covering Northern Territory and Western Australia), Charles Darwin University, Darwin; Licence to Use Premises for Teaching or Research involving Animals No. 029, Animal Welfare Authority; Permit to Interfere with Wildlife for Commercial Purposes No. 70834, Parks and Wildlife Commission NT; Benefit Sharing Deed No. COM2003/203:JGS, Dept. of Trade, Business and Innovation. **QLD**: Community Access AEC approval No. CA 2022/04/1598, Dept. of Agriculture and Fisheries; Scientific Use Registration No. 168 Dept. of Agriculture and Fisheries; Permit to Take, Use, Keep or Interfere with Cultural or Natural Resources (Scientific Purpose) No. P-PTUKI-100442769 (protected areas), Dept. of Environment and Science; Scientific Purpose Permit No. WA0013568, Dept. of Environment and Science. **SA**: Wildlife Ethics Committee approval No. 11/2019, Dept. for Environment and Water; Permit to Undertake Scientific Research No. C24781-18, Dept. of Environment, Water and Natural Resources; Licence for Teaching, Research or Experimentation involving Animals No. 135, Dept. for Environment and Water. **WA**: AEC approval No. A12018, see NT; Authorisation to Take or Disturb Threatened Species (Section 40) No. TFA 2324-0038, Dept. of Biodiversity, Conservation and Attractions; Licence to Use Animals for Scientific Purposes No. U 224/2023, Dept. of Primary Industries and Regional Development. **Federal**: Banding Authority No. 2484, Class: A, Type: Bird (including colour marking scheme), mist-net endorsement, covering all traps and devices used in this study, ABBBS, Dept. of Sustainability, Environment, Water, Population and Communities. **New South Wales**: AEC approval and all licences and permits were discontinued in March 2019 due to a lack of breeding records for the study species in that state.

REFERENCES

Bird, J. P., Martin, R., Akçakaya, H. R., Gilroy, J., Burfield, I. J., Garnett, S. T., Symes, A., Taylor, J., Şekercioğlu, Ç. H. and Butchart, S. H. M. (2020). Generation lengths of the world's birds and their implications for extinction risk. *Conservation Biology* **34**: 1252-1261. https://doi.org/10.1111/cobi.13486

Cade, T. J. (1982). *The Falcons of the World*. Collins, London.

Mullin, D. W., McCulloch, G. A., Schoenjahn, J. and Walter, G. H. (2020a). Phylogeography of the rare Australian endemic Grey Falcon *Falco hypoleucos*: implications for conservation. *Bird Conservation International* **30**: 447–455. https://doi.org/10.1017/S0959270920000106

Mullin, D. W., McCulloch, G. A., Schoenjahn, J. and Walter, G. H. (2020b). Coping with heat in the arid interior - what can feather structure reveal about the ecology of Australia's desert-living Grey Falcon *Falco hypoleucos*? *Emu* **120**: 83–89. https://doi.org/10.1080/01584197.2019.1698301

Recovery Round-up. (2020). *Corella* **44**: 106–108.

Schoenjahn, J. (2010a). Field identification of the Grey Falcon *Falco hypoleucos*. *Australian Field Ornithology* **27**: 49–58.

Schoenjahn, J. (2010b). The type and other early specimens of Grey Falcon *Falco hypoleucos*. *Bulletin of the British Ornithologists' Club* **130**: 102–115.

Schoenjahn, J. (2011a). Morphometric data of recent specimens and live individuals of the Grey Falcon *Falco hypoleucos*. *Corella* **35**: 16–22.

Schoenjahn, J. (2011b). How scarce is the Grey Falcon? *Boobook* **29**: 24–25.

Schoenjahn, J. (2013). A hot environment and one type of prey: investigating why the Grey Falcon (*Falco hypoleucos*) is Australia's rarest falcon. *Emu* **113**: 19–25. https://doi.org/10.1071/MU12049

Schoenjahn, J. (2018). Adaptations of the rare endemic Grey Falcon *Falco hypoleucos* that enable its permanent residence in the arid zone of Australia. PhD thesis, The University of Queensland, Brisbane.

Schoenjahn, J., Mullin, D. W., Pavey, C. R., McCulloch, G. A., Runge, C. A., Tulloch, A. and Garnett, S. T. (2021). Grey Falcon *Falco hypoleucos*. In: *The Action Plan for Australian Birds 2020* (eds S. T. Garnett and G. B. Baker), pp. 381–383. CSIRO Publishing, Melbourne.

Schoenjahn, J., Pavey, C. R. and Walter, G. H. (2020). Ecology of the Grey Falcon *Falco hypoleucos* – current and required knowledge. *Emu* **120**: 74–82. https://doi.org/10.1080/01584197.2019.1654393

Schoenjahn, J., Pavey, C. R. and Walter, G. H. (2021). A true desert falcon with a delayed onset of heat dissipation behaviour. J*ournal of Arid Environments* **190**: 104530. https://doi.org/10.1016/j.jaridenv.2021.104530

Schoenjahn, J., Pavey, C. R. and Walter, G. H. (2022a). Delayed juvenile behavioral development and prolonged dependence are adaptations to desert life in the grey falcon. *Current Zoology* **68**: 679–687. https://doi.org/10.1093/cz/zoac001

Schoenjahn, J., Pavey, C. R. and Walter, G. H. (2022b). Low activity levels are an adaptation to desert-living in the Grey Falcon, an endotherm that specializes in pursuing highly mobile prey. *Journal of Thermal Biology* **103**:103108. https://doi.org/10.1016/j.jtherbio.2021.103108

Schoenjahn, J., Pavey, C. R. and Walter, G. H. (2022c). Has the Australian endemic Grey Falcon the most extreme dietary specialization among all *Falco* species? *Animals* **12**: 1582. https://doi.org/10.3390/ani12121582

Steenhof, K., Bates, K. K., Fuller, M. R., Kochert, M. N., McKinley, J. O. and Lukacs, P. M. (2006). Effects of radiomarking on Prairie Falcons: attachment failures provide insights about survival. *Wildlife Society Bulletin* **34**: 116–126. http://dx.doi.org/10.2193/0091-7648(2006)34[116:EOROPF]2.0.CO;2

Sutton, A. J. G. (2011a). Aspects of the biology of the Grey Falcon *Falco hypoleucos* in the Pilbara region of Western Australia. *Corella* **35**: 11–15.

Sutton, A. J. G. (2011b). Observations on the raptor community of the Pilbara region of Western Australia. *Australian Field Ornithology* **28**: 129–132.