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## Development of independence in Powerful Owl *Ninox strenua* fledglings in suburban Sydney

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**Summary.** This paper extends previous observations of behavioural development in Powerful Owl *Ninox strenua* fledglings. The study combines a near-daily visual monitoring program on a pair of owlets in Oatley, suburban Sydney, New South Wales, with corresponding pellet analysis. The fledglings were initially fed on possums, fruit-bats, birds and insects, and first demonstrated independence by disassembling carcasses by themselves. By October, they apparently mimicked the adults' strategy for capturing insects, and began to chase birds and bats. Behaviours thought to be part of honing their hunting skills—including tearing and ferrying strips of bark, foliage-snatching, and swooping at animals on the ground—were recorded. Such actions intensified during a period when the adults were mostly absent in November and December.

### Introduction

The Powerful Owl *Ninox strenua* is the largest owl in Australia, endemic to the south-eastern coastal ranges (Higgins 1999; Hollands 2008; Olsen 2014). Despite its being sedentary (Kavanagh 1988; Hollands 1991; Debus 2009; Olsen 2011), studying it can be challenging owing to its cryptic nature and use of many roost-sites (Pavey *et al.* 1994). Possibly because of such difficulties, the Owl was once thought to be a strict habitat specialist of extensive old-growth forest (Fleay 1968; Traill 1993). Since the late 1980s, many breeding pairs have been found persisting in developed areas and the urban interface, including Melbourne (Cooke *et al.* 2002a,b, 2006; Menkhorst *et al.* 2005; Isaac *et al.* 2008; Fitzsimons & Rose 2010; Hogan & Cooke 2010; McNabb & Greenwood 2011), Brisbane (Pavey *et al.* 1994; Pavey 1995; Pavey & Smyth 1998) and the Greater Sydney area (Kavanagh 1988; Chafer 1992; Rose 1993; McAllan & Larkins 2005). In Sydney, Powerful Owls have established territories close to the central business district (Kavanagh 2004).

Breeding pairs of Powerful Owls reproduce annually, typically mating in late April and May (Debus & Chafer 1994; McNabb 1996). The nest is established in a large tree-hollow, lined with decayed wood debris, often at the head of a well-vegetated gully (Kavanagh 1997). The female incubates the clutch of one–three eggs, and is fed by the male during the nesting period. Following fledging, the period of rearing young may last until the following April (Pavey *et al.* 1994).

Concern has been expressed for the Powerful Owl's long-term survival, including listing it as a vulnerable species in the New South Wales *Threatened Species*

*Conservation Act 1995*. Further research has been encouraged for improving management of the Owl across a range of environments (Chafer 1992; DEC 2006). This paper summarises the outcomes of an intensive monitoring program of a breeding pair in southern Sydney over the 2012 season. The information adds to the growing body of literature relating to urban-dwelling Powerful Owls in eastern Australia. More specifically, the unique observations develop our understanding of how fledglings develop their independent hunting abilities.

## Methods

### *Breeding pair and study site*

The adult Powerful Owls documented in this paper were first located by DRW in July 2012. Successive observations were helped by the species' sedentary behaviour (Kavanagh 1988). This breeding pair resides in Oatley (33°59'S, 151°4'E) in the St George district of Sydney. Anecdotal evidence from local residents suggests that the Owls have been present for consecutive breeding seasons since the 1980s (J. Cartwright pers. comm.).

The study site consists of a remnant bushland gully, covering ~2.5 ha, adjacent to an open expanse of recreational parkland. Foraging area would evidently be much larger (Soderquist & Gibbons 2007), with Powerful Owls from this site identified in separate parklands up to 600 m away (MM, DRW & P. Hayler unpubl. data). The canopy of the gully is dominated by Blackbutt *Eucalyptus pilularis* and Smooth-barked Apple *Angophora costata*, with a dense understorey, mostly of Cheese Tree *Glochidion ferdinandi* and Sweet Pittosporum *Pittosporum undulatum*. The site was ideal for monitoring of owls, with its walking track that was semi-lit by the nearby residential area. In addition, the site being in a confined area meant that long-range calls (described by Fleay 1944) were easily located and followed. The Owls could be inspected frequently because they were habituated to human activity. In addition, they were seemingly not affected by light sources that strobe the gully at dusk.

### *Monitoring program*

Once the nest-hollow was located, this area was the focus of monitoring, discontinuing when the fledglings began to inhabit the various roost-sites. Visits were conducted most nights from dusk between July and December, with visit duration ranging from 90 minutes to 3 hours. Observations were recorded in a notebook, focussing on captured prey species, length of time feeding, roost-tree species, movements, distance from the nest-hollow and inter-species interactions (mobbing birds and prey species).

The adult Powerful Owls and their successive progeny were also monitored for a second season in 2013 until the Owls' sudden disappearance eliminated the opportunity for observing any development of independence in these fledglings.

### *Analysis of pellets*

Analysis of pellets is a rapid method of sampling the diet of Powerful Owls, allowing for extensive data to be collected within a short time period (Southern 2008) and providing a comprehensive inventory of the Owls' prey. Results from pellet analysis complemented the rigorous schedule of direct observations outlined above.

Fifty-three pellets found beneath roost-trees throughout the study period were collected

in sealable plastic bags and stored frozen. Prey remains (orts) were also searched for, but not found. Collection dates and locations were recorded on each bag in permanent marker. Pellets were dried in direct sunlight and sent to the BirdLife Australia Discovery Centre, Homebush Bay, in suburban Sydney for analysis. In the laboratory, the contents of each pellet were identified to species level where possible.

## Results and discussion

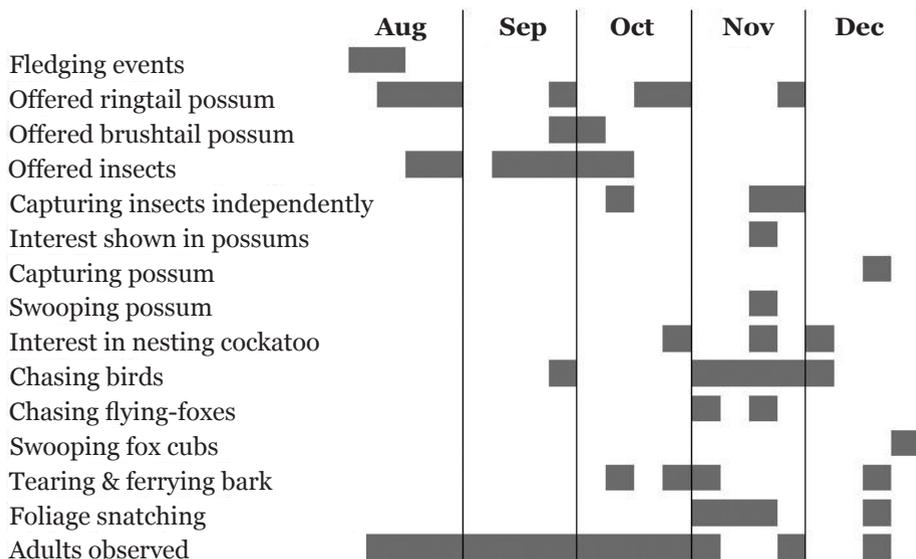
The Powerful Owls' nest-hollow was situated in a Smooth-barked Apple at the head of a gully. Its entrance was ~12 m above ground, which is at the lower range of the mean height for Powerful Owl nests (Fleay 1968; McNabb 1996; Kavanagh 1997; Higgins 1999). The male Owl frequented a roost-site close by from July to August. Two owlets left the nest-hollow at separate times, on 5 and 14 August. The second fledgling was observed flying out at 1754 h. It crashed into a shrub close to the ground, but was seen with the adults in the treetops the following night. The first fledging event was not witnessed, but its timing was determined from seeing the owlet perched on 6 August, combined with its absence from previous nights' observations. The fledglings were first seen flying on 17 August, but remained in the confines of the gully until mid October.

A summary of the fledglings' early development is shown in Figure 1. The adults were apparently mostly absent from mid November onwards, in contrast with being easily found earlier in the study period. Bird-chasing and insect-catching by the fledglings had begun from late September to early October, but particularly intensified during the period of absence of the adults. This pattern appears to be similar to observations of the Southern Boobook *Ninox novaeseelandiae*, Peregrine Falcon *Falco peregrinus* and other raptors, in which adults encourage independence by departing from and withholding food from the fledglings at a certain stage before their dispersal (Olsen 2011, 2014).

### *Feeding of possums to fledglings by adults*

Diet composition of Powerful Owls varies geographically and seasonally (Debus & Chafer 1994; Pavey 1995). In this study, two species of possum, as well as insects (see p. 147) were seen offered to the fledglings (Figures 1–2). The Common Ringtail Possum *Pseudocheirus peregrinus* appears to be the staple prey species, as reported in the literature (Seebeck 1976; Pavey *et al.* 1994; McNabb 1996; Webster *et al.* 1999; Cooke *et al.* 2002a). Their carcasses were discovered in the adult Owls' talons in 50% of the weeks from August to October. The Common Brushtail Possum *Trichosurus vulpecula*, another known prey item (Pavey 1995; Kavanagh 2002; Olsen 2011), was included in the diet in late September and early October. The results of the pellet analysis show a broader timeframe of predation on this species (Table 1), though numbers do seem slightly higher in these two months.

The adult Powerful Owls used two methods of feeding their young. Firstly, with their beaks they tore pieces off the prey carcasses and placed these in front of the



**Figure 1.** Chronology of behaviours displayed by Powerful Owl fledglings at Oatley, NSW, 2012.

**Table 1.** Prey items (minimum number of individuals) of Powerful Owls in Oatley, NSW, 2012, identified by pellet analysis.

<i>Prey species</i>	<i>Aug.</i>	<i>Sep.</i>	<i>Oct.</i>	<i>Nov.</i>	<i>Dec.</i>	<i>Total (%)</i>
Common Ringtail Possum <i>Pseudocheirus peregrinus</i>	4	2	4	2	1	13 (24.5)
Common Brushtail Possum <i>Trichosurus vulpecula</i>	0	4	3	2	1	10 (18.9)
Grey-headed Flying-fox <i>Pteropus poliocephalus</i>	3	0	0	0	0	3 (5.7)
Unidentified mammal	0	0	0	1	0	1 (1.9)
Rainbow Lorikeet <i>Trichoglossus haematodus</i>	3	1	0	5	1	10 (18.9)
Unidentified small bird	0	0	2	1	3	6 (11.3)
Christmas beetle <i>Anoplognathus</i> sp.	0	0	2	2	6	10 (18.9)
<b>Total prey items</b>	<b>10</b>	<b>7</b>	<b>11</b>	<b>13</b>	<b>12</b>	<b>53</b>

fledglings (cf. McNabb 1994). Except for one occasion (28 September), the adults had only one carcass at a time, and both adults stripped it and offered morsels to each fledgling. The second method of feeding was offering the whole tail of a possum to the fledglings. The earliest observation of this occurred on 30 August. The fledgling devoured the Common Ringtail Possum tail in a few gulps (see McNabb 1996). Notably, whenever a fledgling was supplied a large food item, it did not share this with its sibling. The same behaviour was repeated on 28 September, 28 October and 22 November. In the latter two instances, both the posterior of the possum and the tail were offered. Both times, the fledglings tore off morsels without assistance before swallowing the tail whole.

Pellet analysis revealed at least two additional vertebrate species that did not appear in direct observations (Table 1). Both are known prey items—Grey-headed Flying-fox *Pteropus poliocephalus* (Pavey *et al.* 1994; Menkhorst *et al.* 2005; McNabb & Greenwood 2011), and Rainbow Lorikeet *Trichoglossus haematodus* (Pavey *et al.* 1994). The former are sporadically captured by another breeding pair with a territory ~3 km away (C. Lloyd & MM unpubl. data). In our study, predation on flying-foxes was apparently restricted to August, whereas Rainbow Lorikeets were fed to the fledglings frequently throughout the study period.

### Capture of insects

The Powerful Owl fledglings were offered insects periodically between mid August and mid October (Figure 1). This component of the diet has also been reported by other authors (Seebeck 1976; Pavey *et al.* 1994; Pavey 1995; McNabb 1996; Schulz 1997). More recently, some authors have described Powerful Owls hawking insects in mid air (Hollands 2008; Debus 2009; Olsen 2011, 2014). The earliest observation of insect-catching by the adults in the present study occurred on 15 September, reaffirming that the adults snatched them in the air. Most times, the Owls perched immediately after a successful capture to feed (Olsen *et al.* 2013). On subsequent evenings, the fledglings were seen flying over to an adult's perch immediately after an adult had landed with prey.

The first observation of a Powerful Owl fledgling feeding itself an insect occurred on 1 October. It used its foot to bring particles to its beak. Whether the fledgling captured the insect itself could not be determined. Observations of fledglings receiving insects from adults continued over the next seven nights. The first time that they were seen catching insects independently was on 8 October (Figure 1). After the adults left to hunt, the fledglings repeatedly crashed into treetop foliage, then returned to perch positions. In this manner, they caught and consumed several insects. This behaviour strongly reflects the adults' technique, and was repeated the following evening. The same technique has been observed in other members of the genus *Ninox* (Debus 2009; Olsen 2011), e.g. Christmas Island Hawk-Owl *N. natalis* (Phillips *et al.* 1991), Rufous Owl *N. rufa* (Hollands 2008), Barking Owl *N. connivens* (Stanton 2011) and Southern Boobook (Olsen *et al.* 2006, 2008). The capture of insects in the canopy and mid air by *Ninox* owls is not seen in other owl species of greater than 300 g body mass (Olsen *et al.* 2013).

By 18 November, observations of the fledglings successfully obtaining Christmas beetles *Anoplognathus* spp. were routine. This development was supported by increased numbers of pellets containing beetles (Table 1), during which observations of feeding of fledglings by the adult Powerful Owls had become infrequent (Figure 1). Although the fledglings were capable of swallowing the beetles whole (as they had with possum tails), they often dismantled them, stripping off wings and elytra, before consuming the beetles. Beetles were abundant on some nights, aggregating near artificial lighting. There is a close similarity to Seebeck's (1976) findings, where Powerful Owls in western Victoria took advantage of a seasonal peak in insect biomass in late summer and early autumn. This pattern may be associated with this species' timing of breeding (Olsen 2011).

### *Bark-tearing and foliage-snatching*

Several observations of the fledgling Powerful Owls showing attention to tree materials were recorded. The first occurred on 12 October, in which the fledgling was perched on a dead branch and proceeded to break off pieces of bark with its beak (Figure 1). This behaviour was repeated on 17 December, and has been observed in the Southern Boobook as a means of uncovering retreating insects (Olsen *et al.* 2006), although no confirmation of this occurred in the present study. The fledglings were also seen carrying long strips of eucalypt bark in their talons in flight and discarding them after a short distance (cf. McNabb 1994). This type of behaviour, herein referred to as 'bark-ferrying', was first recorded on 28 October and intensified in early November, especially when the adults were absent hunting. Bark-ferrying was witnessed again on 17 December.

Snatching at foliage was another behaviour frequently recorded, beginning on 2 November (Figure 1). On this evening, a Powerful Owl fledgling swooped at a eucalypt branch, snapping off a sprig of leaves. It then landed upside-down on another branch, still clutching the leaves in its talons as it scrambled to an upright position. Soon after, the other fledgling attempted to tug the topmost foliage off a Swamp Oak *Casuarina glauca*, but failed. The following evening, a fledgling flew to grasp a cluster of foliage and hung upside-down from it, rotating slowly in the manner of courting Rainbow Lorikeets. Similar behaviour was also recorded on 20 November and 17 December. This behaviour is common in all *Ninox* species (Olsen *et al.* 2006; Olsen 2011, 2014; Stanton 2011). In all accounts of foliage-snatching, there were no prey items involved. We suspect that the fledglings were honing their ambush skills, similar to young Peregrine Falcons snatching at wind-blown leaves (Cade 1982; Hollands 1984). The acrobatics observed when the fledglings swooped at branches and grabbed them upside-down would potentially apply to capturing arboreal mammals.

Throughout the study period, there were further observations for which there is no clear explanation. For example, a fledgling Powerful Owl occasionally landed on the ground in the open parkland and remained there for several minutes for no apparent reason. In the gully, the fledglings also descended to the ground to land on fallen branches and leaf-litter, and picked up strips of bark or dead tree-fern fronds, behaviour which is presumably a precursor to bark-ferrying.

### *Powerful Owl fledglings chasing birds*

In this study, fledgling Powerful Owls were recorded pursuing four species of birds. The first observation occurred on 22 September, in which a fledgling chased a Pied Currawong *Strepera gracula*, which easily escaped. In November, the fledglings once pursued an Australian Magpie *Cracticus tibicen* and twice pursued Noisy Miners *Manorina melanocephala*. In all three instances, the birds were settling to roost when disturbed by the Owls. These species have all been identified in the Powerful Owl's diet in other studies (Tilley 1982; Lavazanian *et al.* 1994; Pavey *et al.* 1994; Schulz 1997; Kavanagh 2002; Olsen *et al.* 2011).

Nesting Sulphur-crested Cockatoos *Cacatua galerita* were apparently a particular target, receiving attention from the Powerful Owl fledglings on several occasions. The first incident occurred on 23 October while the adult Owls were present. The fledglings flew to the vicinity of the nest-tree near where a Cockatoo had occupied a tree-cavity. They showed considerable interest, but did not interfere. Several attempts to capture Cockatoos proceeded during the period of the adult Owls' absence from mid November onwards. On 15 November, a Cockatoo narrowly missed an intercept from one of the Owl fledglings as it flew toward the Cockatoos' nest-hollow. The Cockatoo screeched as it neared the cavity, and we suspect that it anticipated an attack from an Owl.

A successful intercept between a fledgling Powerful Owl and a Sulphur-crested Cockatoo was witnessed on 4 December. The fledgling appeared to close in on the usual flight-path of the Cockatoo, which regularly entered the tree-cavity. Contact between the Owl and the Cockatoo was confirmed by two feathers from the Cockatoo's back that were dropped. The Owls' interest in the Cockatoos escalated gradually from mere visual inspections to timing attacks as the Cockatoos entered the nest-hollow. No successful kills were recorded, and these incidents may reflect either developing hunting capability or play in the juvenile Owls. It is important to note that all *Ninox* owls also chase birds and mammals for reasons other than hunting, such as competition for nest-hollows; such incidents are usually distinguished by the owl beak-clacking (Olsen 2011), though this was never heard in the present study.

Birds that are consumed by Powerful Owls are probably caught when perched rather than in direct flight (C. Lloyd pers. comm.). As far as we can determine, bird-chasing is likely to be a combination of play and developing the juvenile Owls' hunting skills (Higgins 1999).

### *Powerful Owl fledglings chasing bats*

The Powerful Owl fledglings were recorded chasing small groups of Grey-headed Flying-foxes on two evenings in November (Figure 1). In the first observation, the bats were only displaced and did not appear to be greatly alarmed, soon settling nearby to resume feeding on gum blossom. Sixteen days later, bat-chasing was observed again, with chases being more prolonged. Pellet analysis showed that the fledglings were familiar with this species as a food resource (Table 1).



**Figure 2.** Powerful Owl fledglings with a Common Ringtail Possum carcass supplied by an adult. Photo: Matthew Mo

### *Progression to independent hunting*

Attempts by the Powerful Owl fledglings to hunt independently were observed during the period of the adults' absence. On 18 November, the fledglings flew to an area of parkland that they had previously not frequented, where they showed interest in a Common Brushtail Possum with young. One of the Owls swooped down towards them, but did not attempt to catch either animal. As with the bats, the possums did not flee in alarm nor seem perturbed after the incident. The Owl fledglings performed similar swoops on a pair of Red Fox *Vulpes vulpes* cubs in an open section of parkland on 20 December. The cubs were drinking from a puddle, and ran in response to the approaching Owls. The fledglings repeatedly swooped the cubs, but without any attempt to capture them. No accounts of predation on foxes are reported in the literature, although subadult Powerful Owls have been recorded to swoop small dogs (McNabb 1996).

By December, the Powerful Owl fledglings were beginning to develop adult plumage. Successful capture of a mammal was recorded on 17 December. The fledglings had flown 200 m across open ground to reach a fruiting Port Jackson Fig *Ficus rubiginosa*. A loud squeal was heard as one of the fledglings landed, and the Owl was found feeding on a young Common Ringtail Possum. As in previous observations, it did not share with its sibling. Over subsequent nights, the fledglings spent substantial time in the vicinity of the fruiting tree, perhaps because they recognised the potential for such an area as a regular site for their prey. Similar occurrences have been found in Panama, Central America, where owls were drawn to fruiting trees frequented by fruit-bats (Morrison 1980).

## Conclusions

Many studies have focussed on the urban ecology of Powerful Owls (Cooper 1964; Webster *et al.* 1999; Cooke *et al.* 2002a,b; Kavanagh 2004), with particular attention given to diet (Lavazanian *et al.* 1994; Pavey 1995; Wallis *et al.* 1998; Menkhorst *et al.* 2005; Fitzsimons & Rose 2010). This paper provides extensive accounts of fledglings' behaviour and their graduation to independence. According to our dataset, the earliest events of the owlets becoming non-reliant were when the adults offered prey and left the fledglings to dismember a carcass themselves. In the absence of the adults, the fledglings appeared to perform the same action on tree bark.

During their development, the Powerful Owl fledglings appear to mimic the adults' hunting strategies, such as snatching at branches to capture insects and showing interest in cockatoos entering nest-cavities. These exploits intensified during the period of the adults' absence. Members of the genus *Ninox* also adopt strategies from their siblings (Trost & Olsen 2013; J. Olsen pers. comm.). The fledglings also ferried bark strips, struck and hung upside-down on branches, chased birds and bats, and swooped animals on the ground. At present, these behaviours can only be assumed to be play. Whether the observations in this study are typical of Powerful Owl fledglings in general remains to be verified.

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## References

- Cade, T. (1982). *The Falcons of the World*. Cornell University Press, New York.
- Chafer, C.J. (1992). Observations of the Powerful Owl *Ninox strenua* in the Illawarra and Shoalhaven regions of New South Wales. *Australian Bird Watcher* **14**, 289–300.
- Cooke, R., Wallis, R. & Webster, A. (2002a). Urbanisation and the ecology of Powerful Owls (*Ninox strenua*) in outer Melbourne, Victoria. In: Newton, I., Kavanagh, R., Olsen, J. & Taylor, I. (Eds). *Ecology and Conservation of Owls*, pp. 100–106. CSIRO Publishing, Melbourne.
- Cooke, R., Wallis, R. & White, J. (2002b). Use of vegetative structure by Powerful Owls in outer urban Melbourne, Victoria, Australia – implications for management. *Journal of Raptor Research* **36**, 294–299.
- Cooke, R., Wallis, R., Hogan, F., White, J. & Webster, A. (2006). The diet of Powerful Owls (*Ninox strenua*) and prey availability in a continuum of habitats from disturbed urban fringe to protected forest environments in south-eastern Australia. *Wildlife Research* **33**, 199–206.
- Cooper, R.P. (1964). The Powerful Owl in the Royal Botanic Gardens, Melbourne. *Australian Bird Watcher* **2**, 108–111.
- Debus, S. (2009). *The Owls of Australia: A Field Guide to Australian Night Birds*. Envirobook, Sydney.

- Debus, S.J.S. & Chafer, C.J. (1994). The Powerful Owl *Ninox strenua* in New South Wales. *Australian Birds* **28** (Supplement), S21–S38.
- DEC (2006). *NSW Recovery Plan for the Large Forest Owls: Powerful Owl (Ninox strenua), Sooty Owl (Tyto tenebricosa) and Masked Owl (Tyto novaehollandiae)*. Department of Environment & Conservation, Sydney.
- Fitzsimons, J.A. & Rose, A.B. (2010). Diet of Powerful Owls *Ninox strenua* in inner city Melbourne parks, Victoria. *Australian Field Ornithology* **27**, 76–80.
- Fleay, D. (1944). Watching the Powerful Owl. *Emu* **44**, 97–112.
- Fleay, D. (1968). *Nightwatchmen of Bush and Plain*. Jacaranda Press, Brisbane.
- Higgins, P.J. (Ed.) (1999). *Handbook of Australian, New Zealand & Antarctic Birds, Volume 4: Parrots to Dollarbird*. Oxford University Press, Melbourne.
- Hogan, F.E. & Cooke, R. (2010). Insights into the breeding behaviour and dispersal of the Powerful Owl (*Ninox strenua*) through the collection of shed feathers. *Emu* **110**, 178–184.
- Hollands, D. (1984). *Eagles, Hawks and Falcons of Australia*. Nelson, Melbourne.
- Hollands D. (1991). *Birds of the Night*. Reed, Sydney.
- Hollands D. (2008). *Owls, Frogmouths and Nightjars of Australia*. Bloomings Books, Melbourne.
- Isaac, B., Cooke, R., Simmons, D. & Hogan, F. (2008). Predictive mapping of Powerful Owl (*Ninox strenua*) breeding sites using Geographical Information Systems (GIS) in urban Melbourne, Australia. *Landscape and Urban Planning* **84**, 212–218.
- Kavanagh, R.P. (1988). The impact of predation by the Powerful Owl, *Ninox strenua*, on a population of the Greater Glider, *Petauroides volans*. *Australian Journal of Ecology* **13**, 445–450.
- Kavanagh, R.P. (1997). Ecology and Management of Large Forest Owls in South-eastern Australia. PhD thesis. University of Sydney, Sydney.
- Kavanagh, R.P. (2002). Comparative diets of the Powerful Owl (*Ninox strenua*), Sooty Owl (*Tyto tenebricosa*) and Masked Owl (*Tyto novaehollandiae*) in southeastern Australia. In: Newton, I., Kavanagh, R., Olsen, J. & Taylor, I. (Eds). *Ecology and Conservation of Owls*, pp. 175–191. CSIRO Publishing, Melbourne.
- Kavanagh, R.P. (2004). Conserving owls in Sydney's urban bushland: Current status and requirements. In: Lunney, D. & Burgin, S. (Eds). *Urban Wildlife: More than Meets the Eye*, pp. 93–108. Royal Zoological Society of New South Wales, Sydney.
- Lavazanian, E., Wallis, R. & Webster, A. (1994). Diet of Powerful Owls (*Ninox strenua*) living near Melbourne, Victoria. *Wildlife Research* **21**, 643–646.
- McAllan, I.A.W. & Larkins, D. (2005). Historical records of the Powerful Owl *Ninox strenua* in Sydney and comments on the species' status. *Australian Field Ornithology* **22**, 29–37.
- McNabb, E. (1994). The successful rehabilitation of two Powerful Owl fledglings. *Australian Bird Watcher* **15**, 287–297.
- McNabb, E. (1996). Observations on the biology of the Powerful Owl in southern Victoria. *Australian Bird Watcher* **16**, 267–295.
- McNabb, E. & Greenwood, J. (2011). A Powerful Owl disperses into town and uses an artificial nest-box. *Australian Field Ornithology* **28**, 65–75.
- Menkhorst, P., Buckingham, R. & Loyn, R. (2005). Diet of the Powerful Owl roosting in the Royal Botanic Gardens, central Melbourne. *Australian Field Ornithology* **22**, 83–87.
- Morrison, D.W. (1980). Foraging and day-roosting dynamics of canopy fruit bats in Panama. *Journal of Mammalogy* **61**, 20–29.
- Olsen J. (2011). *Australian High Country Owls*. CSIRO Publishing, Melbourne.
- Olsen J. (2014). *Australian High Country Raptors*. CSIRO Publishing, Melbourne.
- Olsen, J., Fuentes, E., Rose, A.B. & Trost, S. (2006). Food and hunting of eight breeding raptors near Canberra, 1990–1994. *Australian Field Ornithology* **23**, 77–95.
- Olsen, J., Judge, D., Trost, S., Rose, A.B., Flowers, G., McAuliffe, J., Lawrence, R. & Maconachie, M. (2011). Powerful Owl *Ninox strenua* diet from two sites in the Australian Capital Territory. *Australian Field Ornithology* **28**, 120–128.

- Olsen, J., Judge, D., Trost, S. & Rose, A.B. (2013). Does the relative abundance of large versus small arboreal marsupials determine sexual dimorphism in Powerful Owls? *Australian Field Ornithology* **30**, 22–39.
- Olsen J., Trost, S. & Rose, A.B. (2008). Southern Boobook *Ninox novaeseelandiae* pair feeding two broods of fledglings. *Australian Field Ornithology* **25**, 12–21.
- Pavey, C.R. (1995). Food of the Powerful Owl (*Ninox strenua*) in suburban Brisbane, Queensland. *Emu* **95**, 231–232.
- Pavey, C.R. & Smyth, A.K. (1998). Effects of avian mobbing on roost use and diet of Powerful Owls, *Ninox strenua*. *Animal Behaviour* **55**, 313–318.
- Pavey, C.R., Smyth, A.K. & Mathieson, M.T. (1994). The breeding season of the Powerful Owl *Ninox strenua* at Brisbane, Queensland. *Emu* **94**, 278–284.
- Phillips, D.J., Olsen, P.D., Rentz, D.C.F. & Lawrence, J. (1991). Observations on the diet of the Christmas Island Hawk-Owl *Ninox squamipila natalis*. *Emu* **91**, 250–251.
- Rose, A.B. (1993). Notes on the Powerful Owl in New South Wales. *Australian Birds* **26**, 134–136.
- Schulz, M. (1997). The diet of the Powerful Owl *Ninox strenua* in the Rockhampton area. *Emu* **97**, 326–329.
- Seebeck, J.H. (1976). The diet of the Powerful Owl *Ninox strenua* in western Victoria. *Emu* **76**, 167–170.
- Soderquist, T. & Gibbons, D. (2007). Home-range of the Powerful Owl (*Ninox strenua*) in dry sclerophyll forest. *Emu* **107**, 177–184.
- Southern, H.N. (2008). Prey taken by Tawny Owls during the breeding season. *Ibis* **111**, 293–299.
- Stanton, M.A. (2011). Barking Owl Diet in the Pilliga Forests of Northern New South Wales. MSc thesis. University of New England, Armidale, NSW.
- Tilley, S. (1982). The diet of the Powerful Owl, *Ninox strenua*, in Victoria. *Australian Wildlife Research* **9**, 157–175.
- Trail, B.J. (1993). The diet and movements of a pair of Powerful Owls *Ninox strenua* in dry eucalypt forest. In: Olsen, P.D. (Ed.). *Australian Raptor Studies*, pp. 155–159. Australasian Raptor Association, Royal Australasian Ornithologists Union, Melbourne.
- Trost, S. & Olsen, J. (2013). Fostering an already-fledged Southern Boobook. *Boobook* **31**, 13–14.
- Wallis, R., Cooke, R. & Webster, A. (1998). Diet of Powerful Owls *Ninox strenua* in the Yarra Valley, Victoria. *Australian Bird Watcher* **17**, 395–397.
- Webster, A., Cooke, R., Jameson, G. & Wallis, R. (1999). Diet, roosts and breeding of Powerful Owls *Ninox strenua* in a disturbed, urban environment: A case for cannibalism? Or a case for infanticide? *Emu* **99**, 80–83.