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Home-range, diet and breeding of a Powerful Owl *Ninox strenua* in East Gippsland, Victoria

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Summary. Between 2004 and 2008 the diet and breeding success of a pair of Powerful Owls *Ninox strenua* were studied near Lakes Entrance, Victoria. In early November 2006 the adult female Powerful Owl was captured and radio-tracked for a period of 7.5 months. During this time the Owl's location was recorded on 111 occasions, including 65 nocturnal locations over 29 nights. Her home-range was calculated as 1589 ha using the Minimum Convex Polygon (MCP) method, or 871 ha based on the 95% Adaptive Kernel method. The area of forested habitat within the MCP home-range was 896 ha (the remainder representing cleared land). Her activity was centred primarily on the nesting gully where two dependent juveniles roosted, but several long-distance foraging expeditions (including roosting) that occurred more than 2.5 km from the juveniles were recorded. Arboreal mammals and birds dominated the Owls' diet. Low prey availability is suggested as being responsible for the single successful breeding event recorded in four nesting seasons.

Introduction

The Powerful Owl *Ninox strenua* is a large, naturally uncommon, top-order predator that occupies a wide range of forest types in eastern Australia (Higgins 1999; Barrett *et al.* 2003). Despite being subject to numerous ecological studies investigating aspects such as diet, roosting, nesting, distribution and habitat occupation (e.g. Kavanagh 1997; Higgins 1999; Cooke 2000; Loyn *et al.* 2001; McIntyre & Henry 2002; Bilney *et al.* 2011a), there have been limited radio-tracking studies examining home-range size, movements and habitat usage (Kavanagh 1997; Cooke 2000; Soderquist & Gibbons 2007). Without this information our ability to apply appropriate conservation measures is limited.

This study investigated breeding success and diet for a pair of Powerful Owls, combined with the adult female's home-range movements.

Methods

Study site

The main study area was situated ~4 km north-west of Lakes Entrance, Victoria. The region comprises a matrix of continuous forest, cleared land and fragmented forest (incorporating private property and State Forest). The dominant vegetation types, based on Ecological Vegetation Classes, comprise Lowland Forest (dominated by White Stringybark *Eucalyptus globoidea,* Silvertop Ash *E. sieberi* and Mountain Grey Gum *E. cypellocarpa*), Limestone Box Forest (dominated by Blue Box *E. baueriana,* Coast Grey Box *E. bosistoana* and

Mountain Grey Gum*)*, Plains Grassy Forest (dominated by White Stringybark and Red Stringybark *E. macrorhyncha*), and Warm Temperate Rainforest (dominated by Lilly Pilly *Syzygium smithii* and Sweet Pittosporum *Pittosporum undulatum*). The area has been subjected to extensive selective logging in the past, resulting in low densities of large hollow-bearing trees persisting in the landscape. Elevation ranges from 5 to 100 m above sea-level.

Survey techniques

Between June 2004 and February 2008 the rainforest gully east of Harrisons Track, Lakes Entrance, was surveyed regularly (at least every 3 months) by walking the gully, searching for signs of roosting Powerful Owls. Roosting sites were identified, and regurgitated pellets were collected for dietary analysis. Breeding behaviour and outcomes were monitored, primarily by listening surveys at dusk conducted during winter and early spring.

Dietary remains were identified principally from skeletal remains contained within regurgitated pellets, but for mammalian remains with insufficient skeletal material, hair was identified microscopically as described by Brunner & Coman (1974). Bird remains in pellets were not identified to species; instead, they were identified from observations of Owls holding prey at their roost or from feathers collected beneath roosting sites.

Owl capture technique

The owl capture technique involved broadcasting pre-recorded Powerful Owl calls through a megaphone to provoke the Owl to fly towards the megaphone, where a 10 × 12 m net suspended in the canopy was used to intercept its flight-path (Kavanagh 1997; Soderquist & Gibbons 2007; Bilney *et al.* 2011b). Although playback was broadcast only through one megaphone at a time, three megaphones were positioned around the net: one directly below, and two perpendicular (~15 m either side of the net) to direct the Owl into the net. On capture, the net was immediately lowered to the ground so that the Owl could be processed and a radio-transmitter attached. A Titley Electronics (Ballina, NSW) 25-g radio-transmitter (GPI-16MS2) was attached to the bird, using a backpack weak-link harness arrangement (see Karl & Clout 1987).

Radio-telemetry

Owl locations were triangulated from compass bearings at three locations (within 10 min.) using a three-element Yagi aerial and Telonics (Tr-2) radio-receiver. A minimum of one and maximum of five location fixes of the Powerful Owl were taken in any one night, whereas only one roosting record was conducted per day. All nocturnal location fixes were taken at a time interval of greater than 1 h. Roosting sites were located either by triangulation or by following the signal and observing the Owl at its roost (visual inspection was rarely conducted, due to the risk of flushing the Owl). Roosting sites of juveniles were located either by hearing their initial calls at dusk or observing them at roosting sites near the female.

Home-range analysis

Two techniques were used to calculate the Owl's home-range, being the 100% Minimum Convex Polygon (MCP) method and the Adaptive Kernel (AK) method using 95%, 75% and 50% isopleths, calculated using Biotas v 1.03 (Ecological Software Solutions, see www.ecostats.com) home-range analysis software.

Results

Breeding

In 2004 the pair was heard courting and attempted to breed, yet breeding appeared to be unsuccessful and the nest-site was not located. In mid August 2005 the adult

female and a nestling were heard calling from within a hollow of a Mountain Grey Gum. Subsequent visits to the nest in the weeks after failed to detect any sign of a fledgling, despite diurnal and dusk surveys and adults being observed (earliest fledging usually occurs in early September, with adults roosting close to fledglings: Bilney *et al.* 2011a). The most likely scenario was that the nestling had died before fledging. With no evidence that fledging had occurred, breeding was therefore considered unsuccessful. In 2006 the Powerful Owls nested in another Mountain Grey Gum ~250 m from the 2005 nest, and two juveniles fledged (in approximately early October). In 2007 the Owls again failed to breed, despite attempting to do so (courting behaviour observed), and in 2008 they appeared to have vacated the gully and breeding success was unknown.

Diet

A total of 125 prey items was detected in Powerful Owl regurgitated pellets collected between 6 June 2004 and 9 January 2008. Mammals comprised 63% of the Owls' diet, including Sugar Gliders *Petaurus breviceps* 30%, Greater Gliders *Petauroides volans* 21%, Common Ringtail Possums *Pseudocheirus peregrinus* 6.4%, brushtail possums *Trichosurus* spp. 4.8% and Yellow-bellied Gliders *Petaurus australis* 1.6%. Birds constituted 37% of the diet and, although a quantified analysis of bird prey was not conducted, the predominant species were Pied Currawong *Strepera graculina*, Tawny Frogmouth *Podargus strigoides*, Laughing Kookaburra *Dacelo novaeguineae*, Gang-Gang Cockatoo *Callocephalon fimbriatum*, Australian Magpie *Cracticus tibicen* and Magpie-lark *Grallina cyanoleuca* (the open-country species possibly taken at roosts in forest). A total of 1.6% of pellets contained invertebrate material.

Radio-tracking

On 10 November 2006 an adult female Owl weighing 1340 g was captured ~750 m south of the 2006 nest-site. She had two recently fledged dependent young.

Home-range

A total of 111 location fixes of the Powerful Owl was obtained, with 65 nocturnal locations recorded from 29 nights and 46 diurnal roosting locations over a 7.5-month period. The last location fix of the female was on 24 June 2007, and it appeared likely that the transmitter failed prematurely or was damaged by the Owl. The female was observed roosting on several occasions following transmitter failure, and the harness and transmitter could not be seen attached to the bird.

The Powerful Owl's home-range during this time was calculated as 1589 ha based on the 100% MCP method, or 871 ha using the 95% AK method. Approximately 56% (or 896 ha) of the MCP home-range was forested, and all location fixes of the Owl were within forested habitat (Figure 1). The 75% and 50% AK isopleths were 228 and 88 ha respectively, and centred on the gully where the nest-tree was located and where the two juveniles were observed roosting. The maximum distance across the home-range was 6247 m, and 6176 m between roosting sites.

In the 8-week period before 8 January 2007, the female typically roosted 5–20 m from the juveniles, rarely more than a few hundred metres away, and only twice

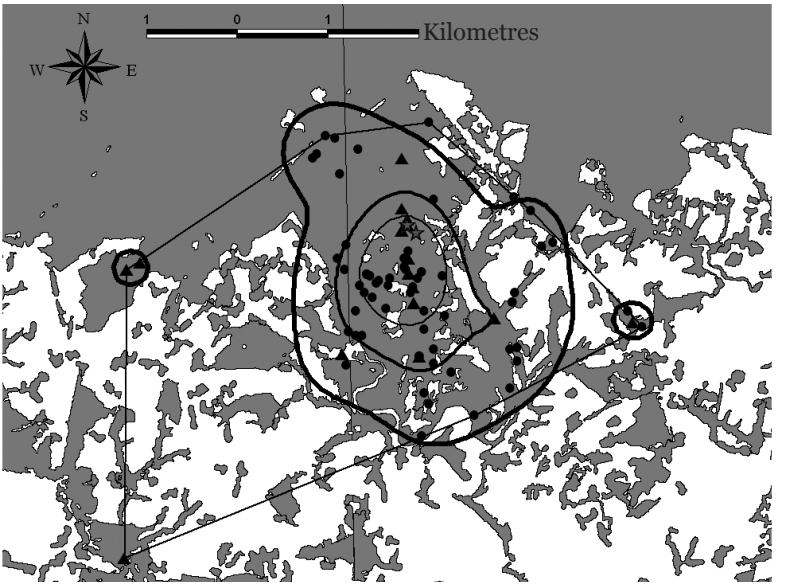

Figure 1. Size and shape of the home-range of a female Powerful Owl near Lakes Entrance, Victoria. The 100% Minimum Convex Polygon home-range is outlined by the narrow straight black line; the 95%, 75% and 50% Adaptive Kernel isopleths are represented by the dark curved outlines ranging from broad through medium to narrow, respectively. Nocturnal locations of the Owl are represented by black dots, roosting sites by black triangles and nest locations by stars. Forest is represented by light-grey shading, and cleared land is white.

(from 24 observations) was she noted >1 km away (the roosting locations of the male were unknown during this time). Her MCP home-range during this time was only 370 ha (from 24 roosting events and 22 foraging locations over 12 nights). In a ~5-week period from 8 January 2007 to 15 February 2007, she began to range farther away from the juveniles (occasionally roosting up to 2.5–3.1 km away), and her home-range size steadily increased to 1069 ha (from a further nine roosting events and 20 foraging locations over eight nights). Only one more recorded long expedition to the south-west, in early May, extended her MCP home-range beyond this size.

After fledging, the juveniles stayed close to the nest-tree, roosting in the rainforest gully nearby, and over time tended to slowly move south, down the rainforest gully away from the nest. The farthest from the nest that they were observed was 1.3 km away, but they spent most of the time ~500–750 m south of the nest. They were seen or heard only in the gully or on the slopes immediately surrounding the gully. They were last heard (begging trill) in late March, and around this date became difficult to identify as their plumage began to resemble that of the adults.

Roosting

The female Powerful Owl roosted predominantly (78% of occasions) in the rainforest gully close to where the nest was located, and where the juveniles

roosted. Because of the inaccuracy of vegetation mapping in the area, it was difficult to determine the habitat type in which the Owl roosted on five occasions, but on the 41 occasions where her roosting habitat was known, she roosted in a gully either in or exceptionally close to rainforest.

Discussion

Information from a limited number of radio-tracked Powerful Owls has revealed that home-range size can vary considerably, with figures ranging from 311 to 4774 ha or potentially larger, being influenced by many factors including breeding status, age, sex, prey availability (or habitat quality), degree of forest fragmentation, duration of radio-tracking study and method of calculating home-range size (Kavanagh 1997; Cooke 2000; Soderquist & Gibbons 2007; McNabb & McNabb 2011). It is therefore important that the home-range size of the Powerful Owl in this study is considered in the context of these issues.

Firstly, the estimates of home-range size varied widely between the methods of calculation. This variation is primarily related to the 100% MCP calculation incorporating several long-distance movements that were located outside the core area used in the calculation of the 95% AK. This variation may also have been influenced by the degree of forest fragmentation. As the Powerful Owl is dependent on forest, the degree of fragmentation is likely to significantly influence home-range size (as seen in other owl species, e.g. Carey *et al.* 1992). When the amount of cleared land is subtracted from the 100% MCP calculation, this figure (896 ha) is more likely to accurately reflect the amount of habitat available within the Owl's home-range, and is therefore possibly a more suitable measure of home-range size.

Breeding status appeared to significantly influence home-range size. For the first ~8 weeks of this radio-tracking study (until 8 January 2007), the localised movements of the female Powerful Owl support the findings of Kavanagh (1997) and Cooke (2000) that breeding females tend to stay close to the nest and dependent juveniles (probably the core territory) for several months after fledging, rarely venturing farther away than 500 m. The home-range size calculated by Kavanagh (1997) during the time period of late August until late November was 311–352 ha. By early January in the present study the home-range size began increasing significantly (~3 months after young fledged), which correlates with similar observations by Cooke (2000) where movements of a breeding female increased significantly, starting in mid February (travelling up to ~1400 m from the nest area). This finding suggests that females may spend several (3–4) months within close proximity of fledged dependent juveniles, and that for 7–9 months the home-ranges of breeding females may be highly localised around the nest area (Higgins 1999; Cooke 2000). After juvenile independence, the home-range movements may be further influenced by pre-breeding behaviour and pair-bonding leading up to the next breeding season. The home-range size of a female is therefore likely to be much larger during the non-breeding season or if breeding fails, because her movements will not be concentrated around a nest. The 100% MCP home-range size for non-breeding females has previously been calculated

for three individuals, ranging between 808 and 4774 ha in the short term (4–7 months) (Kavanagh 1997; Soderquist & Gibbons 2007).

Habitat quality and prey availability can also influence home-range size of owls (Carey *et al.* 1992; Zabel *et al.* 1995), and were likely to be a major influence on the female Powerful Owl's home-range size in this study. Although no assessment of habitat quality or density of arboreal mammals was conducted during this study, the forest has been subjected to a long history of selective logging, and the density of hollow-bearing trees appears low (most hollow trees being near riparian habitats), suggesting that density of mammals is also likely to be low (typically the density of arboreal mammals is correlated with the density of hollows, e.g. Smith & Lindenmayer 1988; Lindenmayer *et al.* 1990). The high proportion of bird prey in this study also suggests that arboreal mammals may have had low densities, because they usually dominate the Owl's diet (Kavanagh 2002; Bilney *et al.* 2011a). However, fragmented forest near urban areas (with forest, paddocks and forest edges) provides suitable conditions for many bird prey species (e.g. Pied Currawong, Australian Magpie, Magpie-lark: Higgins *et al.* 2006), so that the high consumption of bird prey may be from both low mammal densities and higher bird densities. The poor breeding success for this pair during the four breeding seasons is also likely to be a function of low prey availability (especially of mammals of suitable sizes), which was considered responsible for the low breeding success of several other pairs of Powerful Owls nearby (Bilney *et al.* 2011a).

Without detailed information about the Powerful Owl's home-range and habitat utilisations, our ability to apply appropriate conservation measures is likely to be limited (e.g. Webster *et al.* 1999; Loyn 2004). Importantly, there is a pressing need to investigate home-range and habitat use by both male and female Powerful Owls in the breeding and non-breeding seasons in contiguous forested ecosystems, especially over the long term. Long-term studies are important, owing to the ability of pairs of Owls to exert considerable impacts on prey population densities (Kavanagh 1988). Therefore, the Owls potentially require large home-ranges in the long term to incorporate areas of both high and low prey availability, so that they can shift foraging areas and so that depleted prey populations can recover.

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