

Conserving owls in Sydney's urban bushland: current status and requirements

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ABSTRACT

The distribution of records for the seven species of owls that have been recorded in the Sydney region are presented. Records made during the past decade have been compared, where possible, with records made since the beginning of the twentieth century. Information is also presented on aspects of the ecology (diet, habitat, nest sites, roost sites, breeding success) of these species in the Sydney region.

The Powerful Owl is widely distributed, albeit at very low population density, throughout the outer suburbs of the greater metropolitan area, particularly where these suburbs adjoin substantial areas of bushland and reserves. The Sooty Owl and the Masked Owl are restricted to a few such locations near Sydney, but both are more common in the wetter and the drier forests, respectively, of the Central Coast. The Barking Owl appears to be uncommon and of concern because this species is poorly conserved in national parks of the region and its habitat is threatened by continued clearing for agriculture and urban developments. The Grass Owl appears to be a rare vagrant to the Sydney region. The Southern Boobook and the Barn Owl may be common in the region, but their distribution and abundance appears to have been under-represented by official records. The status of all owls is imperfectly known within the most suburban parts of the Sydney metropolitan area and on surrounding semi-rural properties. Efforts are needed to encourage broadscale community participation in voluntary surveys for owls (and several of their main prey species) throughout residential areas. The conservation of owls in the Sydney region depends on the protection of extensive bushland areas from urban and rural development, especially the major forested gully systems which provide essential nesting, roosting and core foraging habitat for most species. The role of fire frequency and weed control in Sydney's urban bushland needs to be examined in terms of its impact on populations of the Common Ringtail Possum, and other important prey species of the owls.

Key words: *Ninox*, *Tyto*, distribution, habitat, diet, nest, roost, breeding, Atlas.

Introduction

There are nine species of owls occurring on mainland Australia, seven of which occur in New South Wales (Hollands 1991). Of these seven, five species are listed as "vulnerable" in NSW by the *Threatened Species Conservation Act 1995* (TSC Act): the Powerful Owl *Ninox strenua*, Barking Owl *N. connivens*, Sooty Owl *Tyto tenebricosa*, Masked Owl *T. novaehollandiae* and Grass Owl *T. capensis*. The two non-threatened species are the Southern Boobook *N. novaeseelandiae* and Barn Owl *T. alba*.

There have been no comprehensive assessments of the status and requirements of owls in the Sydney region, partly because most ornithologists are not in the habit of birdwatching at night and, until recently (late 1980s), effective survey methods for the owls had not been developed (Kavanagh and Peake 1993, Debus 1995). Other difficulties include the large proportion of privately-owned land in the region, which is generally inaccessible to ecologists wanting to conduct nocturnal surveys.

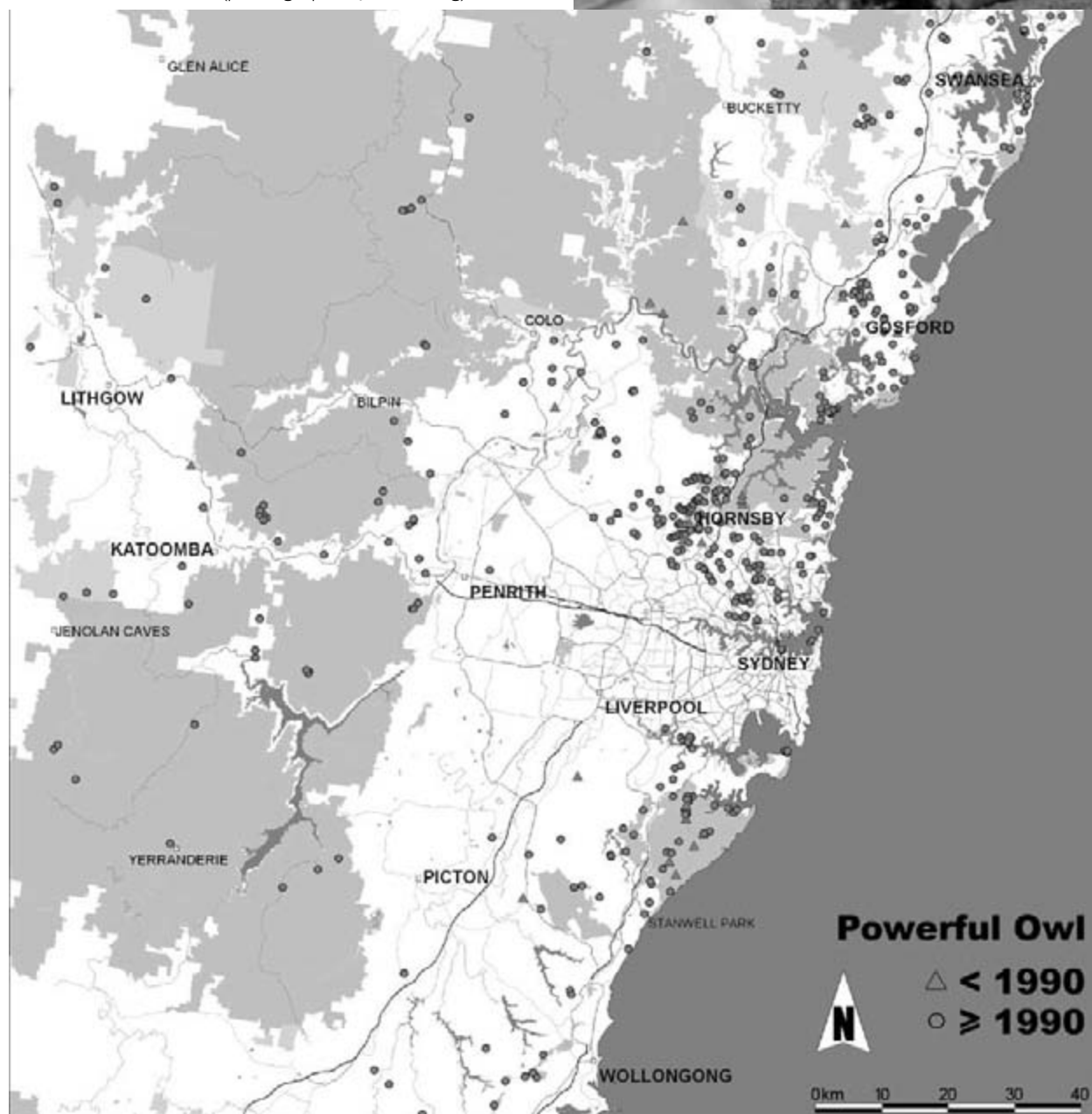
Consequently, there is no baseline available from which to assess changes in the abundance of owls in the Sydney region. Several long-term studies of bird species abundance in this region have conspicuously omitted any consideration of the owls (e.g. Bell 1983, Keast 1995, Wood 1998, Recher 1999), and only one study lists the scant details known about owl species occurrence during most of the twentieth century (Hoskin *et al.* 1991). However, since the 1990s when owls appeared to become more popular with ornithologists and the general public, increasing numbers of records for owls have been reported in the Sydney region and elsewhere (e.g. O'Brien 1990, Sansom 1991, Chafer 1992, Lundie-Jenkins 1993, Debus 1994, Debus and Chafer 1994, Debus and Rose 1994). In particular, the surrounding areas of publicly-owned bushland have received attention. For example, Royal National Park south of Sydney has been estimated to contain sufficient habitat for up to five territories of the Sooty Owl, all of which may be occupied (Chafer and Anderson 1994).

In general, there is much better information available about the status of owls throughout public forest lands (state forests and national parks) than near urban areas (e.g. Kavanagh and Bamkin 1995, Kavanagh *et al.* 1995b, Kavanagh 2002b). These data have influenced the national listing of several species (*N. strenua*, *T. tenebricosa* and *T. novaehollandiae*), previously classified as “rare”, to species regarded nationally as having a conservation status of “least concern” (Garnett and Crowley 2000). Recent studies of owls living near the edges of major cities (Brisbane, Newcastle, Sydney, Melbourne) have shown a degree of tolerance of human activities by several species, despite the increased risks involved (e.g. Pavey *et al.* 1994, Lavazanian *et al.* 1994, Pavey 1995, Kavanagh and Murray 1996, McNabb 1996, Kavanagh and Jackson 1997, Cooke *et al.* 2002).

In this paper, we report the status of owls in the Sydney region and review the information available on their ecology and habitat requirements.



Figure 1. Distribution of the Powerful Owl in the Sydney region.
 Plate 1. Powerful Owl (photographer John Young).



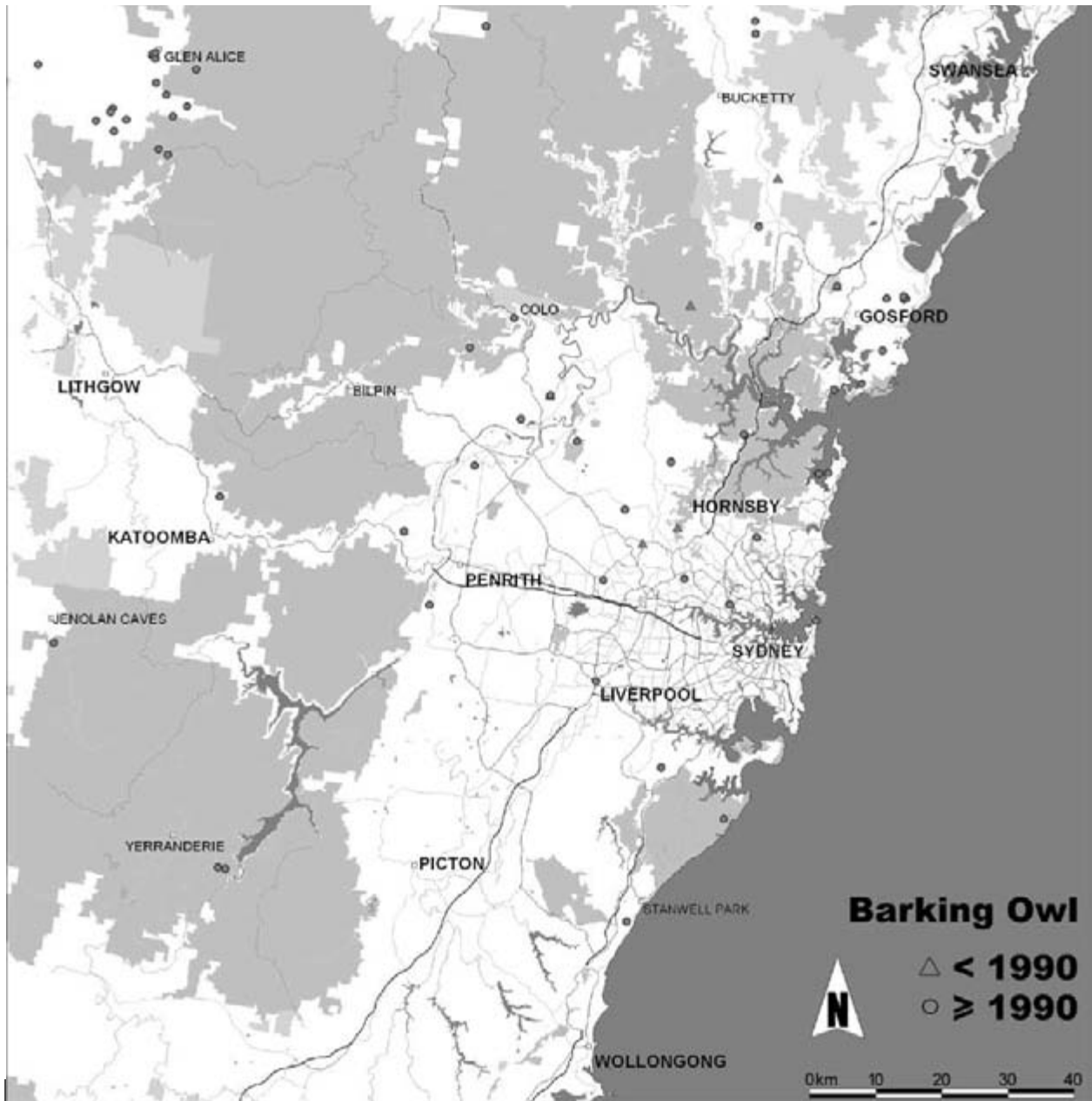


Figure 2. Distribution of the Barking Owl in the Sydney region. **Plate 2.** Barking Owl (photographer David Hollands).

Methods

The Atlas of New South Wales Wildlife, maintained by the NSW National Parks and Wildlife Service, and the second (1998-2002) Atlas of Australian Birds, maintained by Birds Australia (Royal Australasian Ornithologists Union), were the principal sources of records for this paper. The records in these databases come from a number of sources including government agencies, non-government organisations and private individuals and, consequently, may differ in their reliability. Also, there may be some duplication of records between the two databases. The geographic location of the records in both is usually accurate to within 500 m. Data from the first (1977-1981) Atlas of Australian Birds were also obtained for inspection, but these records were not plotted in Figs. 1-7 because they are accurate only to within about 8 km. All locations within this database were provided as the mid-point of the 10 minute grid cell in which the record occurred.

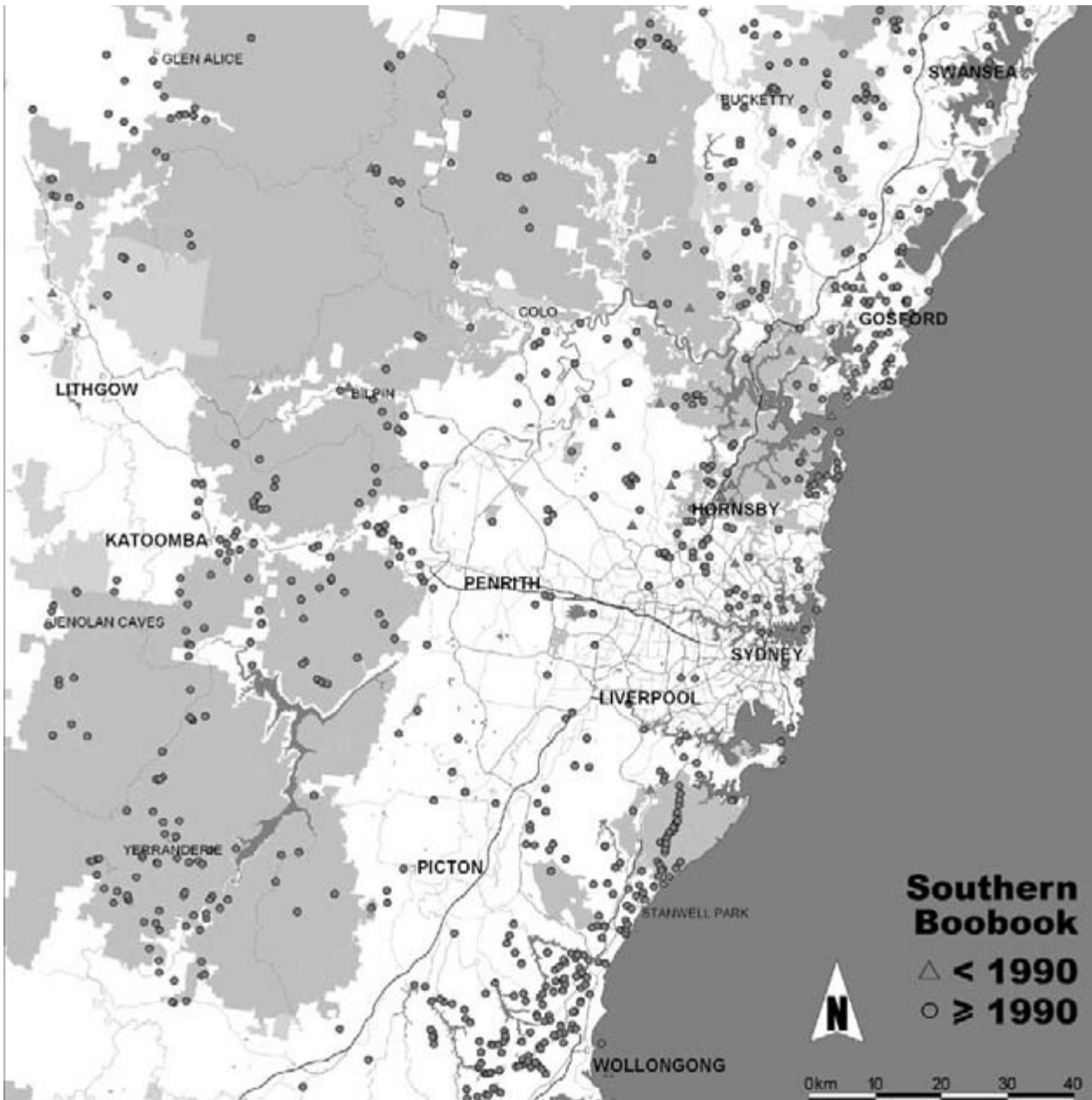


Figure 3. Distribution of the Southern Boobook in the Sydney region.

Plate 3. Southern Boobook (photographer David Hollands).

The Sydney region is defined here as the area bounded by the Hawkesbury River to the north, the Nepean River to the west, Picton in the south-west to Stanwell Park in the south-east. This area is the focus of this paper. However, for perspective, distribution records for each owl species are displayed on maps of the broader Sydney region, extending from Swansea in the north, to Wollongong in the south, and west to Lithgow (i.e. from latitude $33^{\circ} 0'$ to $34^{\circ} 35'$, and longitude from $150^{\circ} 0'$ to $151^{\circ} 40'$). Records are partitioned into those made before and after 1990. The records presented are those listed on the two databases as at June 2003. All place names mentioned in the text are represented in the *Sydney and Blue Mountains Street Directory, UBD 2003, 39th Edition*, Universal Press, Sydney and on the internet (www.whereis.com.au and www.wilmap.com.au/nswmaps/sydney).

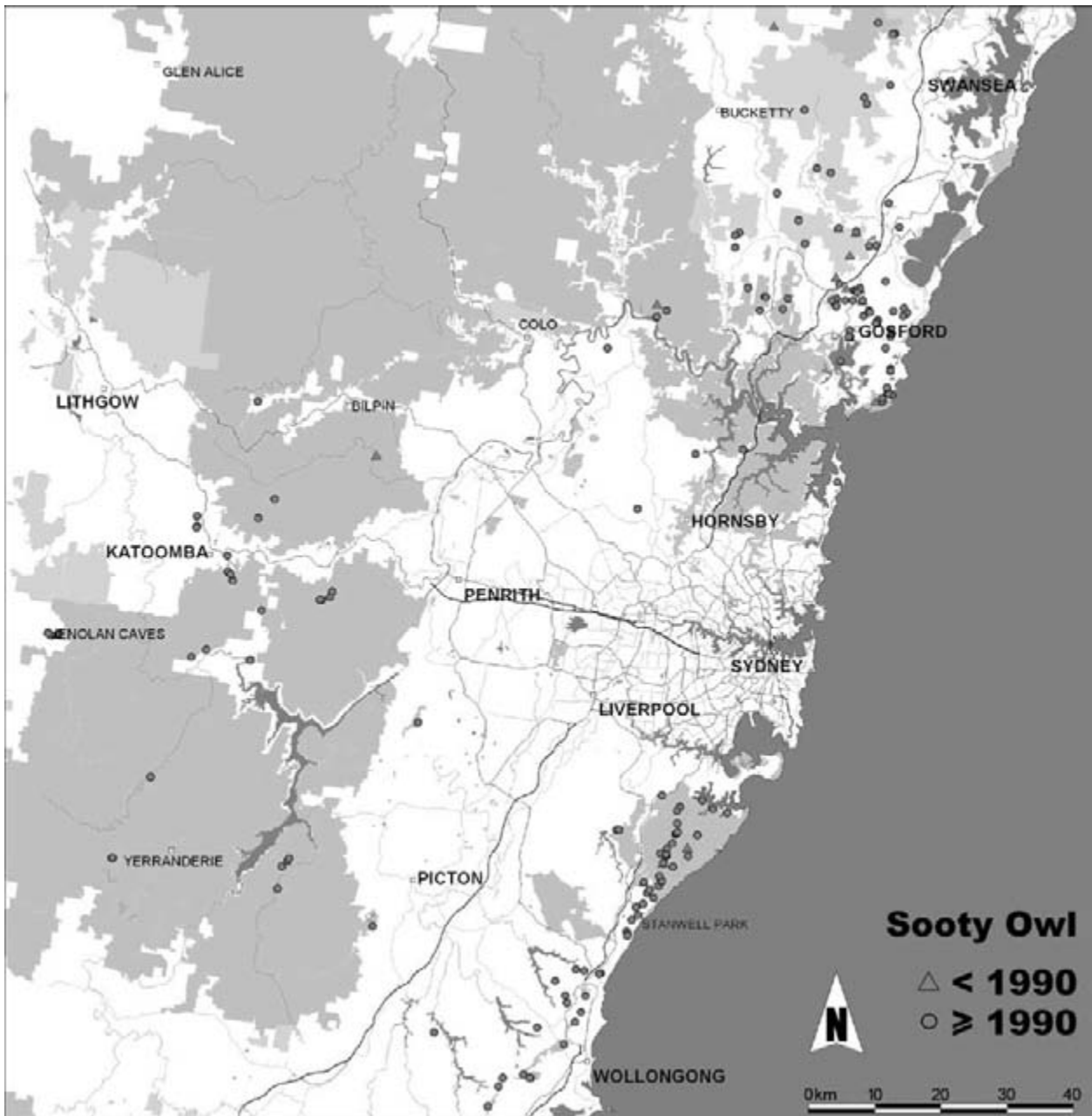


Figure 4. Distribution of the Sooty Owl in the Sydney region. Plate 4. Sooty Owl (photographer David Hollands).

Information about the ecology and habitat requirements of owls in the Sydney region is drawn mainly from the studies of Kavanagh (1997) who focused on the three large forest owls (Powerful Owl, Sooty Owl and Masked Owl).

Results

Distribution and Status

Powerful Owl

The Powerful Owl is widespread throughout the northern leafy suburbs of Sydney, particularly those that are adjacent to the many extensive bushland national parks and reserves that intrude into the outer metropolitan area (Fig. 1). Significant areas of habitat for the Powerful Owl in the outer north include the Cattai Creek and Little Cattai Creek systems and the Marra Marra Creek, Berowra Creek

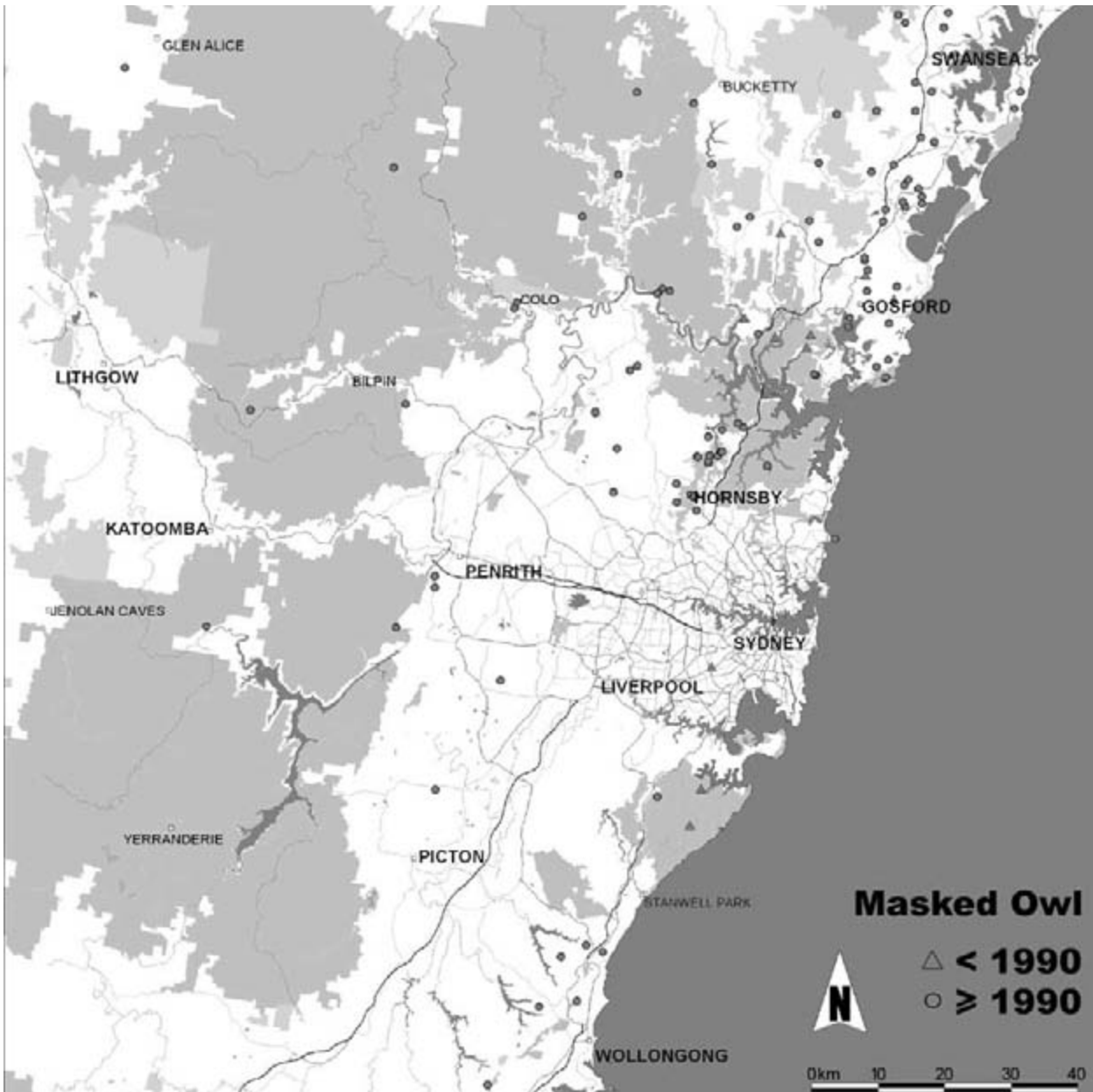


Figure 5. Distribution of the Masked Owl in the Sydney region.
Plate 5. Masked Owl (photographer John Young).

and Cowan Creek systems. Important areas closer to the city include Darling Mills Creek at the headwaters of the Parramatta River, Pennant Hills Park and the Lane Cove River system, Middle Harbour and its many tributaries, and several extensively forested areas nearer the coast from Pittwater south through Narrabeen to Manly.

To the south of Sydney, the major areas of habitat for the Powerful Owl include the extensively forested parts of the Georges River, Woronora River and the Hacking River systems (including the Royal National Park) and their many tributaries. Further south, the extensively forested Water Catchment Areas provide habitat for the Powerful Owl.

The forested areas along the Nattai River, the Nepean-Hawkesbury River system and the Colo River and their tributaries provide significant habitat for the Powerful Owl in far western Sydney. These river systems drain out of the large Blue Mountains and Wollemi National Parks further west.

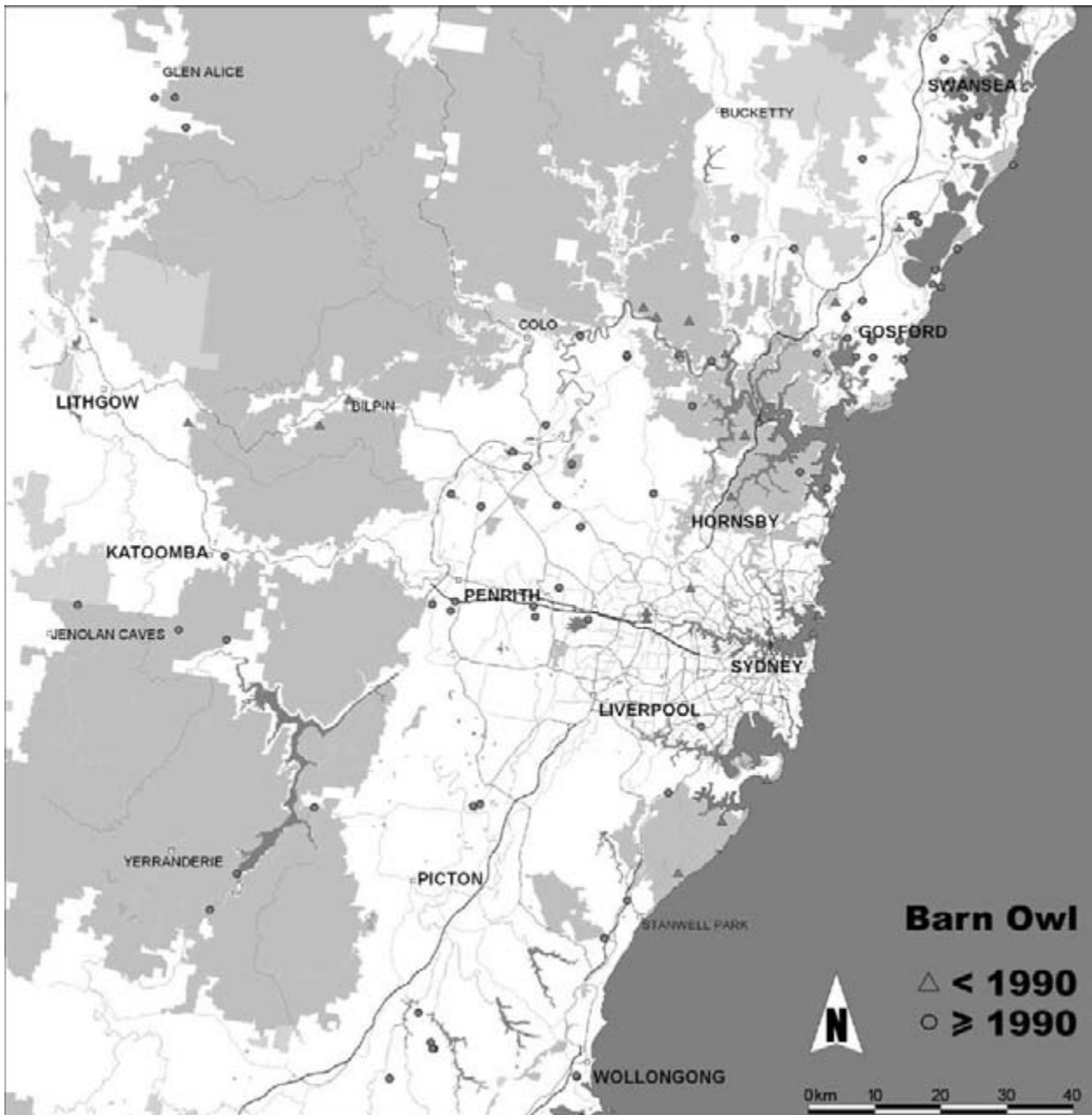


Figure 6. Distribution of the Barn Owl in the Sydney region.
Plate 6. Barn Owl (photographer David Hollands).

The Powerful Owl has been recorded near the inner city of Sydney on many occasions recently. Within the past eight years, records have been made at several locations near Mosman, Wollstonecraft, Vacluse, Malabar and Kurnell. Two birds were seen roosting regularly in the Royal Botanic Gardens during 2000; they failed to breed in the Gardens that year (A. Leishman, personal communication). One bird was found barely alive by the side of the road on Kent Street in the city near its intersection with Market Street on 30 April 2001. This animal died shortly afterwards, after presumably being hit by a car in the early morning (J. Joyce, personal communication). A Grey-headed Flying-fox *Pteropus poliocephalus* was found on the ground nearby, suggesting that the owl was carrying it back to a roosting area when it was hit by a car.

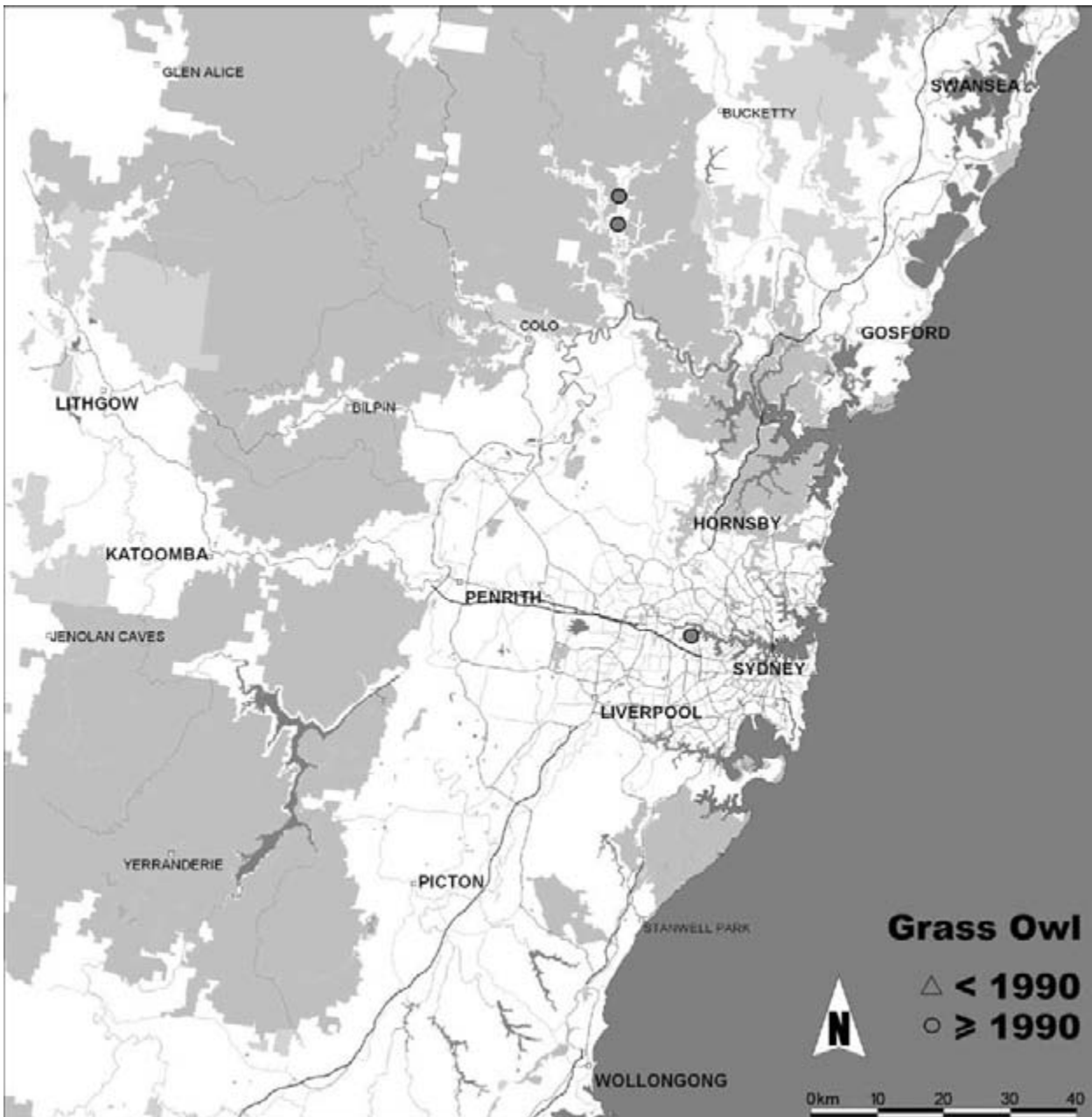


Figure 7. Distribution of the Grass Owl in the Sydney region. **Plate 7.** Grass Owl (photographer David Hollands).

The main areas where there are no records of the Powerful Owl in Sydney are the most built-up suburbs of the eastern and western suburbs where little or no natural bushland remains, and areas further west that have been long cleared for agriculture and which are now being steadily replaced by large housing developments.

Breeding records for the Powerful Owl have been made for at least 15 locations in the broader Sydney region, 10 of which occur within 30 km of the GPO, over the past 15 years (Table 1; Kavanagh 1997 and unpublished data). These locations include Rocky Creek near Killara, Devlins Creek near Epping, Darling Mills Creek near North Rocks, Berowra Creek near Galston Gorge, Sams Creek near Berowra, Pyes Creek near Cherrybrook, Stills Creek near Galston, Joe Crafts Creek near Berowra, Forbes Creek near Engadine, and Cumberland State Forest at West Pennant Hills.

Table 1. Breeding success of the Powerful Owl near Sydney

Territory	Year														
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Glenorie	2														
Rocky Creek		2	1	2	N	F	N								
Devlins Creek			1	2	1	1	1	F	2	F	1	2*	N	1	2
Blue Gum Swamp Ck.			B	2	2	1	N								
Euroka Creek				2		1									
North Rocks					1	1	B								
Galston Gorge					1	2	1								
Sams Creek						1	2	B			1*	2*			B*
Cherrybrook						1	1	2							
Stills Creek						1	B								
Joe Crafts Creek						1									
Maroota							B								
Swansea									2						
Engadine												1			
Cumberland SF													1	F	N

B Bred, but numbers fledged unknown
 F Nest attempt failed

* Nested in a different tree
 N Did not attempt to breed

Powerful Owls in the Sydney region appeared to breed successfully in most years, usually producing either one or two fledglings per year (Table 1; Kavanagh 1997 and unpublished data). At least 51 fledglings were recorded from 40 nesting attempts, with the owls producing an average of 1.42 fledglings from 36 successful breeding events (Table 1). At each location, the owls usually nested in the same tree in each of several consecutive years. One pair nested in the same tree during each of nine consecutive years, before changing to another tree where they bred successfully. The owls then returned to the original tree (after one year in which no breeding took place because one member of the pair was missing, presumed dead) and again bred successfully in the following two years and are currently nesting there again in 2003 (Table 1). The nest trees used by the owls in eight territories were *Angophora costata* (3), *A. floribunda* (1), *Eucalyptus pilularis* (1), *E. piperita* (1), *E. deanii* (1), and *Corymbia gummifera* (1).

Barking Owl

There are very few records in total, and few recent records for the Barking Owl in the Sydney region (Fig. 2). During the past decade, Barking Owls have been recorded near Vacluse, Bayview, Clareville, Cowan, St Ives, Carlingford, Seven Hills, Cherrybrook, Castle Hill, Arcadia, Annangrove, Scheyville, Freemans Reach, Ebenezer, Colo, Agnes Banks, Valley Heights, Mulgoa, Liverpool, Engadine and Scarborough (Fig. 2). The status of the birds at these locations is unknown. One recent (>1990) breeding record for this owl was made at Ebenezer, near Windsor (Kavanagh *et al.* 1995a).

The Barking Owl has been recorded at several locations near Glen Alice (west of the Great Dividing Range) in recent years.

Southern Boobook

The Southern Boobook is common and widespread throughout the Sydney region, and elsewhere, but records appear to be absent from the inner west and western suburbs (Fig. 3). It is likely that the distribution and relative abundance of this species has been inadequately represented by one database, the NSW NPWS Wildlife Atlas. This is because the Southern Boobook may have received a lower priority in recording because it is not listed as a threatened species under the TSC Act. Thus, the status of this species within urban areas is not clear.

Sooty Owl

The Sooty Owl has a more restricted distribution in the Sydney Region (Fig. 4). The local stronghold for this species is Royal National Park, although it is unlikely that more than five pairs occur in the Park (Kavanagh, personal observations). A radio-tracking study of one unpaired male owl living in the northern part of Royal National Park found it foraged extensively (and roosted by day) outside the Park, utilising the major bushland reserves along the gullies and bayside areas of surrounding suburbs including Woronora, Engadine, Gynea and Lilli Pilli (Kavanagh and Jackson 1997).

Other than Royal National Park and the adjacent Heathcote National Park, the closest records of the Sooty Owl to Sydney are near Bilgola, Cowan, Berrilee, Kenthurst, Maroota and Silverdale (Gulguer Nature Reserve).

The most significant areas within the greater Sydney region for the Sooty Owl are the tall, moist eucalypt forests and rainforests growing on the relatively fertile soils of the Central Coast (Fig. 4). There are many records of this owl near Gosford and its surrounding districts, including Bouddi National Park, Kincumber, Avoca,

Matcham, Narara, Strickland State Forest, Lisarow and Ourimbah. Extensive habitat for the Sooty Owl also extends up into the major and minor valley systems of the adjacent Watagan Mountains.

Sooty Owls are also known from the upper and lower Blue Mountains where they occur in several deep gorge systems, including the Grose Valley and its tributaries. The species also occurs on the western side of the range among tributaries of the Coss River, and in several major limestone cave systems, including Jenolan Caves.

There is only one breeding record for the Sooty Owl in the Sydney region (Helensburgh; R. Jordan, personal communication).

Masked Owl

The Masked Owl has a very sparse distribution, mainly in the north and north-west, in the Sydney region (Fig. 5). Recent records include Collaroy, Hornsby, Cowan, Berrilee, Maroota, Cattai, Maraylya, Annangrove, Colo, Kurrajong Heights, Regentville, Mulgoa, Bringelly, Camden and Heathcote. Its stronghold in the greater Sydney region is the Central Coast, and includes records from Dharug National Park, Bouddi National Park, Somersby, Wyong and the Lake Macquarie Shire.

There are no recent (>1990) breeding records for the Masked Owl in the Sydney region south of the Hawkesbury River.

Barn Owl

There are surprisingly few records of the Barn Owl in the Sydney region, despite its known association with rural and semi-urban areas elsewhere (Fig. 6; Higgins 1999, Kavanagh and Stanton 2002). Post-1990 records for the Barn Owl include Clareville, Ku-ring-gai Chase National Park, Middle Dural, Canoelands, Maroota, Wilberforce, Scheyville, Box Hill, Rouse Hill, Londonderry, Rooty Hill,

Eastern Creek, Mulgoa, Penrith, Camden, Hurstville, Engadine and Helensburgh. As for the Southern Boobook, the distribution and relative abundance of the Barn Owl may have been inadequately represented by the NSW NPWS Wildlife Atlas because it is not listed as a threatened species under the TSC Act. Thus, the status of the Barn Owl within urban areas is not clear.

Grass Owl

There are only three records of the Grass Owl listed on the NSW NPWS Wildlife Atlas, and none on the BA Atlas, for the greater Sydney region, and all were made since 1990 (Fig. 7). Two records, presumably duplicates of the same dead bird (S. Debus, personal communication), occurred about the same time near St Albans and another record was made at the Homebush Olympic site (Hobcroft and James 1997). It appears that this species may be a vagrant to the Sydney region because the distribution of this owl in NSW is mainly north of Taree (Debus *et al.* 1998, 2001).

Ecology and Habitat Requirements

Aspects of the ecology and habitat requirements of owls in the Sydney region are summarised in Table 2.

Powerful Owl

Australia's largest owl, the Powerful Owl, inhabits a wide range of eucalypt forest vegetation types (e.g. Kavanagh *et al.* 1995b) where it specialises in taking a restricted range of prey species. Arboreal marsupials are its main prey and, in the Sydney region, based on 19 owl territories, the Common Ringtail Possum *Pseudocheirus peregrinus* comprises 70.6% of the prey biomass for this owl (Table 3, Kavanagh 2002a). Other important prey species are the Common Brushtail Possum *Trichosurus vulpecula* (8.5%), Greater Glider *Petauroides volans* (7.2%), and a range of medium-sized birds (7.3%), including especially the Pied Currawong *Strepera*

Table 2. Ecology and habitat requirements of owls in the Sydney region

Species	Body weight (g) ¹		Clutch size ^{2,3}		Main food types ^{1,3}	Predominant habitat type ^{1,3}	Nest site ^{1,3}	Roost site ^{1,3}
	male	female	mean	range				
Powerful Owl <i>Ninox strenua</i>	1535*	1350*	1.9	1-2	arboreal mammals	forest	tree hollow	among foliage
Barking Owl <i>Ninox connivens</i>	740	710	2.2	1-3	birds, insects, ground mammals	woodland	tree hollow	among foliage
Southern Boobook <i>Ninox novaehollandiae</i>	250	315	2.5	1-4	insects, ground mammals	forest and woodland	tree hollow	foliage/hollow/ cave
Sooty Owl <i>Tyto tenebricosa</i>	650*	1250*	1.5	1-2	arboreal and ground mammals	dense forest	tree hollow/ cave	foliage/hollow/ cave
Masked Owl <i>Tyto novaehollandiae</i>	500*	835*	2.6	2-4	ground mammals	forest and woodland	tree hollow/ cave	foliage/hollow
Barn Owl <i>Tyto alba</i>	310	360	4.0	1-7	ground mammals	open woodland, large clearings	tree hollow	foliage/hollow
Grass Owl <i>Tyto capensis</i>	310	310	6.0	3-8	ground mammals	grassland and heathland	ground	ground

Source: ¹Higgins (1999); ²Olsen and Marples (1993); ³Hollands (1991). *RPK personal observations

graculina but also the Crimson Rosella *Platycercus elegans*, Rainbow Lorikeet *Trichoglossus haematodus* and several other large parrots. Grey-headed Flying-foxes comprised a large proportion (25.8%) of the diet for one pair of Powerful Owls living near the bat camp at Gordon. The Greater Glider replaces the Common Ringtail Possum as the most important prey of the Powerful Owl in the localities where this Glider is abundant (namely, in parts of the Blue Mountains and the Central Coast).

Powerful Owls nest inside a large hollow within an old tree. The diameters of eight nest trees in the Sydney region ranged from 77-164 cm at breast height (Table 4). Nest hollows have a wide opening with a lateral inclination, and they tend to have a pronounced lower "lip" on which the birds alight before entering the hollow. Nest trees are most often situated near minor drainage lines (stream order 1 and above). Nest tree/site fidelity appears to be high for Powerful Owls (Kavanagh 1997; Table 1), but some exceptions have been reported (McNabb 1996). A pair of Powerful Owls has recently (2000) established a breeding territory centred on Cumberland State Forest at West Pennant Hills (mostly 60-65 year old planted and older-aged regrowth forest), a locality where breeding had not been recorded for at least several decades previously (Hoskin *et al.* 1991, RPK personal observations).

Powerful Owls (excluding nesting females) roost by day among foliage, and principally among rainforest trees or tall understorey and sub-canopy trees (Table 5). The most commonly-used roost trees for Powerful Owls in the Sydney region are the Coachwood *Ceratopetalum apetalum*, Turpentine *Syncarpia glomulifera*, Black She-Oak *Allocasuarina littoralis* and Lilly Pilly *Acmena smithii*, but many other tree species have been recorded (Kavanagh 1997).

There have been no studies of home-range size for the Powerful Owl in the Sydney region.

Barking Owl

The habitat of the Barking Owl is primarily open forest and woodland, which is now usually embedded within semi-cleared agricultural landscapes, near rivers, creeks or swampy areas. It nests inside tree hollows of large old *Eucalyptus* and *Angophora* trees, and roosts among the foliage of these canopy trees or in dense thickets of paperpark (*Melaleuca* spp.), wattles (*Acacia* spp.) or regrowth eucalypts. The diet of the Barking Owl is broad, consisting of a wide range of ground-dwelling mammals, birds and insects (Kavanagh *et al.* 1995a, Debus 2001).

The habitat for a breeding pair near Windsor during the 1990s was Cabbage Red Gum *Eucalyptus amplifolia*, Forest Red Gum *E. tereticomis* and Rough-barked Apple

Table 3. Owl diets in the Sydney region.

Species	no. territories	no. prey items	Proportion of prey biomass			
			arboreal mammals	ground mammals	birds	other
Powerful Owl	19	1201	92	<1	7	<1
Sooty Owl	7	412	73	24	2	<1
Masked Owl	2	44	<1	56	44	<1
Barking Owl	1	24	5	94	>0	1

Source: Kavanagh (2002a) and Kavanagh *et al.* (1995a).

Table 4. Characteristics of owl nest trees in the Sydney region.

Species	no. nest trees	no. territories	nest type	tree diameter	hollow inclination	nest site fidelity	nest tree location
Powerful Owl	8	8	eucalypt	77-164	lateral	high	minor drainage line (so1)
Sooty Owl	1	1	eucalypt/cave	(124-183)	lateral/vertical	high?	minor drainage line (so2)
Masked Owl	2	2	eucalypt	100-191	vertical	high?	minor drainage line

Source: Kavanagh (1997). *Data in columns 5-8 for the Sooty Owl are from south-eastern NSW, Jenolan Caves is the breeding record indicated; so = stream order; based on 1:25,000 scale maps

Table 5. Characteristics of owl roost sites in the Sydney region.

Species	no. roost sites	no. territories	Proportion of roost sites				
			rainforest trees	eucalypt trees	other trees	caves/ledges	hollow trees
Powerful Owl	151	18	75	11	14	0	0
Sooty Owl	38	7	42	5	0	53	+
Masked Owl	6	1	0	50	50	0	50

Source: Kavanagh (1997). + indicates that hollows are commonly used for roosting elsewhere

Angophora floribunda woodland, with some Narrow-leaved Ironbark *E. crebra* nearby, and a patchy understorey of Parramatta Wattle *Acacia parramattensis*, Sally Wattle *A. floribunda* and Paperbark *Melaleuca linariifolia*. The diet of these owls was mainly ground-dwelling mammals (European Rabbit *Oryctolagus cuniculus*) with some arboreal mammals (including Sugar Glider *Petaurus breviceps*) and a range of invertebrates (Kavanagh *et al.* 1995a).

Southern Boobook

The Southern Boobook is the most common and widespread owl in Australia, occurring anywhere there are trees with hollows available for nesting (Higgins 1999). This owl is a common forest bird, but it is also found in highly fragmented landscapes (Kavanagh and Stanton 2002). Southern Boobooks roost in a wide range of situations, principally among the foliage of dense understorey or sub-canopy trees, including palm trees, and in tree hollows, but also under bridges and rocky overhangs. They have often been recorded roosting in densely-foliaged trees in urban leafy gardens. For their size, these owls are ferocious predators, taking a wide variety of mammal, bird, reptile, frog and invertebrate prey, up to the size of juvenile Common Ringtail Possum and Rock Dove *Columba livia* (McNabb 2002). Southern Boobooks usually nest within the hollows of very large eucalypts.

Sooty Owl

The Sooty Owl is a habitat specialist, favouring tall moist eucalypt forests and rainforests (Kavanagh *et al.* 1995b). Within this restricted habitat, the Sooty Owl takes a very wide range of, principally mammalian, prey. Although arboreal mammals form the largest component of the diet for this owl, ground-dwelling and scansorial mammals are the most frequently taken (Table 3). In the Sydney region, based on 7 owl territories, the Common Ringtail Possum comprised 56.1% of the prey biomass for this owl (Kavanagh 2002a). Other important prey species are the Bush Rat *Rattus fuscipes* and Black Rat *R. rattus* (10.5% combined), Greater Glider (10.1%), Long-nosed Bandicoot *Perameles nasuta* (8.8%) and the Sugar Glider (5.8%).

Sooty Owls nest inside a large hollow within an old tree or, rarely, within a cave. Sooty Owls have been recorded breeding at Jenolan Caves (Hollands 1991, Kavanagh personal observations), and they are known to roost in other caves in the region although breeding is unconfirmed. There are no published details of nest trees used by Sooty Owls in the Sydney region. However, based on data collected in south-eastern NSW, nest trees are likely to be in the range 124-183 cm diameter at breast height (Table 4; Kavanagh 1997). Nest hollows have a wide opening with a lateral or a vertical inclination. Nest trees are most likely to be situated near minor drainage lines (stream order 1 and 2). Nest site fidelity is unknown.

Sooty Owls roost by day inside tree hollows and among dense foliage and vines in rainforest trees, and in rocky overhangs and caves (Table 5). In the Sydney region, the most commonly-used roost sites for Sooty Owls are on rocky ledges and in rocky overhangs (Kavanagh 1997).

An adult male Sooty Owl was radio-tracked for more than 12 months in Royal National Park and surrounding areas (Kavanagh and Jackson 1997). The home-range size for this bird was more than 3000 ha; an area larger than expected (based on home-range studies done elsewhere, Kavanagh unpublished data) because most of its range within the Park had been burnt by wildfire 18 months previously. Instead, this owl hunted extensively in the unburnt forested gullies among residential areas adjacent to the Park. All recorded roost sites for this owl were in rocky overhangs.

A brief (10 weeks) radio-tracking study of an adult female Sooty Owl at Strickland State Forest near Narara (Gosford) found that this bird ranged over an area larger than 1000 ha, to eat mainly small ground mammals, and to roost mainly in Cabbage Tree Palms *Livistona australis* (Kavanagh unpublished data).

Masked Owl

The habitat for the Masked Owl is open forest with a sparse mid-storey layer, but with patches of dense, low ground cover (Kavanagh *et al.* 1995b, Kavanagh and Murray 1996). These conditions may also be found at the ecotones between wet and dry eucalypt forest types, along the edges of minor drainage lines, and near the boundaries between forest and cleared land. The Masked Owl specialises in a range of ground-dwelling mammals, in particular rats, and in some areas rabbits, but it also takes a number of large birds and a few arboreal mammals. In the Sydney region, based on two owl territories, the Black Rat comprised about 55% of the prey biomass for this owl, and birds made up 45% (Kavanagh 2002a). House Mouse *Mus domesticus* made up the remainder.

Masked Owls nest, and frequently roost, inside large hollows of old trees (Kavanagh 1997, and unpublished data). These hollows normally have a vertical inclination. Two nest trees on the Central Coast (both *Angophora costata*) were 100 and 191 cm diameter at breast height (Kavanagh unpublished data). Masked Owls also commonly roost among dense foliage in a variety of sub-canopy trees.

One adult female Masked Owl was radio-tracked for 14 weeks near Newcastle in 1994 and this bird's home-range was estimated to be larger than 1000 ha (Kavanagh and Murray 1996). More than half of its time (59%) was spent within 100 m of the ecotone between bushland (open forest) and open country (e.g. roads, fields, golf course) or the ecotone between bushland and residential areas. Aside from several tree hollows regularly used for roosting (in *A. costata* and Scribbly Gum *E. haemastoma*), this bird also commonly roosted among the dense foliage of several introduced *Cupressus* sp. trees near residential areas.

Barn Owl

The Barn Owl is the most widespread of the world's owls (Taylor 1994). It is a bird of open country needing only a few isolated trees, or clumps of trees, to provide its essential requirements of large tree hollows for nesting and roosting. It is often associated with agricultural areas,

particularly those growing cereal crops, which provide an abundant food source for its primarily rodent prey (Taylor 1994, Higgins 1999). Little is known about the ecology and habitat requirements of the Barn Owl in the Sydney region, nor the extent to which it has adapted to use man-made structures in the urban environment.

Grass Owl

The habitat of the Grass Owl is low coastal heath and tall grasslands in areas allowed to lie fallow from grazing or cropping (Hollands 1991, Debus *et al.* 1998, 2001, Higgins 1999). It is the only Australian owl that nests (and roosts) on the ground. The Grass Owl is a specialist predator of rodents. This species is thought to be a vagrant in the Sydney region.

Discussion

Caution is needed before accepting all of the locations identified within Figs 1-7 because the records have been taken directly from the NSW NPWS Wildlife Atlas and the new Birds Australia Atlas which contain a number of unverified records. Thus, it is possible that some records may be incorrect. Also, not all known records are listed in these databases. Species mis-identifications are always possible, and most likely to occur for the Barking Owl (which may be confused with the Southern Boobook or with the barking sounds of domestic dogs), and the Masked Owl and Barn Owl (which may be confused with each other). It is unlikely that the larger Powerful Owl and Sooty Owl, and their distinctive calls, have been mis-identified to any significant extent.

Until recently, the NSW NPWS Wildlife Atlas (which also included all of the pre-1990 records used in this paper) was strongly biased towards the recording of threatened species only. Accordingly, the distribution and status of common species, such as the Southern Boobook and the Barn Owl, may be under-represented (see Table 6). Relatively more information is known about the three large forest owls, the Powerful Owl, Sooty Owl and the Masked Owl, because they have been the focus of a recent study that included the Sydney region (Kavanagh 1997).

This paper reviews the available information on the current status of Sydney's owl species. However, the lack of awareness and surveys in the past for these owls has meant that there is no suitable baseline available from which to assess changes in their abundance in the Sydney region. For example, comparisons between the first (1977-1981) and second (1998-2002) Birds Australia Atlases show that the numbers of records for most owl species (irrespective of their locational accuracy) increased dramatically over the past 20 years, due to increased and improved survey effort (Table 6). A compilation of the distribution of older (mostly pre-1990) records is given by Hoskin *et al.* (1991), Debus (1994, 1997), Debus and Chafer (1994), Debus and Rose (1994), Debus *et al.* (1998) and Higgins (1999).

The Powerful Owl was reported by Hoskin *et al.* (1991) to be rare in the County of Cumberland during the twentieth century, but they noted it had been recorded more regularly during the 1980s than previously. Debus and Chafer (1994) identified a total of 19 localities for the Powerful Owl on the Central Coast of NSW (approximately from Newcastle to Wollongong) from 1880 to 1990. Fig. 1 shows that the Powerful Owl is now widespread throughout the more forested parts of the Sydney region. It is likely that the apparent increase in abundance of this species is due to the greater awareness among ornithologists of its likely presence, and by increasing knowledge about owl survey methods.

The Sooty Owl has always been regarded as a rare, mysterious and highly cryptic species. Hoskin *et al.* (1991) cite North (1898) who considered the Sooty Owl to be "rare and met with in the dense scrubs near George's River and at Port Hacking". Hoskin *et al.* (1991) provide only one additional record before the mid-1980s when Sooty Owls began to be recorded regularly in Royal National Park; this record was made at Marsfield in 1960. Debus (1994) lists 23 localities, including the above, for the Sooty Owl on the Central Coast of NSW from 1895-1992. Most of these records were from well outside the present metropolitan area of Sydney; several were from the Gosford area in the late 1980s (O'Brien 1990). The Marsfield record, and one near Manly before 1904, are the closest records to Sydney.

Table 6. Numbers of records of owls for the greater Sydney region, as at June 2003.

Species	NPWS Wildlife Atlas		Birds Australia Atlases	
	<1990	1990-2003	1977-1981	1998-2002
Powerful Owl	57	423	19	138
Barking Owl	9	48	15	28
Southern Boobook	62	688	411	614
Sooty Owl	30	213	2	32
Masked Owl	13	96	2	11
Barn Owl	27	66	32	20
Grass Owl	0	3	0	0

Source: NSW NPWS Wildlife Atlas, and the first (1977-1981) and second (1998-2002) Birds Australia Atlases of Australian Birds

The current status of the Sooty Owl in the Sydney region appears unchanged; it is still a rare bird in this region. New (post 1990; Fig. 4) records of this owl to the north and west of Hornsby probably do not represent an expansion of the species' range, because of inadequate sampling in earlier years, but are significant nonetheless. The Royal National Park and the Gosford area remain the most important localities for the conservation of this species in the region.

The Masked Owl is another highly cryptic species that is very poorly known. Hoskin *et al.* (1991) cited Jackson (1907) as stating that this species was a rare bird in 1906. Only two nests of the Masked Owl were known to Hoskin *et al.* (1991) for the Sydney region: one near Lindfield (1906) and the other near Warriewood (1974). Debus and Rose (1994) list 27 localities for this species on the Central Coast of NSW from 1897-1991. About half of these localities can be regarded as occurring within the present boundaries of the Sydney metropolitan area. At least eight of these localities are not represented in recent (post 1990; Fig. 5) records for the Masked Owl, suggesting that this species has not fared well with increasing urbanisation. Important areas for the conservation of the Masked Owl in the Sydney region include bushland to the north and west of Hornsby.

The Barking Owl is a species that has only recently come to the attention of conservation managers. It was not until June 1998 that this owl was listed as "vulnerable" under the TSC Act. Two of the reasons for listing this species were given as "Records of the Barking Owl in the past decade have declined..." and "The primary habitat of the Barking Owl – woodland – has declined dramatically due to clearing for agriculture and other human development". Hoskin *et al.* (1991) stated that the Barking Owl was known only from very early records within the County of Cumberland (Sydney region), but that since 1973 it had been recorded "more regularly" over a wide area. However, records since 1990 (Fig. 2) show that this species is rarely recorded in the Sydney region. Debus (1997) reported a total of 18 localities for the Barking Owl on the Central Coast of NSW from 1903-1996. The strong association of the Barking Owl with open forests and woodlands on relatively fertile soils, and its poor representation in the national parks of the region, indicate that this species deserves attention by conservation managers.

The Southern Boobook and the Barn Owl are widespread and secure; however, the paucity of records for both species in the Sydney region, especially the Barn Owl (Table 6), is noteworthy. It is likely that both have been

under-reported because they are generally assumed to be common. The Southern Boobook is found in a broad range of forest and woodland types throughout the sandstone and shale areas of Sydney, but its status within the most built-up areas is poorly known. The Barn Owl may now be less common in the Sydney region because of its association with shale areas (Hoskin *et al.* 1991). These areas, which were extensively cleared or semi-cleared for agriculture, are now subject to increasing urban developments. The Grass Owl is not a regular inhabitant of the region; Hoskin *et al.* (1991) cite only one record (in 1898), and Debus *et al.* (1998) report only two additional localities (mentioned above).

Sydney is fortunate to be surrounded by several large national parks and other areas of extensive bushland that occur near residential areas. Often, residential developments in the outer metropolitan area have been confined to ridgetops and plateaux in the sandstone areas, while the deeply-dissecting valley systems have remained forested and relatively undisturbed. These forested gullies provide the essential nesting and roosting areas, and the core foraging areas, for the Powerful Owl in the Sydney region. Most other owl species are also likely to benefit from conservation of these extensive bushland areas. Fire exclusion within these valleys and nutrification of the creeks and waterways draining from residential areas have led to changes in the understorey structure of these gully forests which may have favoured the Powerful Owl and its main prey, the Common Ringtail Possum. These changes include greater development of rainforest species (*Ceratopetalum apetalum*, *Doryphora sassafras*, *Acmena smithii*, *Bacchousia myrtifolia*, *Ficus* spp. and *Tristania laurina*), Turpentine *Syncarpia glomulifera*, *Pittosporum undulatum* and Sheoaks (*Allocasuarina* spp.), but also infestation of many areas with weedy species, especially by Privets *Ligustrum* spp. The role of fire frequency and weed control in Sydney's urban bushland needs to be examined in terms of its impact on populations of the Common Ringtail Possum, and other important prey species of the owls.

The status of all owls is imperfectly known within the most suburban parts of the Sydney metropolitan area and on surrounding semi-rural properties. This situation could best be addressed by encouraging broadscale community participation in voluntary surveys of residential areas, such as occurs presently for diurnal birds in Sydney's "Birds in your Backyard" programme (administered jointly by Birds Australia and the Australian Museum).

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