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Authors: Davis, Robert A., Joseph, Leo, and Johnstone, Ronald E.

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# Status of Barking Owl *Ninox connivens* in south-west Australia

by Robert A. Davis, Leo Joseph & Ronald E. Johnstone

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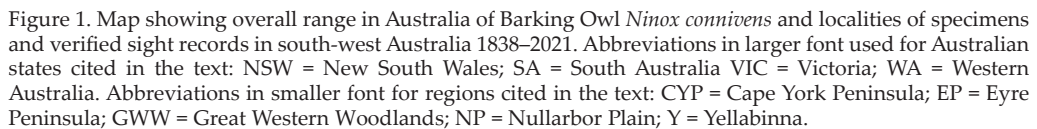
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**SUMMARY.**—Barking Owl *Ninox connivens* has two recognised subspecies in Australia: *N. c. connivens* and *N. c. peninsularis*. *N. c. connivens* currently includes the isolated south-west Australian population, which is separated from eastern populations by the Nullarbor Plain and from *N. c. peninsularis* to the north. *N. c. connivens* in south-west Australia occurs from near Perth in the north, east to Northam and south-east to Katanning and Bremer Bay; it has been treated subspecifically as *N. c. addenda* Mathews, 1912, but this name is not currently in use. Given concern over the apparent rarity of the south-west Australian population, we sought to compile all known historical and contemporary records in order to assess its conservation status and ecology. We located the holotype of *N. c. addenda* Mathews, 1912, and found only ten sightings in the past 20 years that met our criteria for acceptance. No sound-recordings or photographs of wild birds are known.

Barking Owl *Ninox connivens* has two currently recognised subspecies in Australia: *N. c. connivens* Latham, 1801, and *N. c. peninsularis* Salvadori, 1876 (see Schodde & Mason 1981, Schodde & Mason 1997, Higgins 1999). A third subspecies *N. c. assimilis* Salvadori & D'Albertis, 1875, occurs in New Guinea and a fourth, *N. c. rufostriata* G. R. Gray, 1861, in the North Moluccas. *N. c. peninsularis* is assigned to populations in north-east, north and north-west Australia (Schodde 1997, Higgins 1999). In eastern Australia, *N. c. connivens* ranges from the base of the Cape York Peninsula in Queensland, south through New South Wales (NSW) and Victoria to eastern South Australia (Fig. 1; cf. Higgins 1999, Loyn et al. 2021). Additionally, *N. c. connivens* also currently includes the isolated population in south-west Australia. This population is widely separated from those in the east by the Nullarbor Plain and fringing xeric vegetation of the Eyre Peninsula and Yellabinna in South Australia, and areas east of the Great Western Woodland in Western Australia (WA; Fig. 1). It is also isolated from *N. c. peninsularis* to the north, in the Pilbara region of WA. *N. c. connivens* in south-west Australia occurs from near Perth in the north, east to Northam, and south-east to Katanning and Bremer Bay (Johnstone & Storr 1998; see Fig. 1 for localities in south-west Australia). This population was separated by Mathews (1912) as *N. c. addenda*, but this name is not currently in use.

*N. c. connivens* is sparsely distributed across its continental range and listed as Near Threatened (Loyn et al. 2021). In coastal and central Queensland (QLD) it occurs mainly in waterside forests. In NSW, populations are mostly confined to the western slopes and plains, and particularly in the Pilliga Forest (Kavanagh & Stanton 2009, NSW Office of Environment and Heritage 2020). In Victoria, it predominantly occurs in the Great Dividing Range (Clemann & Loyn 2003) and in South Australia it occurs in the east of the state, inland to Lake Eyre and the Flinders Ranges (Mees 1964, Loyn et al. 2021; Fig. 1).

*N. c. connivens* mostly inhabits dry sclerophyll woodland across its range and is usually associated with watercourses, wetlands and forest edges (Loyn et al. 2021); it nests in



The status of *N. c. connivens* in south-west Australia is very poorly known compared to other Australian populations. In this region it was listed as rare by Storr (1991) and as rare and declining by Johnstone & Storr (1998). It is currently listed as Priority 3 under the 2016 Biodiversity Conservation Act. Priority species and subspecies are used by the West Australian state Dept. of Biodiversity, Conservation and Attractions, based on the advice of the Threatened Species Scientific Committee. Under this act, a Priority 3 species is described as ‘known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat’. Overall, *N. c. connivens* is currently listed as Near Threatened (Loyn *et al.* 2021). Two formal surveys using playback across large areas of south-west Australia during 1999–2000, 2015–16 and 2022 failed to locate any Barking Owls (Liddelow *et al.* 2002, Fulton 2017; B. Wykes

*in litt.* 2022). Garnett *et al.* (2010) mentioned approximately ten records during 2000–09 but could provide no substantiating details.

There is a clear need to clarify the current conservation status of *N. c. connivens* in south-west Australia, and we review all known records here. We do not discuss whether the population should continue to be included within *N. c. connivens* or be recognised as an endemic subspecies *N. c. addenda* Mathews, 1912.

## Methods

We reviewed all historical and contemporary records of *N. c. connivens* in south-west Australia. This region extends from Shark Bay in the north to east of Esperance in the south-east (Beard 1981). Sources of data included all specimen and sight records in the database of the Western Australian Museum (WAM), Perth, including the Storr-Johnstone Bird Databank (a database compiled by G. M. Storr and R. E. Johnstone from the period 1966–2021 covering Western Australia, Northern Territory and Queensland, and containing more than two million records, available on request from REJ), eBird, and the Atlas of Living Australia.

The scientific literature was also reviewed by searching Web of Science, Scopus and Google Scholar using the keyword searches 'Barking Owl', 'Ninox connivens' and 'Western Australia', and any records pertaining to south-west Australia were extracted and included. We searched all copies of some key non-indexed publications, including *Western Australian Naturalist* and *Western Australian Bird Notes* for Barking Owl reports.

Irrespective of the source of records, we determined the level of veracity for each via application of the following criteria: (1) Certain: a specimen, sound-recording or photograph; (2) Probable: a sighting or calling bird within the known range, confirmed by experienced observers or supported by a written description; (3) Likely: a sighting within the known range but lacking a description or independent verification; and (4) Unlikely: a sighting outside the known range or habitat, or lacking accurate location data; these were not extracted and are not presented here.

## Results

**Specimens.**—A total of nine skin specimens and three eggs from two clutches of the south-west Australian Barking Owl were located in museum collections (Table 1; Figs. 1–2). The oldest known specimen of this population is a single egg collected by the English naturalist John Gilbert in October 1843 (Fig. 2). Gilbert inscribed this egg in ink 'Athene fortis Oct 1843', using a name for Barking Owl published by his employer John Gould in his *A synopsis of the birds of Australia* (1837–38); Gould subsequently realised Latham's 1801 name *Falco connivens* had precedence, hence he added (twice) 'connivens' to the egg. In early October 1843 Gilbert was in the York area, 100 km east of Perth; later that month he travelled north to the Wongan Hills, c.130 km north of York. Gilbert had previously been in Western Australia in 1839–40, when he collected in the York, Northam and Toodyay areas, but did not reach as far north as the Wongan Hills. His manuscript notes 'The birds of Western Australia', produced for John Gould, do not mention Barking Owl. Gould described Gilbert's single egg in the *Handbook of Australian birds* (1865) but did not mention it under 'Athene? Connivens' in *The birds of Australia* (vol. 1, text and Pl. 34), although the relevant part (XVII) was not issued until December 1844. The egg measures 50.8 × 41.275 mm (measurements on specimen card), i.e., slightly larger than the range 46.8–48.1 × 36.7–38.9 mm reported by Johnstone & Storr (1998). In comparison, those of Southern

TABLE 1

Known and possible specimens of *Ninox c. connivens* from south-west Australia. \*Abbreviations: ANSP = Academy of Natural Sciences of Drexel University, Philadelphia; F = female; HLW = H. L. White Collection, Museums Victoria, Melbourne; M = male; MV = Museums Victoria, Melbourne; n.d. = no date; NHMUK = Natural History Museum, Tring; SAMA = South Australian Museum, Adelaide; U = unknown; WAM = Western Australian Museum, Perth. \*\* = see text for discussion.

Specimen category	Institution, reg. no.*	Collector	Date*	Location	Sex*	Notes	Map reference (Fig. 1)
Eggs	NHMUK 1884.10.1.98 / 1962.1.195	J. Gilbert	October 1843	south-west Western Australia**	-	One egg	
	SAMA B42531	E. G. Watts	n.d. (est. 1930s)	Gnowangerup	-	Two eggs	1
Skins	ANSP 2544	J. Gilbert (probably)	1842–43	south-west Western Australia**	U	Study skin (former mount)	
	ANSP 2545	J. Gilbert (probably)	1842–43	south-west Western Australia**	U	Study skin (former mount)	
	WAM A41554	W. K. Adam	23 July 1897	Katanning	F	Mounted specimen	2
	WAM A15362	Mr Ostle	8 May 1902	Herdsmen Lake, Perth	F	Study skin	3
	MV HLW 6957	T. Carter	22 April 1911	Lake Muir, Manjimup	M	Study skin**. Holotype of <i>N. c. addenda</i> Mathews, 1912	4
	MV HLW 5307	F. L. Whitlock	7 July 1911	Stirling Ranges	M	Study skin	5
	WAM A2944	U	1 July 1928	Chillinup, Borden	U	Study skin	6
	WAM A8783	G. A. Lodge	1 January 1963	Boyup Brook	U	Wing	7
	NHMUK 1955.6.N.20.4688	Mr Stevens	unknown	Swan River	U	Study skin	Not mapped

Boobook *Ninox boobook*, the only congeneric species with which eggs could be confused, measure 39.1–44.0 × 34.3–37.4 mm (Johnstone & Storr 1998).

We located two skins in the Academy of Natural Sciences of Drexel University, Philadelphia (ANSP 2544, 2545), described by Gould (1865) and labelled as being from ‘West Australia’ but which he did not refer to by specimen numbers. The precise location and collection dates are not known, but they are the oldest skins of south-west Australian Barking Owls.

A specimen registered as WAM A41554 is an ex-display mount (Fig. 3) collected at Katanning (Fig. 1) in 1897 by W. K. Adams. The specimen was on display at WAM from the early 1900s and has faded to a light brown (south-west specimens are usually very dark), but possesses the distinctive plumage of *N. connivens*, including streaking on the feathered parts of the tibia.

WAM A15362, collected at Herdsmen Lake near Perth by ‘Mr Ostle’ in 1902 is the only known specimen from the Perth region and the most northerly specimen in south-west WA. Further to this, there are two south-west Australia specimens in the H. L. White (HLW) collection held in Museums Victoria, Melbourne: HLW6957 was collected by Tom Carter on 22 April 1911 at Lake Muir and HLW5307 by F. L. Whitlock on 7 July 1911 in the Stirling Ranges (Fig. 1).

Mathews (1912) described *N. c. addenda* from south-west Western Australia based on an unspecified specimen and its ‘larger size’ vs. *N. c. connivens*. There has been some



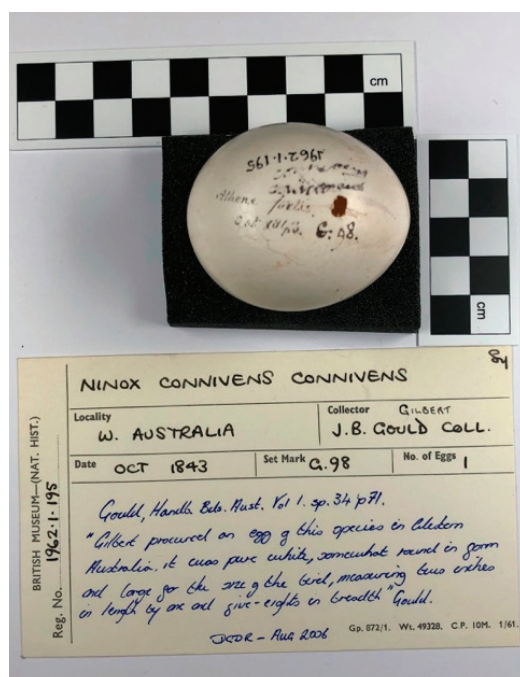


Figure 2. South-west Australian Barking Owl *Ninox c. connivens* egg collected by John Gilbert in October 1843 (Alex Bond, © Natural History Museum, London)



Figure 3. Mounted specimen of the first known Barking Owl *Ninox c. connivens* collected in south-west Australia, from Katanning in 1897 (Robert A. Davis)

confusion over the whereabouts of the holotype. Mees (1964) reported that it is in the American Museum of Natural History, New York (AMNH), whereas Schodde & Mason (1997) considered its whereabouts unknown. However, searches at AMNH have failed to find any Barking Owl specimens from south-west Australia (P. Sweet *in litt.* 2022). From his subsequent, longer account (Mathews 1915–16), we deduce that the holotype was collected by Tom Carter at Lake Muir in 1911, and as noted above it is now in Museums Victoria (HLW 6957). This resolves the issue of its whereabouts and confusion regarding an AMNH specimen.

There is one skin collected at Borden in 1928 and a clutch of two eggs from Gnowangerup in the South Australian Museum, Adelaide (Fig. 4). These were measured by M. Penck as  $47.9 \times 41.0$  mm and  $48.2 \times 40.7$  mm and were collected by E. G. Watts. Although no dates are given, Edward Watts was active in Western Australia in the early 1930s (Whittell 1939) and so they are likely to have been collected around that time. In the forested south-west, a wing from Boyup Brook in 1963 is the most recent specimen (Table 1).

Finally, a skin mentioned in Mees (1964) is at the Natural History Museum, Tring (NHMUK) (Table 1). Previously in the Gurney collection at the Norwich Castle Museum, it is now NHMUK 1955.6.N.20.4688, with locality 'Swan River' on its original label, but has also later, and presumably mistakenly, had 'NSW' (New South Wales) added. Unfortunately, no further information is available except that its original label, and Gurney's 1889 register (also now held by NHMUK), include the name 'Stevens'. This probably refers to the collector, but just possibly might be the London dealer Samuel Stevens, via whom Gurney received an array of raptor specimens. We have construed (as did Mees 1964) that 'Swan River' pertains to the Swan River colony in Western Australia. Use of this locality name implies an older collection period, but unfortunately none of this can be corroborated at this stage.

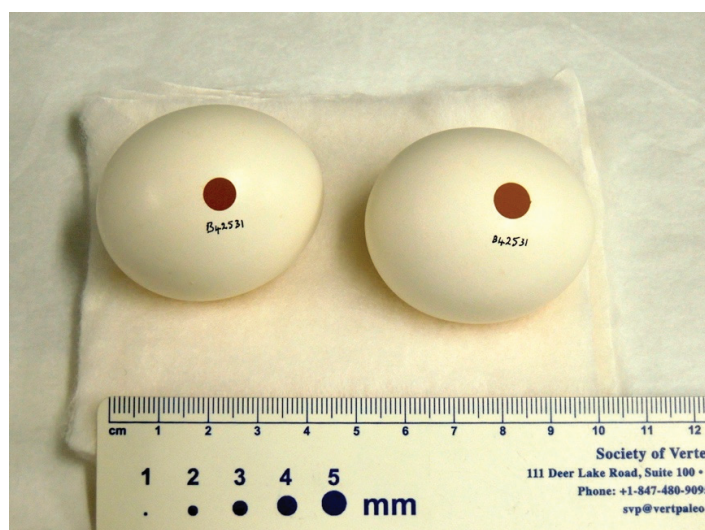


Figure 4. Clutch of two south-west Australian Barking Owl *Ninox c. connivens* eggs, SAMA B42531, collected by E. G. Watts in the 1930s (© Maya Penck, South Australian Museum, Adelaide)

**Sightings.**—There are very few probable or certain sightings and no photos of Barking Owls in south-west Australia. We have recovered a total of just 41 sight records since 1842 (Fig. 1; Table 2). Notably, there have been only ten sightings in the past 20 years that we consider to be reasonably verified. We discarded sightings in which birds were not seen or their well-known dog-like barking call was not described. It has not been possible to verify all sightings and our list may well over-represent reliable sightings.

**Calls.**—Our research has elicited no known recordings of the south-west Barking Owl. Several reports we followed up were based on a ‘screaming’ call, which we discuss later and do not consider a reliable indicator of the species.

**Breeding.**—The specimen collected by E. G. Watts has a label inscribed ‘No nest made. Eggs laid on rotted wood in hollow of moral [*sic* probably = Red Morrell *Eucalyptus longicornis*] tree about 35 feet up’.

**Habitat and range.**—The sightings reveal several key foci regions for the species, including Lake Muir–Tonebridge, Narrogin–Williams, Fitzgerald River–Jerramungup, Toodyay–Julimar–Northam–Avon Valley and Ongerup–Gnowangerup–Katanning (Fig. 1). Virtually all records are associated with open woodland in semi-arid habitats, apart from some from the south-west capes, Boyup Brook and Manjimup. The Lake Muir and Tonebridge areas also hold some dense forest.

**Diet.**—The specimen collected by Carter (1923) was described as having ‘in gut large brown beetles and small furry animals, that seemed to be mice’.

## Discussion

Barking Owl in south-west Australia appears to have always been uncommon. Mathews (1915–16) mentioned an account from Carter, who stated, ‘The winking owl [*sic* = Barking Owl] is apparently a rare bird in West Australia, as the first specimen seen by me was after residing twenty-six years in various parts of the state’. In the same account, Carter went on to mention that local residents near Lake Muir were not familiar with Barking Owl despite them being ‘old settlers constantly out with gun or rifle’.

With a paucity of specimens, none more recent than 1963, and a paucity of contemporary sightings, the current status of *N. c. connivens* in south-west Australia is unknown. With only eight confirmed skin specimens, no known photographs or sound-recordings, and

TABLE 2

Verified locations for Barking Owls *Ninox connivens* in south-west Western Australia (see Methods) arbitrarily partitioned roughly by decade to facilitate examination. Key to codes in Status column: 1 = certain, 2 = probable, 3 = likely. Abbreviations: WABN = *Western Australian Bird Notes*; WAM = Western Australian Museum, Perth. Birdata refers to the BirdLife Australia ongoing bird atlas programme.

Date	Location	Map reference (Fig. 1)	Observer/s	Notes	Status	Source
25 October 1842	Lake Coogee, Perth	8	Gilbert and Drummond	Heard calling	2	Serventy & Whittell (1976)
17 May 1905	Woodanilling, Narrogin	9		One found injured. 'There are a few resident pairs in this area but very rare in Great Southern and seen on only a few occasions'.	1	Garstone (1973)
23 April 1911	Lake Muir, Manjimup	10	T. Carter	In jarrah and red gum at dusk. Weighed 2 pounds, 17 inches long and 42-inch wingspan. Presumably relates to HLW 6957.	1	Carter (1923)
1921	Perth	11		Resident and rare in Swan River district. May be only a visitor to the district but little-known species.	2	Alexander (1921)
20 June 1931	Claremont, Perth	12	A. G. Kilpatrick	Found asleep in <i>Banksia</i> tree.	3	Storr-Johnstone database
1958	Jitarning, Kulin	13	T. Bush	Single bird in a patch of wandoo.	3	Storr-Johnstone database
1953–63	Moingup Spring, Stirling Ranges	14	E. H. Sedgwick	Heard occasionally around water.	2	Sedgwick (1964)
1 July 1962	Wubin, Dalwallinu	15	J. Ford, P. Fuller & I. Carnaby	Heard at night in York Gum woodland.	1	Ford (1965)
August 1961	Latham, Perenjori	16	R. Stranger	Heard calling near railway station.	3	Stranger (1967)
August 1961	Latham, Perenjori	17	R. Stranger	Heard '6 miles NE of Latham'.	3	Stranger (1967)
6 September 1968	Gibb Rock, NNE of Hyden	18	E. H. Sedgwick	Flushed two birds when walking through stand of gimlet and mallee along northern border of farm.	2	Sedgwick (1974)
1970s	Woodanilling, Narrogin	19	R. Garstone	Occurs in vicinity of lakes.	3	Garstone (1973)
1930–73	Northam	20	J. Masters & A. Milhinch	'Near the Avon River seen only once. Rarely heard.'	2	Masters & Milhinch (1974)
1979	Ongerup	21	B. Newbey	Pair of owls on farm.	1	WABN 88
19 July 1984	Walliston, Kalamunda	22	Birdata	One in garden	3	Birdata
30 August 1985	Fitzgerald River National Park	23	K. & B. Newbey	'Barking and screaming call heard on one occasion in woodland (30 August 1985).'	2	Newbey & Chapman (1995)
1986	Bremer Bay	24	B. Buchanan	Seen at swamp.	1	WAM sightings
17 May 1986	Witchcliffe, Augusta–Margaret River	25	G. W. Kendrick	Calling at night (1) in mixed karri-jarrah-marri forest.	3	WAM sightings
26 March 1987	Bolgart	26	R. E. Johnstone	Heard calling in Salmon Gums.	1	WAM sightings
12 July 1988	Bindoon	27	R. Schulz	Army training area.	3	WABN 47





Date	Location	Map reference (Fig. 1)	Observer/s	Notes	Status	Source
30 July 1988	Kulunilup Lake Nature Reserve, Manjimup	28	R. Vervest, J. Hunt	-	3	WABN 47
26 September 1991	Pinnaroo Valley, Padbury	29	R. & J. Shaw	One calling.	2	WABN 60
October 1994	Avon Valley National Park	30	J. Masters	Bird heard over three nights in wandoo woodland.	2	WABN 76
17 February 1995	Cape Naturaliste	31	R. Payton	Sugarloaf Road.	3	WABN 74
12 October 1996	Point Dalling, Dunsborough	32	R. Payton	-	3	WABN 81
23 April 1997	Dryandra	33	Birdata		2	Birdata
9 February 1999	Glen Avon, Northam	34	Birdata	Flushed from tree near fence line.	2	Birdata
6 June 1999	Julimar Reserve, west of Toodyay	35	J. Dell	1	2	WABN 93
August 2000	Congelin Dam, Dryandra woodland, NW of Narrogin	36	I. Wheeler	-	2	WAM sightings
August 2000	Fitzgerald River National Park	37	I. Wheeler	-	2	WAM sightings
August 2000	West Cape Howe	38	I. Wheeler	-	2	WAM sightings
August 2000	Malyalling Siding, Wickiepin	39	I. Wheeler	-	2	WAM sightings
13 April 2001	Blue Gum Lake, Bateman	40	W. Maddeford	One seen perched.	1	WABN 99
17 June 2004	Mabel Road, Lesmurdie	41	J. Stewart	One heard.	2	WABN 111
15 April 2005	Congelin Dam, Dryandra woodland, NW of Narrogin	42	D. Secomb		1	WABN 114
24 April 2005	Congelin Dam, Dryandra woodland, NW of Narrogin	43	BirdLife excursion	Seen in open wandoo woodland.	1	WABN 114, 115
18 March 2006	Congelin Dam, Dryandra woodland, NW of Narrogin	44	Birdata		1	Birdata
25 May 2006	Youraling State Forest	45	W. Bancroft & B. Metcalf	One heard.	1	W. Bancroft
16 September 2008	Congelin Dam, Dryandra woodland, NW of Narrogin	46	Birdata		1	Birdata
16 April 2011	Boyagin Rock, Nature Reserve	47	Birdata	Bird seen.	1	Birdata
30 May 2015	Gabanninga Hill, Hoddy's Well, Toodyay	48	Birdata	Heard by campers.	3	Birdata
6 October 2019	Tone River, Tonebridge	49	Birdata		1	Birdata

probably fewer than 40 reliable sightings since 1842, the status of Barking Owl in this region is enigmatic, but it is likely to meet the criteria for an Endangered or Critically Endangered population. Even the increase in birdwatching and bird photography in recent years has failed to produce a large number of sightings. Concern was expressed about the status of the population by Mees (1963) and there have been no further specimens since then.

Although we applied stringent criteria to the acceptance of sight records (including, where possible, observer expertise, likely habitat and any extra details provided) and followed up on many of these, a large percentage of reports are of doubtful veracity in the absence of further information. Given the species' rarity in south-west WA, we suggest that the weight of evidence required to accept a Barking Owl sighting should be great. This should include: (1) field notes describing previous experience and how calls were distinguished from those of Southern Boobook, which can have aberrant calls; (2) records based on a screaming call alone, with no further information, should be considered doubtful (see below); (3) preferably photographing the bird, but otherwise providing detailed notes on key features used to eliminate Southern Boobook; and (4) recordings of vocalisations.

One major issue that we have encountered is that many, if not most, reports of Barking Owls, particularly in the Perth Hills, are based on the screaming call. This call is not described in the scientific literature, and we know of just one recording of it, made by Ed McNab at Chiltern, Victoria, on 12 January 1982. Fleay (1942) provided a colourful description and investigated this vocalisation in a captive pair of *N. c. connivens*. He heard it after the birds had been in captivity 2.5 years and noted that such calls were heard only occasionally, during March–April. He further noted that an informant studying resident wild *N. c. connivens* over many years regularly heard the barking call, but recollections of the screaming call were 'very few indeed' (Fleay 1942). We therefore suggest that although this call may exist, it is probably very rare. However, it seems to have become part of accepted folklore that a screaming sound at night is made by a Barking Owl.

Most records we encountered were based on observers hearing only this call, rather than seeing birds or hearing the distinctive barking vocalisation. One recent recording we received from Bickley of such a call was definitively identified as a Red Fox *Vulpes vulpes*. This was done via an aural comparison and a visual comparison of spectrograms of the recording with known Red Fox calls, using the software Audacity. Many observers that we have played the Red Fox call to have been very surprised by its screaming intensity and have agreed this is likely what they heard when identifying the call as a Barking Owl. Many observers seem unaware or unfamiliar with these vocalisations. Even if the screaming call of Barking Owl is a rare or infrequent vocalisation, it is unlikely to be heard compared to the common double bark. Tellingly, most observers who we were able to question did not hear this barking vocalisation. This has led us to doubt most records based only on the screaming call. There is also the possibility that some observers may confuse the harsh calls of tytonid owls with what they have read about the screaming call of a Barking Owl.

Apart from recent unsuccessful searches by B. Wykes (*in litt.* 2022) there have been no dedicated broad-scale survey efforts to detect Barking Owls in south-west Australia apart from that of Liddelow *et al.* (2002), who conducted extensive surveys using playback at 100 sites across the south-west over two seasons in spring 1999 and autumn 2000. They recorded all other species of nightbird known in the region, but failed to detect any Barking Owls. Liddelow *et al.* (2002) presented a number of records derived from the Western Australian government's threatened fauna sightings database but did not include any specific details that would enable us to assess the authenticity of sightings. Some records were from habitats not generally considered suitable for the species; without further information it is

impossible to assess these. Liddelow *et al.* (2002) also concluded that Barking Owl 'is clearly uncommon in the south-west and in need of further attention'.

The scarcity of reliable records in the south-west, and the likelihood that it was already rare there at the time of European settlement, make it difficult to undertake formal assessments against IUCN criteria at present. The major challenge is to establish the reliability of records, particularly given confusion over screaming calls and lack of supporting information for many sightings. The south-west population is clearly now very rare, possibly declining and could qualify as Endangered or Critically Endangered if further information becomes available. The spectre of its extinction can reasonably be raised. Proposed key future research by the authors will include a campaign to elicit further sightings coupled with a stronger level of documentation for any Barking Owl sightings. Also needed is genetic and museum work to clarify the taxonomic status of the south-west population. Finally, it is essential to systematically survey for the species throughout its range in south-west Western Australia, and to conduct detailed ecological research to determine and manage the key threats to its effective conservation.

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*Addresses:* Robert A. Davis, School of Science, Edith Cowan University, 100 Joondalup Drive, Joondalup, WA, 6027, Australia, and Research Associate, Western Australian Museum, 49 Kew Street, Welshpool, WA, 6106, Australia, e-mail: robert.davis@ecu.edu.au. Leo Joseph, Australian National Wildlife Collection, National Research Collections Australia, CSIRO, GPO Box 1700, Canberra, ACT, 2601, Australia. Ronald E. Johnstone, Research Associate, Western Australian Museum, 49 Kew Street, Welshpool, WA, 6106, Australia.