

# SURVEYS OF THE BARKING OWL AND MASKED OWL ON THE NORTH-WEST SLOPES OF NEW SOUTH WALES

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Field surveys of the Barking Owl *Ninox connivens* and Masked Owl *Tyto novaehollandiae* were conducted at 49 sites (110 survey points) on the North-west Slopes and adjoining western parts of the Northern Tablelands of New South Wales, to investigate their status in remnant vegetation on public and private land. The surveys were conducted over three years, from 1995 to 1998, using playback of the owls' calls. The Barking Owl was recorded at four survey points (4%) and the Masked Owl at one or possibly two points (1–2%), with one additional, incidental record of each species. Both owl species occurred in large habitat remnants on public land, and the Barking Owl also occurred in two large, healthy woodland remnants on private land. One breeding pair of Barking Owls was monitored over three years, during which they reared first three, then one, fledglings before one adult died during the next (unsuccessful) breeding season. The pair was resident, and defended the nest area throughout the year. The pair's breeding diet, determined from analysis of pellets and prey remains, consisted of 12 per cent mammals, 26 per cent birds and 62 per cent insects by number, and 41 per cent mammals, 57 per cent birds and 1 per cent insects by biomass, and their non-breeding diet consisted of 12 per cent mammals, 12 per cent birds and 76 per cent insects by number, and 58 per cent mammals, 39 per cent birds and 3 per cent insects by biomass. Vertebrate prey were native arboreal species caught in woodland.

## INTRODUCTION

Previous surveys and reviews of the large forest owls in eastern New South Wales have highlighted (a) the rarity and decline of the Barking Owl *Ninox connivens* statewide and of the Masked Owl *Tyto novaehollandiae* in inland areas, and (b) the need for field surveys of both these species west of the Great Dividing Range (Debus 1993; Debus and Rose 1994; Kavanagh and Bamkin 1995; Kavanagh *et al.* 1995a,b; Debus 1997a,b; Kavanagh and Stanton 1998). Field surveys of these two species were conducted over the period 1995–1998 on the North-west Slopes of New South Wales, in order to compare the owls' status in habitat remnants of various sizes and on private versus public land and, if possible, to relate their occurrence to habitat features. Some preliminary results of these surveys, including calling and response behaviour of the Barking Owl, have been given elsewhere (Debus 1997b). Biological data on one pair of Barking Owls near Armidale, found and monitored during the survey period, were also presented elsewhere (Kavanagh *et al.* 1995a; Debus 1997a; Debus *et al.* 1998, 1999). This paper presents the results of surveys conducted for the two owl species in northern inland New South Wales over three years. It also combines previous, fragmentary dietary data for one pair of Barking Owls near Armidale (Kavanagh *et al.* 1995a; Debus 1997a; Debus *et al.* 1998, 1999) with additional data collected from that territory, into a re-analysis of the species' local breeding and non-breeding diets. This approach consolidates the dietary data into one larger and more representative sample of the owl's seasonal diets.

## STUDY AREA AND METHODS

The survey was conducted as a combination of targeted surveys for the owls at specific sites, and opportunistic surveys for the owls in the course of general fauna survey work. The targeted surveys were stratified on the basis of land tenure (public versus private) and patch size (large, >100 ha, versus small, <100 ha). The non-specific faunal

surveys were also stratified by tenure and patch size, with systematic surveys on public land and randomized survey sites in wooded farmland. Survey points were distributed almost equally between private and public land, but with twice as many in large remnants as in small (Table 1). The survey was able to sample only a small proportion of the available or potential habitat in the region.

Most of the non-specific surveys were conducted as transects running from the western edge of the tablelands to lower elevations on the inland slopes. The faunal survey transects were:

1. from Armidale (30°30'S, 151°40'E) on the Northern Tablelands, north via 'Strathbogie' (29°27'S, 151°28'E) near Emmaville, to the confluence of the Beardy and Dumaresq Rivers south-east of Bonshaw (29°03'S, 151°16'E) on the North-west Slopes, in March–April 1995 (31 survey points at 15 sites; Appendix 1). Four new survey points on this transect, on the Slopes, were surveyed in November 1995.
2. a subsidiary transect on the Slopes, from near 'Strathbogie' north-west to lower on the Dumaresq River at Texas (28°51'S, 151°10'E), surveyed in November 1997 (16 survey points at five sites).

Targeted and some non-specific surveys consisted of scattered clusters of points on the tablelands and slopes west from Armidale, in the area bounded by Wallangra (29°25'S, 150°54'E), Bingara (29°52'S, 150°34'E), Kenebri (30°47'S, 149°01'E), Gilgandra (31°43'S, 148°39'E) and Tamworth (31°05'S, 150°56'E), with an outlying site near Dubbo on the Central-west Slopes (32°15'S, 148°37'E; Fig. 1). These sites were surveyed variously in August–December 1995, January–May and November 1996, and intermittently through 1997 and 1998 (total 59 survey points at 29 sites). The locations of the 110 survey points are given in Appendix 1.

Sites sampled ridges, slopes, and gullies or watercourses (intermittent streams to major rivers), and were surveyed once each. The transect sites and non-transect sites sampled some box-ironbark woodland, which was specially targeted. A few (10%) of the non-transect points were chosen on the basis of prior records of either owl species in the vicinity (Debus and Rose 1994; Debus 1997a). State Forests of the North-west Slopes previously surveyed by E. M. Date (cited in Debus and Rose 1994; Debus 1997a), particularly those with records for either owl species, were generally avoided, in order to avoid duplication of effort and to spread the geographical coverage.

The pre-settlement open forest and woodland habitats of the survey region have been heavily cleared, fragmented and degraded by

TABLE 1

Stratification of survey points for Barking Owl and Masked Owl, North-west Slopes of New South Wales, 1995–98 by land tenure and patch size: large (>100 ha) habitat remnant on public land (LRPuL); small (<100 ha) remnant on public land (SRPuL); large remnant on private land (LRPrL); small remnant on private land (SRPrL). SF = State Forest; NP = National Park or Nature Reserve; other = other Crown reserve (e.g. travelling stock reserve).

Category	No. survey points
LRPuL: SF	23
NP	16
other	3
total	42
SRPuL	7
LRPrL	32
SRPrL	29
<b>Total</b>	<b>110</b>

agriculture, and grazing of livestock. Most reserves and other large remnants are located on rugged, infertile terrain. Sites, with clusters of survey points, on the above-mentioned transects targeted the largest and most intact habitat remnants mainly on private land (>20 ha) but including some reserves (150 to >1 000 ha), along the route. The other survey sites were similarly placed in open forest or woodland, variously from small (<10 ha) degraded woodland remnants and linear strips in farmland to extensive forest or woodland (>2 000 ha) in reserves or State Forests, and including large remnants on private land. Included were the State Forests of the Pilliga Scrub, at nearly 500 000 ha the largest woodland remnant west of the Great Dividing Range in New South Wales. The Pilliga is in the extreme west of the study region, at the lowest elevation.

The two owl species were surveyed by a combination of listening (15 min), playback of their species' tape-recorded calls (5 min/species, Masked Owl first), stationary spotlighting (2 min), and listening for responses (10 min) at each site, as described previously (Debus 1995, 1997b). Calls of the Powerful Owl *Ninox strenua* were also broadcast, last in the sequence, on transect 1 and some non-transect sites on or near the tablelands (sites 21, 28, 29, 38, 39; Appendix 1). In areas of

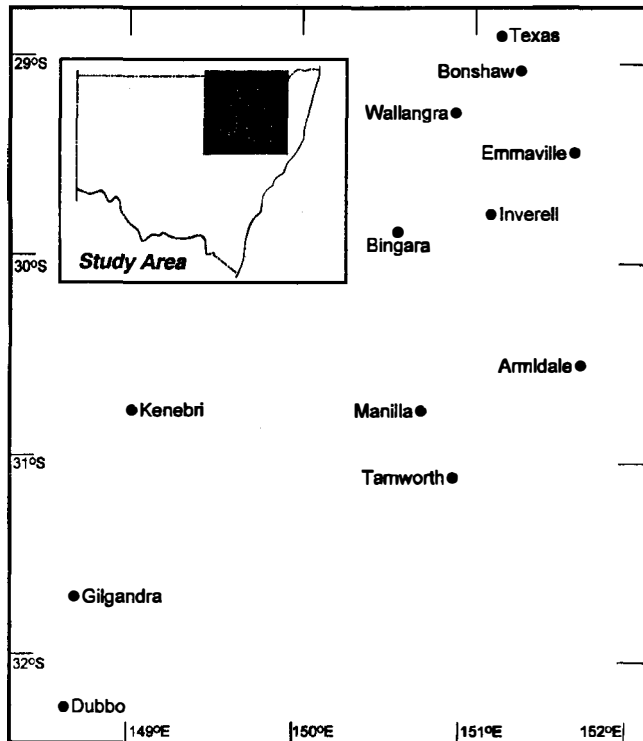


Figure 1. Map of study region, showing major locations mentioned in text.

continuous forest or woodland cover, slow spotlight-driving was also conducted en route between survey points ( $\geq 1$  km apart) in a patch. Surveys were conducted on calm, dry nights, in the first half of the night, from sunset to 2–4 hours after sunset. For most clusters of points in reserves and for some large remnants on private land, overnight campsites were also established at or near one of the survey points in readiness for opportunistic records of owls (Appendix 1).

A breeding pair of Barking Owls located on Boorolong Creek west of Armidale in August 1995 was checked intermittently to December 1998 for territory occupancy, roost use, breeding success and dietary evidence in the form of pellets and prey remains. Dietary items were analysed by A. B. Rose, as described previously (Debus 1997a; Debus *et al.* 1998, 1999). The new data included herein concern three broken pellets collected at a roost in December 1998, after a failed breeding season during which one of the adult owls died.

## RESULTS

### Surveys

Seven Barking Owls were detected, at only four survey points (4%), with an opportunistic record of an eighth bird at an overnight campsite. Two of the records were of pairs in the Pilliga forests, and the opportunistic record was also in the Pilliga. The other records concerned the subsequently monitored breeding pair on Boorolong Creek near Armidale, and a single bird on private land at Tingha (near Inverell). Barking Owls were not recorded at the historical breeding location surveyed, nor at seven localities from which they had been reported within the preceding 1–20 years (Appendix 1). One of the latter sites concerned a pair previously known to be resident. It is possible that a single survey per point had a low probability of detecting owls that were present (Debus 1995), although the Barking Owl is highly vocal and, of the Australian owls, produces probably the strongest response to playback (e.g. Debus 1997a,b; Higgins 1999; pers. obs.). That is, the negative survey results at known locations for the owl probably reflect the absence of the owl from at least some of those sites during survey times.

The two pairs of Barking Owls in the Pilliga were 5 km apart in State Forest, on intermittently flowing creeks within extensive woodland. The fifth bird in the Pilliga was on the edge of the forest, near intermittent and permanent creeks on well-wooded private land, 4 km from one of the pairs. The pair at Boorolong Creek was on a major, permanent tributary of the Gwydir River (1 km away); River She-oak *Casuarina cunninghamiana* gallery forest extended several kilometres along both the creek and river. The 50 ha Crown reserve of eucalypt woodland containing the nest tree was amid patchily cleared private land, and contiguous with 1 000 ha of woodland mostly on private land but extending to and including the granitic hills of Mt Yarrowyck Nature Reserve. The Barking Owl on private land at Tingha was in a large (>500 ha), healthy woodland remnant of box-ironbark-red gum woodland, within 10 km of a previous survey record of Barking Owl(s) in Mt Topper State Forest (P. Sparke, pers. comm.). This State Forest is 1 000 ha, half being exotic *Pinus* plantation which may provide sheltered roost sites similar in structure to River She-oak.

The only survey record of the Masked Owl was at one site in the Pilliga (1% of points), on a creek gorge on the boundary between well-wooded private land and State Forest, and 1 km from the campsite record of the Barking

Owl. An inconclusive record was obtained in Warrabah National Park: a distant, subdued *Tyto* screech, probably referable to the Masked Owl (rather than Barn Owl *T. alba*), after playback. An additional, opportunistic record was obtained of a road-injured juvenile Masked Owl from open farmland near Manilla, 30 km south-west of Warrabah, during the survey period. I examined and photographed this bird, before it was rehabilitated, banded and released near the collection site. The Masked Owl's cryptic behaviour and sometimes weak response to playback (e.g. Debus 1995; Higgins 1999) may mean that this species was under-recorded.

The meagre survey results can be usefully supplemented by the results of colleagues for other sites in the study region (Appendix 2).

The Powerful Owl was recorded at one site on the western edge of the tablelands: a bird on private land in a tributary of the Severn River gorge near Emmaville, attracted into partly cleared farmland by playback.

#### Barking Owl biology

The pair nesting at Boorolong Creek in August 1995 raised three fledglings in spring 1996 and one in spring 1997. The pair was located roosting in the breeding territory, within 100 m of the nest, in autumn 1996 and 1997, and autumn to early winter 1998. The birds were not located on every daytime visit but, when they were located, they were roosting together 5–6 m high in dense River She-oaks growing in the creek bed. On one occasion in autumn when they could not be found within 100 m of the nest by day, they arrived promptly from farther upstream (200–300 m from the nest?) when playback was conducted at dusk. In August 1998, a broken egg and remains of one of the adults were found below the nest hollow during the incubation period. The cause of death could not be ascertained, but the carcass had been chewed by a fox (as revealed by mammalian damage to the bases of the flight-feathers, and strong odour of fox urine on the carcass). The surviving adult, apparently the female on size and behaviour, was located alone in the usual roosting area near the nest on several occasions to December 1998. There was no indication of hatching or fledging of young in that season. The surviving adult had acquired a new mate by late winter 1999, when vigorous calling by both birds signalled the start of breeding (A. Mitchell, pers. comm.).

#### Barking Owl diet

In December 1998 the dietary remains ( $n = 19$  prey items, in three pellets) from the lone adult consisted of one small (approximately 20 g) bird, two cicadas *Psaltoda plaga* and *P. moerens*, and 16 scarab beetles (Scarabaeidae: 12 *Anoplognathus olivieri*, one *Repsimus aeneus*, three unidentified smaller beetles). Thus, on at least some days post-breeding this resident, territorial adult with no fledglings to feed was mostly insectivorous (95% by number, 50% by biomass, assuming 1 g per insect). For the purposes of Tables 2 and 3, these data are considered to form part of the subject pair's non-breeding diet.

The diet of this pair and their offspring over three breeding seasons, covering the pre-laying to post-fledging

TABLE 2

Overall breeding diet of a family of Barking Owls near Armidale, New South Wales: data for 1995–1997 combined, pre-laying period (July) to February while dependent juveniles present (from Kavanagh *et al.* 1995a; Debus 1997a; Debus *et al.* 1998).  $N =$  minimum number of prey individuals in pellets ( $n = 61$ ) and food remains.

Species	Estimated body weight (g)	n	%
Sugar Glider <i>Petaurus breviceps</i>	128	7	
Squirrel Glider <i>Petaurus norfolcensis</i>	230	2	
Common Ringtail Possum			
<i>Pseudocheirus peregrinus</i> juv.	450	1	
House Mouse <i>Mus domesticus</i>	18	1	
<b>Total mammals</b>		<b>11</b>	<b>12</b>
Duckling <i>Anas</i> sp. ( <i>superciliosa</i> ?)	50	1	
Rainbow Lorikeet <i>Trichoglossus haematodus</i>	128	2	
Crimson Rosella <i>Platycercus elegans</i>	120	2	
Eastern Rosella <i>Platycercus eximius</i>	110	3	
Red-rumped Parrot <i>Psephotus haematonotus</i>	65	3	
Dollarbird <i>Eurystomus orientalis</i>	140	1	
Grey Shrike-thrush <i>Colluricincla harmonica</i> (?) juv.	64	1	
Butcherbird <i>Craicticus</i> sp.	100	1	
Australian Magpie <i>Gymnorhina tibicen</i>	387	1	
Pied Currawong <i>Strepera graculina</i>	300	1	
Silvereye <i>Zosterops lateralis</i>	10	1	
Common Starling <i>Sturnus vulgaris</i>	78	3	
Small passerine	20	3	
Small bird	20	1	
Bird sp.	152	1	
<b>Total birds</b>		<b>25</b>	<b>26</b>
Christmas beetles:			
<i>Anoplognathus olivieri</i>	1	3	
<i>Anoplognathus viriditarsus</i>	1	5	
<i>Anoplognathus</i> sp.	1	11	
Other scarabs (Scarabaeidae)	1	22	
Longicorn beetles:			
<i>Phoracantha semipunctata</i>	1	1	
<i>Phoracantha</i> sp.	1	3	
unidentified Cerambycidae	1	1	
Ground-beetle (Carabidae)	1	1	
Stag beetle (Lucanidae)	1	2	
Unidentified beetle (Coleoptera)	1	5	
Cricket/grasshopper (Orthoptera)	1	5	
<b>Total insects</b>		<b>59</b>	<b>62</b>
<b>Total</b>		<b>95</b>	<b>100</b>

periods (Table 2), and of the pair over three non-breeding seasons, including the summer following a failed breeding attempt (Table 3), is summarized in Table 4.

## DISCUSSION

#### Survey results

The Barking Owl was encountered at only four survey points (4%) of the 110 points surveyed, with one additional opportunistic record. More intensive surveys in moist eastern forests also recorded few Barking Owls (0–2% of sites: Debus 1995; Kavanagh *et al.* 1995b). Similarly, a survey of State Forests on the South-west Slopes detected no Barking Owls (Kavanagh and Stanton 1998). However, in appropriate coastal floodplain habitat the encounter rate for Barking Owls was high (16% of sites: Stuart 1995).

The Masked Owl was encountered at only one or possibly two survey points (1–2%) of the 110 points surveyed, with one additional opportunistic record. This is a much lower detection rate than in forests of the coast,

TABLE 3

Overall non-breeding diet of a resident adult pair of Barking Owls near Armidale, New South Wales: data for 1996–1998 combined, December to June when no dependent juveniles were present (from Debus 1997a; Debus *et al.* 1999; new data). Data from December are for a lone adult after the nest failed and its mate died during the egg stage in the preceding August. N = minimum number of prey individuals in pellets (n = 29) and food remains.

Species	Estimated body weight (g)	n	%
Sugar Glider <i>Petaurus breviceps</i>	128	6	
<b>Total mammals</b>		<b>6</b>	<b>12</b>
Red-rumped Parrot <i>Psephotus haematonotus</i>	65	1	
Laughing Kookaburra <i>Dacelo novaeguineae</i>	305	1	
Olive-backed Oriole <i>Oriolus sagittatus</i>	100	1	
Double-barred Finch <i>Taeniopygia bichenovii</i>	11	1	
Small passerine	20	1	
Small bird	20	1	
<b>Total birds</b>		<b>6</b>	<b>12</b>
Christmas beetle <i>Anoplognathus olivieri</i>	1	12	
Scarab beetle <i>Repsimus aeneus</i>	1	2	
Other scarabs (Scarabaeidae)	1	8	
Water beetle (Hydrophilidae)	1	1	
Unidentified beetle (Coleoptera)	1	2	
Crickets/grasshopper (Orthoptera)	1	9	
Cicadas:			
<i>Psaltoda plaga</i>	1	1	
<i>Psaltoda moerens</i>	1	1	
Mantis (Mantidae)	1	1	
Moth <i>Abantiades magnificus</i> (Hepialidae)	1	1	
Unidentified insect	1	1	
<b>Total insects</b>		<b>39</b>	<b>76</b>
<b>Total</b>		<b>51</b>	<b>100</b>

TABLE 4

Diet of Barking Owl near Armidale, New South Wales by season: percentage by number and biomass of prey in breeding and non-breeding seasons (from Tables 2 and 3).

Prey category	Breeding		Non-breeding	
	% No.	% biomass	% No.	% biomass
Mammals	12	41	12	58
Birds	26	57	12	39
Insects	62	1	76	3

escarpment and tablelands of northern New South Wales (9–14% of sites: Debus 1995; Kavanagh *et al.* 1995b; Stuart 1995), even allowing for the fact that the latter sites were surveyed twice. The Masked Owl was not recorded in State Forests of the South-west Slopes (Kavanagh and Stanton 1998).

In this survey the Barking Owl was recorded most frequently in the largest habitat remnant, on public land (State Forest). It was also recorded in a large remnant encompassing private land and public land (Crown land and National Park), and in a large remnant on private land near State Forest. Supplementary survey records for the region are mostly from large remnants on public land (State Forest and National Park), with some in large remnants on private land (Appendix 2). The factors relating to the importance of the Pilliga for the Barking Owl have not

been quantified, but probably include its size; availability of large hollows; diversity and abundance of native prey species; and milder climate for this Torresian species than at higher altitude on the slopes and tablelands.

The Masked Owl was recorded in the largest habitat remnant, on public land (State Forest). A possible record was also obtained for a large remnant on public land (National Park). The opportunistic record for open habitat on private land may have been a juvenile dispersing from a breeding population in the latter large remnant. Supplementary survey records for the region are all from large remnants on public land (State Forest; Appendix 2).

These survey results, particularly for the Pilliga forests, suggest that on the western slopes of New South Wales large areas of forest on public land are likely to support populations of both owl species, whereas small fragments on private land are unlikely to support either species. The results and Appendix 2 suggest that both owl species are more likely to occur in productive habitat in State Forests than in rugged, unproductive habitat in conservation reserves. It is also apparent that, except for the Pilliga, large owls occur at much lower density in the fragmented forest- or woodland-agricultural landscapes of the tablelands and western slopes than in the forests of the eastern tablelands and coast.

On private land near Armidale, breeding Barking Owls were recorded in large, healthy patches of mature eucalypt woodland with suitable roosting sites such as riparian gallery forest. This is consistent with the habitat of the owl elsewhere in south-eastern Australia (summarized in Higgins 1999). For the Barking Owl in the study region it, appears that: (i) the encounter rate per unit effort is much higher in the Pilliga than elsewhere on the western slopes, and that the Pilliga is a regional stronghold for this species; (ii) the owl occurs at very low density in highly fragmented agricultural landscapes, and that both large habitat reserves and off-reserve conservation measures are likely to be important for its regional survival. The low encounter rate for the Barking Owl suggests that this species is now less numerous than indicated by the historical pattern of records for the region (Debus 1997a).

There are few data for the Masked Owl in the study region. However, the Pilliga forests and perhaps other large reserves and State Forests, supporting appropriate foraging and breeding habitat of open forest or woodland (Higgins 1999), seem likely to contain the only breeding populations. The results of this study support other evidence (Debus 1993; Debus and Rose 1994) that the Masked Owl occurs on the inland side of the Great Dividing Range in New South Wales. Rolls (1981) also reported the Masked Owl in the Pilliga, a record overlooked by Debus and Rose (1994). Dispersing immatures might go undetected among Barn Owls in inland agricultural areas, owing to the morphological similarity of Barn Owls and male Masked Owls of the pale or intermediate morph.

It is likely that the Masked Owl occurs farther inland than the Pilliga forests. Further to previous evidence for its inland occurrence (Debus 1993; Debus and Rose 1994; Higgins 1999), J. Humphreys (pers. comm.) has observed

a *Tyto* owl at Mootwingee National Park (western New South Wales) that resembled captive dark-morph Masked Owls shown to him, and N. Mooney (pers. comm.) has observed a large *Tyto* owl carrying a rabbit on the Strzelecki Track in north-eastern South Australia. The latter owl resembled Masked Owls familiar to Mooney in Tasmania. The status of the Masked Owl in inland Australia requires clarification.

#### *Barking Owl diet and biology*

The breeding and non-breeding diets of the pair at Boorolong Creek were similar, except that the number of birds taken doubled in the breeding season and the relative biomass contribution of birds and mammals was reversed (Table 4). This difference may reflect the greater abundance of birds in spring–summer. Although insects were always numerically dominant and their proportion by number increased in the owls' non-breeding diet, they contributed only 1–3% by biomass (compared with 97–99% for vertebrates). The pair's diet indicated that the owls foraged mostly for native vertebrates, including arboreal mammals, within woodland (Tables 2 and 3), rather than for introduced Rabbits *Oryctolagus cuniculus* which were abundant in surrounding farmland (pers. obs.).

The Barking Owl takes a higher proportion of diurnal birds than do other large Australian owls (Kavanagh *et al.* 1995a; Debus 1997a; Higgins 1999). The proportion of birds in the Barking Owl's diet at Armidale increased in the owls' breeding season, the reverse of the seasonal trend observed for the Powerful Owl, which preys mainly on arboreal mammals larger than those taken by the Barking Owl (Higgins 1999). This capacity may make the Barking Owl fairly resilient to habitat loss, as birds have survived habitat clearance and fragmentation somewhat better than the small (<5 kg) mammals. However, this dietary capacity has not prevented the owl's rarity and decline, and other factors, which require investigation, are apparently involved.

Higgins (1999) noted that the Barking Owl's presumed sedentariness, lifelong monogamy and territorial behaviour are speculative and unconfirmed. The Boorolong Creek pair provided some evidence that adult pairs are permanently resident and defend the breeding territory, vocally and aggressively, against 'conspecifics' (call playback) year-round (Debus 1997b), like other large *Ninox* (Higgins 1999). A pair of Barking Owls in the Pilliga has used the same nest in two consecutive years (R. Kavanagh, pers. comm.).

#### CONCLUSION

The Barking Owl and Masked Owl occurred at very low density in the study region, relative to their occurrence in parts of eastern New South Wales. The small sample of records meant that it was not possible to relate their occurrence quantitatively to habitat features. The Masked Owl appears to occur in the largest woodland remnants, with juveniles possibly dispersing through open country. The Barking Owl seems most abundant in the largest remnants but also occurs at low density in fragmented habitat, where it uses healthy riparian woodland or gallery forest amid extensive, diverse woodland supporting a

diversity of native prey. A major threat to both species in the temperate woodlands appears to be excessive habitat fragmentation, in particular small patch size and lack of connectivity to large patches. Fox predation is also a threat to fledgling Masked Owls in such disturbed environments (Debus 1997c), and perhaps to fledgling Barking Owls, as for other owls (Higgins 1999). Future research in the woodlands could usefully concentrate on finding nests of both owl species, quantifying the habitat, and monitoring breeding success and diet. Pertinent aspects include woodland age and structure; density of hollows of various size classes; and habitat use, home-range size and dispersal of young (from radio-tracking). This should allow threatening processes to be more clearly identified and appropriate management strategies to be proposed. The most pressing management actions required include: (i) further surveys to determine where the owls, and areas of high-quality owl habitat, occur on private land; (ii) off-reserve conservation measures such as habitat protection, through conservation agreements over areas of high-quality owl habitat on private land; and (iii) further reservation of high-quality owl habitat in inland New South Wales. Further surveys are also required for Barking Owls and Masked Owls in inland conservation reserves, to determine whether they support these species.

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## APPENDIX 1

Details and results of owl survey sites. SF = State Forest, NP = National Park, NR = Nature Reserve. Bold = owl species recorded at site during survey; italic = owl species previously reported for locality.

## Transect 1:

1. *Hillgrove Creek SF (now Yina NR), Armidale. Two survey points. Barking Owl previously reported in vicinity (Debus 1997a; see also site 28).*
2. Private land, Puddledock Road, Armidale. Two survey points.
3. Private land, Devils Pinch, Armidale. Two survey points.
4. Boorolong SF (now NR), Armidale. Four survey points.
5. Private land, Guyra-Baldersleigh road. Overnight camp at point.
6. Private land, Wandsworth. Three survey points.
7. Private land, Wandsworth. Two survey points.
8. Single SF east, Wandsworth. Four survey points.
9. Private land, Wandsworth. Two survey points.
10. *Kings Plains mining area (private land) on Kings Plains Creek. Two survey points. Historical record of Barking Owl breeding in vicinity (Debus 1997a).*
11. Private land, Emmaville-Inverell road, four survey points. Overnight camp at one point.
12. Private land, Emmaville-Inverell road, two survey points.
13. Private land, Severn River, Emmaville. Two survey points.
14. Private land and roadside reserve, Emmaville-Ashford road, two survey points.
15. Private land, Beardy/Dumaresq River confluence. Two survey points. Overnight camp 2 km from nearest point.

## Transect 2:

16. Private land, Rocky Creek on Emmaville-Bonshaw road. Three survey points. Overnight camp at one point.
17. *Private land, Emmaville-Bonshaw road near Heatheringtons Sugarloaf. Three survey points. Owl calls previously heard by landholders were attributed by them to the Barking Owl when the playback tape was demonstrated.*
18. Private land, Bonshaw-Atholwood road. Five survey points. Overnight camp at one point.
19. Private land, Texas-Atholwood road. Four survey points. Overnight camp within 1 km of one point.
20. Private land, Boxwell Island, Dumaresq River, Texas. One survey point.

## Other sites:

21. *Warrabah NP. Four survey points. Overnight camp at one point. Barking Owl previously reported at site (in 1995; Debus 1997a). Possible Masked Owl response to playback.*
22. *Linton NR. Four survey points. Overnight camp at one point. Barking Owl previously reported at site (in 1994–95; Debus 1997a).*
23. Gwydir River travelling stock reserve, Torryburn.
24. Crown reserve and private land, Boorolong Creek, west of Armidale. Overnight camp at point. **Resident, breeding pair of Barking Owls found at site.**
25. Eastwood SF (now Imbota NR), Armidale. Two survey points.
26. Sunnyside Crown Reserve, Armidale. Two survey points.
27. Crown land, Woolomol Hills, Tamworth city. Overnight camp at point.
28. *Burying Ground Creek, Grafton road, Armidale. Barking Owl previously reported in vicinity (Debus 1997a; see also site 1).*
29. Private land, Frazers Creek, Nullamanna.
30. Private land, Gwydir River, Bundarra. Overnight camp at point.
31. *Road reserve and private land, Emu Crossing, Gwydir River, Bundarra. Barking Owl previously reported at site (in 1995; Debus 1997a).*
32. Private land, Laura Creek, Armidale-Bundarra road.
33. *Private land, Abington Creek, Armidale-Bundarra road. Pair of Barking Owls previously reported in vicinity (in 1977/78; Debus 1997a).*
34. Bingara SF. Four survey points: two on S boundary on Gwydir River, two on N boundary with private land, on Whitlow Creek.
35. *Private land, Puddledock, Armidale. Barking Owl previously reported roosting on site (in 1996; Debus 1997a).*
36. Private and quarry land, Tooraweenah. Two survey points. Overnight camp at one point.
37. Private land, quarry land and roadside reserve, Dubbo. Two survey points. Overnight camp at one point.
38. New Valley SF, Tingha. Two survey points. Overnight camp at one point.
39. Single SF west, Wandsworth. Three survey points.
40. Private land, Inverell airport verge. Overnight camp at point.
41. Clive SF, Inverell.
42. *Pilliga Scrub: well-wooded private land on Baradine Creek adjoining Merriwindi SF, Kenebri (one survey point); Cumbil SF, Kenebri (two survey points). Overnight camp within 1 km of Baradine Ck point. Both owl species previously reported in Pilliga Scrub (in 1990–96: Debus and Rose 1994; Debus 1997a). Masked Owl recorded at Baradine Creek site; pair of Barking Owls recorded at each of the Cumbil SF sites (Etoo Creek near Aloes Well, and Cumbil Forest Creek). Also incidental record of Barking Owl near the Baradine Creek site.*
43. Private land near Tamworth airport.
44. Private land, Waterloo Road, Kings Plains. Two survey points.
45. Kwiambal NP, Wallangra. Eight survey points.
46. Private land, Gilgai-Inverell. Three survey points on gullies or creeks, Bundarra road.
47. **Private land, Grove Road, Tingha. One Barking Owl recorded.**
48. Private land, Moonbi.
49. Private land and wooded road verge, Kingstown-Bundarra road. Two survey points (Cameron's Creek; roadside reserve).

## APPENDIX 2

Additional records/localities for the Barking Owl and Masked Owl in the survey region, before and during the survey period (1990–1998).

## Barking Owl:

1. Avondale State Forest, Armidale (K. Cherry/NPWS Atlas of NSW Wildlife)
2. Private land, Parlour Mtns, Longford (near Armidale) (K. Cherry/NPWS Atlas of NSW Wildlife)
3. Ironbark Nature Reserve, Kingstown (M. Schulz/NPWS Atlas of NSW Wildlife)
4. Private land, Kings Gap near Bundarra (M. Schulz/NPWS Atlas of NSW Wildlife)
5. Private land between Barraba and Upper Manilla (R. Watts, pers. comm.)
6. State Forests of the Pilliga: Yarrigan, Pilliga West and Cumbil/Euligal (E. M. Date in Debus 1997a); Cumbil/Euligal and Pilliga East (R. Kavanagh, C. Turbill, D. Paull, pers. comm.). Breeding Cumbil/Euligal 1997 and 1998 (R. Kavanagh).
7. Attunga State Forest, Tamworth (G. Mitchell, pers. comm.)

## Masked Owl (E. M. Date, pers. comm.):

1. Sepoy State Forest, Inverell
2. Warialda State Forest
3. Terry Hie Hie State Forest
4. Moema State Forest, Narrabri
5. Bobbiwaa State Forest, Narrabri
6. Pilliga West State Forest
7. Kelvin State Forest, Gunnedah

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**BOOK REVIEW**
**Australian Broad-tailed Parrots (The *Platycercus* and *Barnardius* Genera)**

Stan Sindel and James Gill. Singil Press, Austral, Australia.  
336 pp. RRP. \$Aud70.00.

This is the sixth book in the series of aviculture specialist books covering the Australian Psittaciformes. The previous five dealt with Australian lorikeets, cockatoos, the grass parrots in two volumes and softbill management. All have previously been reviewed in *Corella*.

Stan Sindel and Jim Gill between them have acquired in excess of 90 years experience of Australian birds in the field and aviary. Both of the authors have exceptional avicultural skills and are highly respected in their field both within Australia and overseas. Dr Gill is also widely acclaimed as a leading avian veterinarian.

This book covers the rosellas and ringneck parrots that collectively are referred to as the broad-tailed parrots. It follows the same successful format as the earlier publications, with chapters on housing, including easily understood drawings of desirable aviary layouts, diets and management of birds in aviaries and a chapter on the diseases that may afflict broad-tailed parrots.

Eleven species are recognized in the book and the chapter devoted to each discusses subspecific and geographical or racial plumage variations and aviculture mutations that are illustrated by over 170 high quality colour photographs. Thirty-two of them illustrate the remarkably beautiful natural plumage variability and the mutations of the Eastern Rosella.

Yellow and Adelaide Rosellas are afforded species status as *Platycercus flaveolus* and *P. adelaidae* respectively, rather than as subspecies of the Crimson Rosella *P. elegans*. Hybridization between the eastern population of *P. flaveolus* and Crimson Rosella *P. elegans* and between the western population of *P. flaveolus* and *P. adelaidae* are also discussed. Similarly, the Port Lincoln Parrot *Barnardius zonarius*, Mallee Ringneck *B. barnardi* and Cloncurry Parrot *B. macgillivrayi* are dealt with as distinct species rather than as the major subspecies of the Australian Ringneck *B. zonarius*. The Twenty-eight Parrot, which is widely held in aviculture, is dealt with as the subspecies *B. z. semitorquatus*.

Each of the species accounts provide information on such subjects as classification; early reports of the species; range; habitat and field

notes, including observations on their breeding in the wild; avicultural history; sexing; display; avicultural nesting requirements; incubation and development of the young and information on avicultural mutations. Each species chapter also includes a distribution map and numerous colour photographs to illustrate development of the young, plumage stages and the mutations.

This is another good reference book that should be essential reading for anyone that keeps these parrots in captivity. It not only imparts an immense amount of knowledge about the do's and don'ts for the subject species in aviculture, but also raises an appreciation for the birds in their natural environment.

The earlier books in this series have become standard texts for serious aviculturists and I am sure that this volume will achieve the same high status. I am also sure that those who may not wish to keep birds in captivity would also find this book quite interesting.

As this is a limited edition publication, which is not available through the major retailers, it can generally only be purchased through avicultural societies or publications that advertise it, or direct from the publisher Singil Press, P.O. Box 9, Austral NSW 2171.

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