Canid predation: a potentially significant threat to relic populations of the Inland Carpet Python *Morelia spilota metcalfei* (Pythonidae) in Victoria

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### Abstract

In Victoria’s contemporary rural environments, introduced predators may represent the principal predatory threat to many large, non-venomous reptile species. We present circumstantial evidence that introduced canids are predators of the Inland Carpet Python *Morelia spilota metcalfei*, using data collected during a radio-telemetric study of the sub-species’ ecology across northern Victoria. Seven pythons (23% of those tracked) were killed by predators during the study, and evidence collected during transmitter retrieval suggested that foxes or wild dogs were involved in six of these cases (the seventh having been eaten by a goanna). Evidence includes the recovery of transmitters from fox den sites, their partial burial in several cases (consistent with caching behaviour) and damage to each transmitter consistent with chewing by a fox or dog (teeth marks in the silicon coating, puncture of the metal housing). Given the abundance of canids (specifically foxes) within these study sites, their ability to prey on carpet pythons, and evidence of their involvement with these predation events, we conclude that canid predation was the primary cause of death for each of these six snakes, and represents a potentially significant issue for carpet python conservation in Victoria. Suggestions for canid control programs and habitat management to minimise this threat to remaining populations of this endangered snake are offered. (*The Victorian Naturalist* 123 (2) 2006, 68-74)

### Introduction

The Inland Carpet Python *Morelia spilota metcalfei* (Pythonidae) is a large (to 3 m total length), semi-arboreal snake that is distributed widely across the Murray Darling Basin of south-eastern Australia (Barker and Barker 1994; Greer 1997). In Victoria, the sub-species is considered endangered (DSE 2003) and restricted to the woodland habitats of the northern plains, primarily those associated with watercourses (River Red Gum *Eucalyptus camaldulensis* or Black Box *E. largiflorens* woodland) or prominent granite outcrops (Coventry and Robertson 1991; Allen et al. 2003). Apparent declines in the sub-species’ Victorian range have been attributed primarily to habitat alterations; however, predation by introduced mammals has also been cited as a potentially threatening process (Allen et al. 2003). This snake may be particularly vulnerable to exotic predators: it is relatively slow moving, non-venomous, and inhabits inland regions of southern Australia where introduced predators can be abundant and ubiquitous across habitats (Newsome et al. 1997).

In this paper, we present circumstantial evidence that these pythons are vulnerable to predation by introduced canids (primarily the Red Fox *Vulpes vulpes* but potentially also Wild Dogs *Canis familiaris*). Specifically, we detail evidence that canids killed the majority of carpet pythons lost to predation during a radio-telemetric study of the sub-species’ ecology conducted across Victoria’s northern plains between 1997 and 2002.

### Methods

#### Study areas

Pythons were radio-tracked in nine study areas, spanning three regions of northern Victoria (Fig. 1). In the north-east, 17 snakes were tracked in three study sites...
either within, or adjacent to, the Warby Range State Park, including Mt Killawarra (36°15'N, 146°11'E), Mt Bruno (36°19'N, 146°09'E) and Boweya (36°17'N, 146°09'E). An additional study site, the Mt Meg Flora and Fauna Reserve (36°22'N, 146°05'E), is located in the Chesney Vale Hills, 22 km WSW of the Warby Range. All areas within the north-east are characterised by steep, rocky slopes (weathered granite outcrops and screes) with open granitic woodland or low heathland. At all locations, remnant vegetation abuts cleared agricultural land, with the extent of fragmentation being highest at Mt Meg, where a mosaic of remnant vegetation occurs (Heard and Black 2003; Heard et al. 2004).

Five pythons were radio-tracked within the Mt Hope Flora and Fauna Reserve (35°59'N, 144°13'E) in north-central Victoria. Mt Hope is a prominent granite massif that rises steeply from the surrounding plains, most of which have been cleared for agriculture. The reserve supports a shrub-land vegetation community dominated by Deane's Wattle Acacia deanei paucijuga (Conn 1993; Parks Victoria 2000).

Eight pythons were radio-tracked within the Riverine forests of north-western Victoria. From east to west, snakes were tracked at Nyah State Forest (35°05'N, 143°20'E), Piambie State Forest (34°52'N, 143°20'E), Lambert Island (34°21'N, 142°22'E) and Walpolla Island State Forest (34°07'N, 141°42'E). All sites were located on the floodplain of the Murray River. Vegetation composition varied little between the three localities, being dominated by River Red Gum and Black Box. Disturbance from cattle grazing, timber extraction and recreational activities are common to all localities.

Study animals and radio-telemetric monitoring
Temperature-sensitive, miniature radio transmitters (Holohil Systems Pty Ltd, Canada; Model SI-2T) were surgically implanted within the body cavity of snakes
under aseptic conditions. A description of implantation techniques is provided in Heard et al. (2004). Units represented less than 2% of python body weight in all cases. We endeavoured to locate each python weekly (usually in the morning to early afternoon). However, logistical constraints occasionally resulted in this interval being reduced or extended between 2 and 21 days. A directional 'H' antenna and miniature radio receiver (Telonics Inc., Arizona) were used to track the signal of radio transmitters, and co-ordinates of each location were recorded in the Universal Transverse Mercator (UTM) system using a Trimble global positioning system (Trimble 10 channel Ensign XL GPS Unit).

Upon the death of a python, notes were maintained on the location of the carcass or transmitter, and descriptions of the surrounding habitat and specific collection site recorded. The identity of any predator involved was assessed by damage to transmitters (including teeth marks), collection site characteristics and the presence of scats or footprints.

**Results**

Seven carpet pythons (23% of those tracked) were killed during the study, five in the north-east and one each at Mt Hope and within the riverine forests of the northwest (Table 1). One of these animals ‘NE11’ apparently fell victim to a Lace Monitor Varanus varius; the transmitter was located within a tree-hollow some four metres above ground amongst numerous goanna scats. However, evidence collected during transmitter retrieval suggests that canids killed the remaining six pythons.

Two animals were killed in remnant woodland at Mt Meg. The first, ‘NE13’, died within 16 days of release. Prior to death, this animal was recorded sheltering in a hollow log amongst intact remnant woodland on the north face of Mt Meg. The heavily chewed transmitter from this snake was located within a fox den in dense shrubbery amongst the remains of other prey items, including rabbits and a possum. The second individual, ‘NE12’, died within two months of release. This snake was last recorded inhabiting remnant woodland on the south-eastern boundary of the Mt Meg Flora and Fauna Reserve, sheltering within a rock crevice. Its transmitter was subsequently located within an open paddock east of this site, partially buried in the soil, with numerous teeth marks in the unit’s silicone coating.

The remaining two snakes lost in the north-east were both apparently killed within the vicinity of residential buildings. At Mt Meg, ‘NE16’ was last recorded inhabiting a roof cavity within a series of buildings in the south of the study site. The snake had occupied these buildings during all locations in the two months following her re-release, and thus appeared to have been taken during her first movement away from the buildings during the tracking period. Her transmitter was subsequently located lying on the ground in an open paddock east of this site. The unit had been bitten repeatedly, exposing its metal casing. At Mt Bruno, an immature female ‘NE15’ was killed after residing for several months in the vicinity of a residential building located in remnant woodland. This snake was also last found inhabiting a roof cavity. Its transmitter was retrieved from a wooded slope overlooking the property; it had been chewed and partially buried.

One python was killed at each of the Mt Hope and Piambie study sites (Table 1). At Mt Hope, the dismembered remains and transmitter of the large, adult female ‘NW31’ were found at the entrance to a rock crevice on 4 May 1999. The snake had been recorded within this rock crevice during the previous two tracking events (25 March, 14 April 1999), and had frequented the site during the months preceding death. This snake had been tracked for 565 days in total. Lastly, the Piambie animal ‘NW01’ was apparently killed whilst inhabiting a large, relatively open hollow log in River Red Gum woodland. The partially chewed transmitter (numerous teeth marks were evident in the silicone coating) from this snake was located approximately 50 m from this log, beneath loose woody debris. Closer inspection of the hollow log revealed numerous bird feathers and other vertebrate remains at its entrance, suggesting that a canid (probably a fox) regularly used the log. The python was an adult female and died within three weeks of release.
Table 1. Gender, morphometric data and tracking details for each python killed during the radiotelemetric study. Snout-vent length (SVL) and weight recorded upon capture. * first located in tree hollow from which transmitter was retrieved on 29 March 1998. ** first located at site from which transmitter was retrieved on 14 March 1997.

<table>
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<tr>
<th>Scale-clip number</th>
<th>Study area</th>
<th>Sex</th>
<th>SVL (mm)</th>
<th>Weight (g)</th>
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<th>Days tracked</th>
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<td>Mt Meg</td>
<td>F</td>
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<td>3300</td>
<td>18/11/97 - 12/3/99</td>
<td>132**</td>
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<td>M</td>
<td>1460</td>
<td>1100</td>
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<td>1640</td>
<td>1475</td>
<td>20/2/97 - ?</td>
<td>18**</td>
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</table>

Discussion

Predation of carpet pythons by canids is of significant concern for the conservation of this endangered snake in Victoria. Records collected during the telemetry study indicate that either foxes or dogs killed the majority (86%) of radio-tracked carpet pythons lost to predators. Whilst our data do not definitively prove this contention (or differentiate between fox or dog predation), we use several pieces of evidence to argue that canid predation is the most likely cause of death of these animals, and that conservation initiatives that minimise the sub-species’ exposure to introduced predators should be pursued.

Firstly, additional evidence that canids prey upon carpet pythons is available. Shine and Fitzgerald (1996) documented seven instances of fox predation among a group of ten Coastal Carpet Pythons M. s. mcdowellii that died whilst being radio-tracked in north-eastern New South Wales (70% of mortality records, 37% of all snakes radio-tracked). Each of the seven retrieved transmitters displayed bite-marks characteristic of a canid, and the authors concluded that foxes were involved in each case. Similar evidence was gathered during the present study. Six of the seven transmitters were retrieved from the ground surface, in relatively open localities (one within a fox den) and either displayed numerous bite marks or had been thoroughly chewed (the exception in each case being the transmitter of ‘NE11’, which was evidently eaten by a goanna). Three of the transmitters were also partially buried. Foxes and dogs regularly cache food items (Saunders et al. 1999; Fleming et al. 2001), and the partial burial of these transmitters appears to be an example of this behaviour. Dietary studies have also identified carpet python remains in canid scats. Canid dietary analysis conducted at the Mt Meg study area identified python vertebrae in one of the scats examined (Heard 2001), and similar research has documented the occurrence of python remains in canid scats collected in south-eastern New South Wales (those of the Diamond Python M. s. spilota; Lunney et al. 1990).

Secondly, canids are the most abundant introduced predators present at these study sites (and possibly most abundant large predators in general), with foxes being particularly abundant. In north-eastern Victoria, where the majority of predation events occurred, foxes are the most commonly detected mammalian predator during regular spotlight surveys and scat sampling within and surrounding the Warby Range State Park (G. Barrow unpubl. data). Analysis of canid scats collected at Mt Meg during the summer of 2000 - 2001 revealed that 87% were deposited by foxes and 13% by dogs (Heard 2001). With the exception of one record of a feral cat, all tracks recorded on baited sand-pads during this period were those of foxes (Heard 2001).

Nonetheless, in the absence of observations of canids actually catching and killing carpet pythons, alternative explanations cannot be discounted. For example, it is possible that they merely consumed the remains of these snakes after some other event caused their death. Death through collision with vehicles is possible for example; however, python home-range rarely overlapped with roads in our study areas, and therefore death from such events seems improbable. Similarly, death resulting from illness is questionable given that
all the pythons that died during our study were sequestered in shelter sites during their last relocation. We assume that these snakes would remain secluded within these shelters during any illness (as they generally do when shedding their skin) and therefore be inaccessible to canids. Shelter sites selected by these pythons generally provide excellent refuge from predators (the exception in this study being the log inhabited by ‘NW01’ prior to death, which had a relatively wide hollow and was evidently used by a fox).

It may also be the case that the fate of these animals was either unnatural due to behavioural changes resulting from transmitter implantation, or misinterpreted due to a failure in the telemetry technique. In the first instance, it may be argued that the death of several snakes within months of release (‘NE12’, ‘NE13’, ‘NE15’, ‘NE16’, ‘NW01’) was the result of transmitter implantation increasing their susceptibility to predation. For example, transmitter implantation may have increased the snakes’ time spent basking (to maintain higher body temperatures, as has been observed when ingestible transmitters are used in snake telemetry projects; Lutterschmidt and Reinert 1990) or moving (due to the stress of captivity and surgery, or disturbance of their normal activity patterns). We cannot discount such behavioural shifts and associated increases in predator exposure. However, considering that these snakes displayed similar behavioural patterns to the other 23 pythons monitored, and one of the snakes killed had been tracked for several years prior to death, a consistent effect of the radio-tracking technique is not apparent. The techniques used during this study are considered standard for radio-tracking snakes, and have been applied widely in Australia without apparent negative effects on the behaviour, health or survivorship of the study animals in most cases (e.g. Shine 1979; Slip and Shine 1988; Madsen and Shine 1996; Webb and Shine 1997; Fitzgerald et al. 2002; Pearson 2002; Butler et al. 2005). In the second instance, it is possible that the transmitters of these pythons were chewed following their expulsion from the snake’s body. Pearson and Shine (2002) documented 14 cases (of 75 pythons tracked) where radio-transmitters surgically implanted within the peritoneum of South-western Carpet Pythons *M. s. imbricata* were subsequently expelled through the alimentary tract, most being deposited within faecal pellets (71%). They subsequently cautioned against the conclusion that an implanted animal had been lost to predation if its transmitter alone was relocated (even if it had been chewed, as this may have occurred after expulsion), and advocated that inference of a radio-tracked snake’s death due to predation be made only if the carcass was located. We agree that such evidence is required for unequivocal conclusions on the fate of tracked animals, but found no evidence of transmitter expulsion during this study. Also, considering that these pythons spent the major part of their time in secluded microhabitats (e.g. rock crevices, tree hollows; Heard et al. 2004) (and often defecated there) it seems improbable that expelled transmitters would be accessible to scavenging canids. The discovery of the dismembered remains of ‘NW31’ and the occurrence of non-fatal injuries consistent with canid attack on other pythons captured during the project (G.Barrow, P. Robertson pers. obs.), suggest that attacks do occur and are the most plausible explanation for the apparent predation events detailed here.

Given our conclusion that canid predation was the primary cause of death for 20% of carpet pythons radio-tracked during this study (and is potentially representative of predation rates in the population as a whole), the effect of canid predation on python population viability must be considered. Small wildlife populations with naturally low birth rates are particularly sensitive to environmental perturbations such as increases in predation levels, as mortality rates can easily exceed recruitment rates and plunge these populations into decline (Primack 2004). Victorian populations of carpet pythons have probably always displayed relatively low densities and reproductive rates as they inhabit a temperate environment that allows a relatively short active period; a circumstance in which snakes find it difficult to accumulate the energy stores needed for annual reproduction; (Shine 1991). Thus, the sub-species is
predisposed to be sensitive to increased predation rates. However, recent reductions in habitat quality through structural simplification, fragmentation and isolation, and concurrent population declines of many of their mammalian prey species (Bennett et al. 1998) have probably further reduced population sizes and recruitment rates amongst Victorian populations of carpet pythons. Canid predation may subsequently be generating unsustainable mortality rates amongst these populations, and jeopardising their long-term viability.

Measures to reduce the threat of canid predation to remaining Victorian populations of carpet pythons should be pursued. Previous research at Mt Meg suggests that control programs that aim to reduce canid abundance before and during the summer months may be most beneficial. Scat analysis confirms that carpet pythons and foxes prey predominantly on rabbits in this region (P. Robertson, G. Barrow unpubl. data) and habitat use by these species suggests they forage primarily within areas of semi-cleared woodland where rabbits are most abundant. At Mt Meg, pythons frequent these habitats in summer when they disperse widely in search of prey (Heard et al. 2004). During this period they select microhabitats in close proximity to rabbit burrows and will also shelter in them at this time (Heard et al. 2004). Scat distribution and visitation rates to sand-pads indicate foraging activity by foxes is also centered on rabbit burrows at Mt Meg (Heard 2001). As carpet pythons move frequently during summer (often through open country between habitat patches) and their habitat use during this period overlaps significantly with that of foxes (both in terms of broad habitat associations and microhabitat locations), these snakes are likely to be most vulnerable to fox predation during the warmer months. It is notable that all pythons, except ‘NW31’, that were apparently killed by predators during this study died during, or late in, the summer activity season of these snakes (December – March).

In combination with control programs, habitat management will be crucial for reducing the susceptibility of carpet pythons to canid predation in Victoria. Vegetation clearing, grazing and timber extraction continue to fragment and degrade the woodland habitats of these pythons across the state’s northern plains. Subsequent reductions in habitat continuity and complexity almost certainly expose carpet pythons to higher predation risk. These snakes rely heavily on camouflage and cryptic behaviour to avoid detection by predators; characteristics that are ineffectual when moving through open country (to move between habitat remnants) or structurally simplified habitats. Shine and Fitzgerald (1996) suspected that carpet pythons in their telemetry group were captured by foxes whilst moving through open habitats (orchards) within a study area in north-eastern New South Wales. Data collected during the present study are insufficient to describe the habitats or microhabitats in which pythons were killed (with the exception of ‘NW31’, the remains of which were located outside the rock-crevice previously occupied by the snake). However, it is apparent that most were killed during excursions from sheltered microhabitats. Two habitat management actions are appropriate: (i) maintaining and expanding connectivity between habitat remnants (through habitat acquisition and revegetation) to reduce the snake’s need to cross cleared land when moving between habitat remnants; and (ii) preservation of ground cover such as woody debris, fallen timber and ground and shrub-layer vegetation within habitat remnants (through the elimination of grazing and timber extraction) to increase the snake’s ability to avoid predators during daily thermoregulatory, foraging and movement activities.

We conclude by proposing that management actions which reduce canid populations (particularly foxes) within and surrounding python habitat during the warmer months, increase the continuity of the subspecies’s woodland habitats, and enhance the structural complexity of these habitats are requisite components of conservation programs for this endangered snake throughout northern Victoria.

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References

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