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Influence of hunting grounds on prey taken in adjacent territories of breeding Southern Boobooks *Ninox boobook* in the Australian Capital Territory

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This study presents the first evaluation of the effects of location of hunting grounds on dietary composition of breeding Southern Boobooks *Ninox boobook*, as a part of our long-term monitoring program. We divided a set of adjacent breeding territories into two groups: owls hunting in city suburbs, parks and urban areas (Suburb hunters); and owls hunting in forest inside Nature Reserves (Wild hunters). Suburb hunters relied more on birds (53% biomass contribution) and mammals (22.6%), whereas for Wild hunters prey biomass came mostly from the combination of birds (43.1%) and invertebrates (42.8%). For owls in both habitat classes, insects and arachnids dominated the breeding diet numerically, but by biomass vertebrates dominated. Overall Geometric Mean Prey Weight (GMPW) (1.6 and 1.9 g), and mammalian GMPW (20.5 and 20.8 g), were similar across hunting areas, although mammalian species composition differed because Suburb hunters captured more rodents and introduced species and wild hunters captured more native mammals. Also, avian GMPW was higher in suburban owl territories (51.8 g) than in bushland territories (29.8 g), reflecting the mid-sized common urban birds taken by suburban owls. Although suburban territories had higher dietary diversity, both areas showed high diversity index values.

Keywords: Southern Boobooks, Ninox boobook, foraging, hunting location, diet

INTRODUCTION

The Southern Boobook *Ninox boobook* is one of the most widespread owls on the Australian mainland, where it is the smallest owl and has a varied diet of vertebrates and invertebrates (e.g. Olsen 2011). Relevant background information on the ecology of this owl is given elsewhere (Olsen *et al.* 2008, 2010, 2011, 2013, 2020, 2023). A long-term study on the diet of the Southern Boobook around Canberra, Australian Capital Territory, examined aspects of dietary composition in relation to stages of the owls' annual cycle (e.g. breeding vs non-breeding season) and trends over almost three decades (Olsen *et al.* 2023). Southern Boobooks hunt in woodland and forest (Olsen *et al*. 2006) and in suburban areas (Olsen and Taylor 2001; Olsen *et al.* 2002). Although the diet of the species has been well described in the study area (Olsen *et al.* 2006, 2023; Trost *et al*. 2008), there is no published information on the influence of different hunting grounds on the diet of the species. The aim of this study is to analyse and compare the dietary composition of adjacent territories of Southern Boobooks hunting over two different areas: inside dense forested areas in Canberra Nature Park versus within the city suburbs in Canberra during the 1993–2019 period.

STUDY AREA AND METHODS

The study was conducted inside the Canberra city limits. A description of the study area, territories, nests and roosts; trapping, banding, tagging and identification of individuals; food collection, prey identification process and prey calculation, including wastage factors, minimum number of prey items (MNI), dietary mass, geometric mean prey weights (GMPW) and dietary niche metrics (Shannon Diversity, Evenness and Pianka Indices), can be found elsewhere (Olsen *et al.* 2020, 2023). We selected eleven territories that were regularly followed during the breeding season, since the birds were colour-banded or radio-tagged, and thus we knew where these pairs hunted. We divided the pellet collections and data into two groups: (1) Suburb hunters: owls that hunted inside suburbs, mostly from the edge of a wooded area in open spaces near houses, and also on urban parks and sports grounds; and (2) Wild hunters: owls that hunted in denser forests and wooded areas inside Canberra Nature Park, specifically Black Mountain, Aranda Bushland and Bruce Ridge Nature Reserves.

A total of 1,713 prey items were identified from six Suburb hunters' territories in a sample of 30 nest-years spanning the 1993 to 2019 breeding seasons. A sample of 1,974 prey items was collected from five Wild hunters' territories for a total of 25 nest-years over the 1993–2010 period. Pellets and prey remains were analysed by A.B. Rose (former Associate, Australian Museum) for the 1993 to 2010 samples, and by Georgeanna Story (www.scatsabout.com.au) for the 2011–12 samples, as previously described (Olsen *et al.* 2023). These dietary samples were reanalysed, by nest-site location, and are a subset from the breeding-season data of Olsen *et al.* (2023). Differences

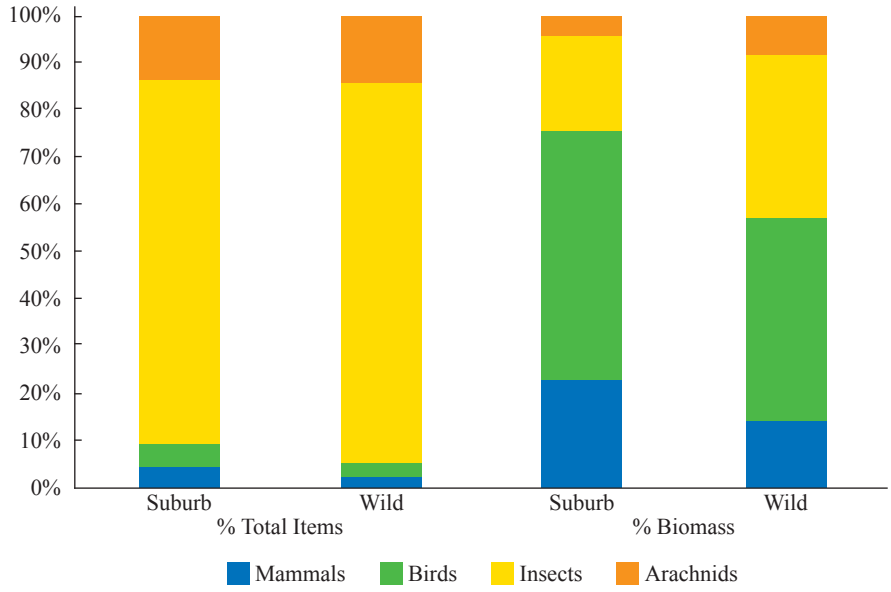

Figure 1. *Diet of breeding Southern Boobooks hunting inside suburban areas (Suburb) and inside forests on Canberra Nature Park (Wild), 1993–2019, expressed as % of the MNI and % biomass.*

Table 1

GMPW (g) of total, mammalian and avian prey for breeding Southern Boobooks in the 1993–2019 period hunting in wild and suburb territories in Canberra, ACT.

Hunting Grounds	GMPW Total	Mammalian	Avian
Wild Hunters	1.6	20.5	29.8
Suburb Hunters	1.9	20.8	51.8

in the proportion of prey captured between the two sites were analysed via Chi-square tests (Zar 1984). For this analysis, prey was assigned to four categories (Mammals, Birds, Insects and Arachnids). There were only three items outside these categories, two reptiles and one millipede, out of 3,687 total prey items, and these were omitted from the subsequent analysis. Shannon Diversity Index was analysed using a Hutchenson T-test specifically designed for this index (Hutchenson 1970; also see Data Analytics UK 2022). GMPW was compared using General Linear Models (GLM). All analysis were performed in SAS OnDemand and R-Studio 4.1.1.

RESULTS

Overall, dietary contribution of the major taxa was significantly different between Suburb and Wild hunters (χ^2 = 27.2, d.f. = 3, P < 0.001; Fig. 1), although not strongly so in all prey categories. Suburb hunters captured more birds (Suburb 4.9% vs Wild 3.0%) and mammals (4.4% vs 2.0%). Insects dominated the diet by number (77.2% vs 80.3%). The biomass contribution of these taxa was also different, with Suburb hunters obtaining more biomass from birds (53.2% vs 43.0%) and mammals (22.6% vs 14.1%) than Wild hunters. On the other hand, invertebrate contribution to biomass was lower for Suburb hunters, both in insects (19.9% vs 34.6%) and arachnids (4.3% vs 8.2%). Invertebrate prey where this trend was particularly marked were locusts (0.02 vs 0.3% total biomass), grasshoppers (1.3 vs 2.6%), Christmas beetles (2.8 vs 5.5%), longicorn beetles (0.8 vs 3.2%), moths (2.7 vs 5.6%), wolf spiders (3.8 vs 6.7%) and huntsman spiders (0.3 vs 1.0%).

Full GMPW was significantly different between areas (Table 1; F = 14.4; df = 1; P <0.001); however, this result was obscured by a significant interaction between hunting grounds and taxonomic group (F = 7.8; df = 3; P <0.001). The exploration of this interaction showed that Suburb hunters captured larger birds than their Wild counterparts (Table 1; Bonferroni Correction; P <0.001 <0.006). The most common prey species was Eastern Rosella *Platycercus eximius* (n = 13; total biomass 12.1 %, bird biomass 22.7 %). Other large species taken were Crimson Rosella *P. elegans*, Crested Pigeon *Ocyphaps lophotes* and Common Myna *Acridotheres tristis*. There was no difference in mammal GMPW (Table 1; Bonferroni Correction; P = 0.737 >0.006). Species composition was different though, because Wild hunters were the only ones capturing Sugar (Krefft's) Gliders *Petaurus notatus*, whereas Suburb hunters were the only ones capturing Bush and (adult) Black Rats *Rattus fuscipes* and *R. rattus* (and one juvenile European Rabbit *Oryctolagus cuniculus*). Also, Suburb hunters took double the amount of House Mice *Mus musculus* (n = 44, 2.6% MNI, 6.4% biomass vs n = 23, 1.2% MNI, 5.3% biomass for Wild hunters). Likewise, Wild hunters were recorded taking only Gould's Wattled Bats *Chalinolobus gouldii*, whereas Suburb hunters took bats from five different species.

The Shannon Diversity Index was significantly higher for Suburb hunters (Suburb 2.78, Wild 2.63: t = 3.73, d.f. = 3440, P <0.001). Evenness Index was similar for both areas (Suburb 0.64, Wild 0.63). The dietary overlap of the two areas was high (Pianka Index 0.96), but it decreased considerably when biomass overlap was calculated (0.62).

DISCUSSION

Boobooks from the different foraging areas captured very different mammal species. Wild hunters were the only ones that preyed on Krefft's Gliders, whereas Suburb hunters were the only ones capturing Black and Bush Rats (also one rabbit) for similar values of GMPW since owls from each area were hunting at least one type of "large" mammal. Similar differences regarding species composition of mammalian prey were found for bats. Differences in prey profile between the two habitat classes are probably related to differences in the availability and life habits of the various prey types in the suburbs versus bushland. For instance, we regularly observed Suburb hunters foraging on open areas (parking lots, parks, sports grounds), particularly near lights, where many insect species aggregate, and so do bats foraging on them.

Regarding avian prey, both rosella species, Crested Pigeons and Common Mynas are among the most frequently recorded bird species in the Canberra Ornithological Group's annual bird reports (ACT Garden Bird Survey indices), published in *Canberra Bird Notes* for the relevant years (http://canberrabirds.org.au/publications/canberra-bird-notes/). Sightings of Crested Pigeons and Crimson Rosellas almost tripled between 1991 and 2002, and Common Mynas had a six-fold increase through this period as well (Veerman 2003). In addition, both rosellas and mynas raise and fledge their young between October and March each year, with a marked peak in abundance around December–January (Veerman 2003), thus increasing the availability of this prey, particularly of young, inexperienced individuals dispersing through areas unknown to them. The importance of Psittaciformes in the diet of Australian raptors has been highlighted before (Fuentes *et al.* 2024) and this group was again of major importance on the breeding diet of Boobooks, particularly at Suburban nests.

The main biomass contribution for Suburb hunters came from birds and mammals, whereas Wild hunters relied more on birds and invertebrates. This difference highlights the importance of large avian prey for breeding Boobooks (Olsen *et al.* 2023), but also how there are different supplementation strategies that depend on many factors, such as foraging grounds (this study), which relates to prey availability; but also other factors such as female food supplementation or brood size (Olsen *et al.* 2023).

Although Suburb hunters had a more diverse diet, both groups had high dietary diversity, over 2.6 for the Shannon Index, which is high compared to other studies of the species, and also to other raptor species with similar foraging habits (i.e. Collared Sparrowhawk *Accipiter cirrocephalus*). This high dietary diversity is also characteristic of most species of the Canberra raptor guild (Fuentes *et al.* 2024). There is evidence that high dietary diversity in generalist and opportunist predators often occurs when there is an abundant prey base, and is also related to fragmented landscapes and ecotones, where species richness is higher (Piana and Mardsen 2012). Both situations apply to the present study.

The urban contribution of introduced rats is common even in Powerful Owls *Ninox strenua* living in some Australian cities (Menkhorst *et al.* 2005; Fitzsimons and Rose 2010), although there are no other comprehensive studies documenting the diet of urban Boobooks for comparison. *Tyto* owls, being mammal specialists, also prey on rats in Australian cities (Kavanagh and Murray 1996; Mo 2019).

In connection with this dietary aspect, the occurrence of a Bush Rat and several bat species in the diet of Suburb owls suggests that the owls sometimes foraged in bushland edge habitat and suburban native vegetation that attracts those prey species. The increased consumption of Black Rats and arachnids during the more recent time period (Olsen *et al.* 2023) may be attributable to (i) a decline in insect abundance in recent years (e.g. Debus *et al.* 2020) and (ii) a possible increase in urban rodent populations; however, the use of second-generation anticoagulant rodenticides to control urban rodents may be adversely affecting Boobooks that live near human settlements (Lohr 2018; Cooke *et al.* 2022). By their dietary association with exotic rodents and their habitat and food-chain associations with domestic, stray and feral Cats *Felis catus*, Boobooks are also susceptible to toxoplasmosis infection (Lohr *et al.* 2020). Further studies should explore how the effect of competition for food and habitat, as well as intra-guild predation, relate to nesting success since there is evidence of this ecological pressure on Boobooks (Fuentes *et al.* 2024). Also, the importance of some species that often do not show up in pellet and prey remain analysis need to be considered, as is the case of geckos (Gekkonidae) for Canberra Boobooks (Olsen *et al.* 2023), which never showed in pellets or prey remains in more than 30 years of the study, but were often registered on camera traps and observed in prey deliveries.

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REFERENCES

Cooke, R., Whiteley, P., Jin, Y., Death, C., Weston, M. A., Carter, N., and White, J. G. (2022). Widespread exposure of powerful owls to second-generation anticoagulant rodenticides in Australia spans an urban to agricultural and forest landscape. *Science of the Total Environment* **819**: 153024.

Data Analytics UK (2022). Comparing ecological diversity. dataanalytics.org.uk/comparing-diversity

Debus, S. J. S., Olsen, J., Trost, S. and Judge, D. (2020). Diet of the Australian Hobby *Falco longipennis* breeding in Canberra, Australian Capital Territory, in 2002–04 and 2005–08. *Australian Field Ornithology* **37**: 174–183.

Fitzsimons, J. A. and Rose, A. B. (2010). Diet of Powerful Owls *Ninox strenua* in inner city Melbourne parks, Victoria. *Australian Field Ornithology* **27**: 76–80.

Fuentes, E., Olsen, J. and Debus, S. J. S (2024). Feeding ecology of the raptor guild of the Canberra Region. *Corella*: **48**: 1– 23.

Hutchenson, K.A. (1970). A test for comparing diversities based on the Shannon formula. *Journal of Theoretical Biology* **29**: 151–154.

Kavanagh, R. P. and Murray, M. (1996). Home range, habitat and behaviour of the Masked Owl *Tyto novaehollandiae* near Newcastle, New South Wales. *Emu* **96**: 250–257.

Lohr, M. T. (2018). Anticoagulant rodenticide exposure in an Australian predatory bird increases with proximity to developed habitat. *Science of the Total Environment* **643**: 134–144.

Lohr, M. T, Lohr, C. A., Burbidge, A. H. and Davis, R. A. (2020). *Toxoplasma gondii* seropositivity across urban and agricultural landscapes in an Australian owl. *Emu* **120**: 75–285.

Menkhorst, P., Buckingham, R. and Loyn, R. (2005). Diet of a Powerful Owl roosting in the Royal Botanic Gardens, central Melbourne. *Australian Field Ornithology* **22**: 83–87.

Mo, M. (2019). Occurrence of the Eastern Barn Owl *Tyto alba delicatula* in the Centennial Parklands, Sydney. *Australian Field Ornithology* **36**: 56–59.

Olsen, J. (2011). *Australian High Country Owls*. CSIRO Publishing, Melbourne.

Olsen, J., Downs, J. A., Tucker, T. and Trost, S. (2011). Home-range size and territorial calling of Southern Boobooks (*Ninox novaeseelandiae*) in adjacent territories. *Journal of Raptor Research* **45**: 136–142.

Olsen, J., Fuentes, E., Rose, A. B. and 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. and Lisle, J. (2013). Prey deliveries at eight nests of the Southern Boobook *Ninox novaeseelandiae* in Canberra. *Corella* **37**: 7–12.

Olsen, J and Taylor, S. (2001). Winter home range of an adult female Southern Boobook *Ninox novaeseelandiae* near Parliament House, Canberra. *Australian Bird Watcher* **19**: 109–114.

Olsen, J., Trost, S., Fuentes, E. and Debus, S. (2020). Behaviour and family association during the post fledging period in Southern Boobooks *Ninox boobook*. *Corella* **44**: 61–70.

Olsen, J., Trost, S. and Hayes, G. (2002). Vocalisations used by Southern Boobooks *Ninox novaeseelandiae* in and adjoining Aranda Bushland, Canberra, Australia. In: *Ecology and Conservation of Owls* (eds I. Newton, R. Kavanagh, J. Olsen and I. Taylor). Pp. 305-319. CSIRO Publishing, Melbourne.

Olsen, J., Trost, S. and Judge, D. (2010). Calling behaviour of the Southern Boobook *Ninox novaeseelandiae* in relation to distance from their nest trees. *Corella* **34**: 11–13.

Olsen, J., Trost, S. and Rose, A. B. (2008). Southern Boobook *Ninox novaeseelandiae* pair feeding combined brood of six fledglings. *Australian Field Ornithology* **25**: 12–21.

Olsen, J., Trost, S., Rose, A.B., Fuentes, E. and Debus, S. (2023). Diet of Southern Boobooks *Ninox boobook* and its relationship with breeding in Canberra, Australian Capital Territory, 1993–2019. *Corella* **47**: 45–55.

Piana, R. P., and Mardsen, S. J. (2012). Diversity, community structure, and niche characteristics within a diurnal raptor assemblage of northwestern Peru. *Condor* **114**: 279–289.

Trost, S., Olsen, J., Rose, A. B. and Debus, S. J. S. (2008). Winter diet of Southern Boobooks *Ninox novaeseelandiae* in Canberra 1997–2005. *Corella* **32**: 66–70.

Veerman, P. (2003). *Canberra Birds: A report on the first 21 years of the Garden Bird Survey*. Canberra Ornithologists Group, Canberra.

Zar, J. H. (1984). *Biostatistical Analysis*. Prentice Hall, Englewood Cliffs, NJ, USA.