

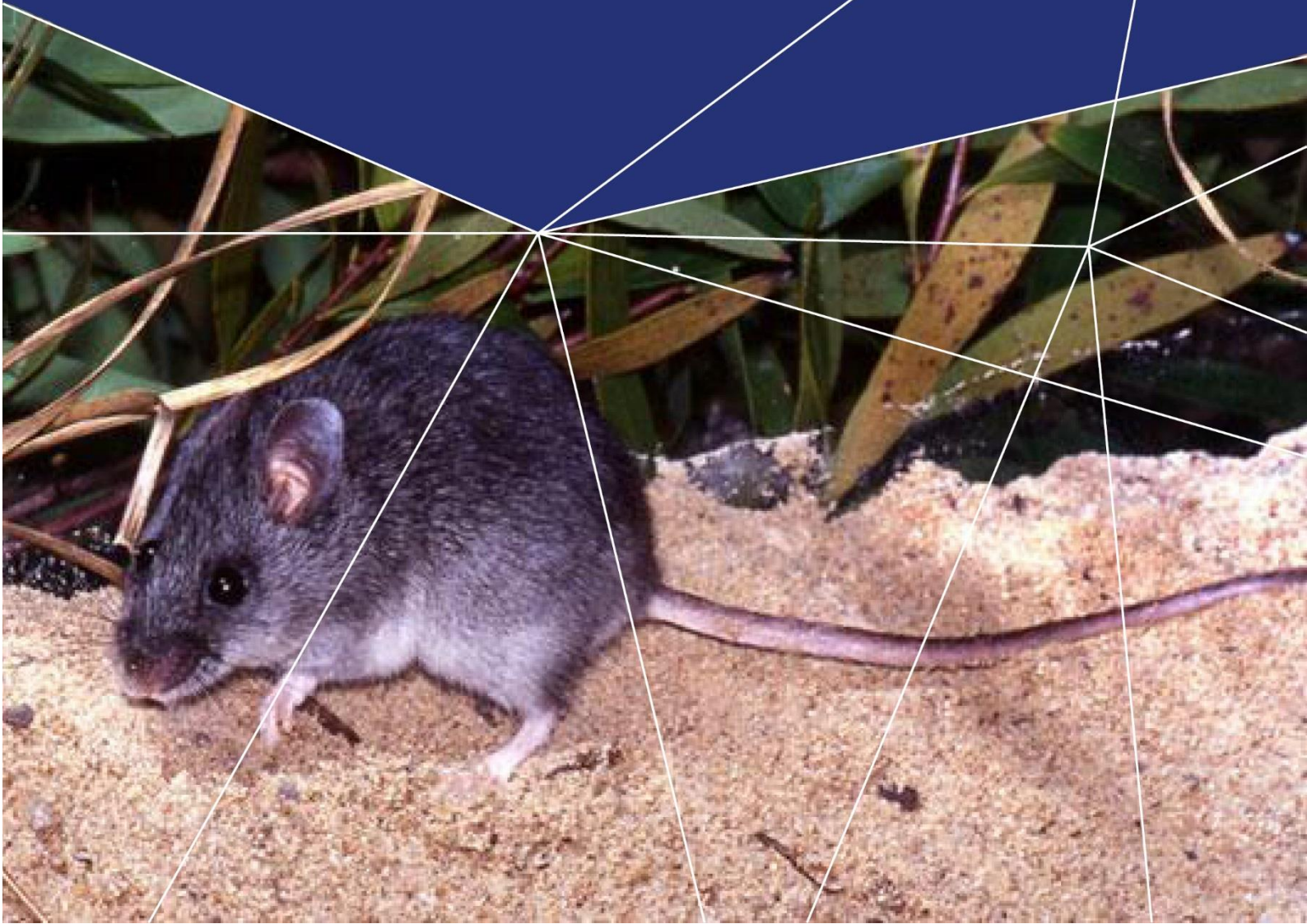


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SURVEY FOR THE SMOKY MOUSE (PSEUDOMYS FUMEUS) IN THE ACT

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August 2018



Research Report Series

**Survey for the Smoky Mouse
(*Pseudomys fumeus*) in the ACT**

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Environment, Planning and Sustainable Development Directorate

August 2018



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Front cover: Smoky Mouse. Linda Broome

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Summary

The Smoky Mouse is a small blue-grey native rodent that was once relatively abundant and widespread in some woodlands and forests of south-east Australia but has disappeared from much of its former range and is now listed as threatened in NSW, ACT, Victoria and nationally. Small and somewhat ephemeral populations of the species remain at several widely dispersed sites in NSW and Victoria. The only confirmed records of the Smoky Mouse from the ACT are from two individuals trapped in Namadgi National Park in the 1980s. Subsequent surveys have failed to detect the species in the ACT.

The aim of this survey was to determine whether the Smoky Mouse still occurs in the ACT.

Fifty sites were surveyed using remote cameras in potential Smoky Mouse habitat in Namadgi National Park. Cameras and bait stations (to attract the mice) were left at each site for 10 nights, totalling in 500 'trap-nights'. Sites were located in four main vegetation types: dry sclerophyll forest, wet sclerophyll forest, subalpine grassy woodland and rocky alpine heath. Sites included some of the most remote and difficult to access areas in Namadgi National Park (such as rocky mountain tops of Mt Namadgi and Mt Kelly) and these were accessed by helicopter. Other sites were accessed by 4WD vehicle and foot.

No Smoky Mice were detected in this survey, which included two sites where the species had been previously trapped and a third site where probable Smoky Mouse hair samples had been found. A range of other mammals, reptiles and birds were detected during the survey, adding to the knowledge of the distribution of these species in Namadgi National Park. Notably, feral cats and foxes were detected at 12% and 8% of sites respectively. Both of these introduced predators were found in the most remote locations in Namadgi National Park, including rocky mountain tops.

It is possible that Smoky Mouse is still present in the ACT (Namadgi National Park) but this and previous surveys have failed to detect it. The results of this survey indicate the Smoky Mouse is either absent in Namadgi National Park, or if present it is extremely rare.

1 Introduction

The endangered Smoky Mouse (*Pseudomys fumeus*) is an enigmatic species about which little is known. The only confirmed records of the species from the ACT are from two individuals trapped in Namadgi National Park in the 1980s. A subsequent large survey for the species in Namadgi National Park in 1994 failed to find it. A recommendation of the ACT Smoky Mouse Action Plan (ACT Government 2012) is to “Undertake survey for the species in likely habitat in the ACT, including sites where the species has been previously recorded”. This survey, conducted two decades after the previous survey for the species in the ACT, aims to fulfil the Action Plan recommendation.

The specific aim of this project is to:

- Undertake survey for the Smoky Mouse in likely habitat in Namadgi National Park with the aim of detecting the species if it is still present in the ACT.

2 Background

Description and Distribution

The Smoky Mouse is a small native rodent that is typically blue-grey above with a pale grey belly, dark hairs around its eyes and pink feet. A distinguishing feature is its bicoloured tail, which is blue-grey dorsally and white ventrally. There is some variability in colour throughout its distribution, with individuals ranging from pale grey to black. The species has a head and body length of 85-100 mm (average 90 mm), a tail length of 110-145 mm (average 140 mm) and weighs between 45-86 g (Ford 2008; Menkhorst and Knight 2011).

The Smoky Mouse was first described from animals collected in the Otway Range of southern Victoria. Other locations where the species has been recorded in Victoria are the Grampians, Central and South-eastern Highlands, Barry Mountains, near Mt Cobberas and coastal east Gippsland between Marlo and Tamboon Inlet (Menkhorst and Seebeck 1981; Lee 1995; Menkhorst 1995, 2003). Surveys in coastal Gippsland (between Marlo and Bemm River) in 2010 using hair tubes and remote cameras failed to detect the species (Nelson et al. 2010).

The species was first detected in NSW in 1993 from hair-sampling tubes in Nungatta State Forest in the Eden district of south-eastern NSW (Menkhorst and Broome 2008b). The species has subsequently been captured at several sites in Nullica State Forest and the adjoining South East Forests National Park (Jurskis et al. 1997). The most recent records from this area are from 2011 (L. Broome pers comm NSW Office of Environment and Heritage; Forestry NSW unpubl. data). Other locations in NSW where the species has been recorded are Kosciuszko National Park (Pilot and Ravine areas) (hair samples and trapped individuals), Yarrangobilly Caves area (three dead individuals) (Ford 1998a, 1998b; EMM Consulting 2018), Ingebyra State Forest (hair sample) and Buccleugh State Forest (Menkhorst and Broome 2008).

Subfossil deposits indicate that the Smoky Mouse was once widespread in south-eastern NSW, reaching as far north as Jenolan Caves (Menkhorst and Seebeck 1981). Subfossil collections held at the CSIRO Australian National Wildlife Collection include abundant specimens of the Smoky Mouse

collected from surface layers of caves from all karst areas in the ACT region including Yarrangobilly, Marble Arch, London Bridge (near Googong), Wombeyan, Wee Jasper, Michelago and Cooleman Caves (F. Ford pers. comm.; Australian National Wildlife Collection database).

Records from the ACT

The first evidence of the species in the ACT was from two males trapped in the Brindabella Ranges in Namadgi National Park, one from near Bulls Head in 1985 (Osborne and Preece 1986) and one from Mt Kelly in 1987 (Mayo 1987). A survey for the species in 1994 failed to find conclusive evidence of its presence though two probable hair samples were obtained from Mt Namadgi, one from a bird's nest and one from a hair sampling tube. There is also an unconfirmed report of an individual trapped near Mt Coree in the 1970s (T. Macdonald pers. com. 1998 ACT Parks and Conservation Service). Subsequent surveys for small mammals in Namadgi National Park have failed to detect the species. More recent records from nearby NSW (Buccleugh State Forest and Yarrangobilly Caves in Kosciuszko National Park) suggest that the species may still occur in the ACT and region, though probably at low densities.

Details of records from the ACT are:

Bulls Head

Trapped individual. 1985. 35o23'6S, 148o50'4E (MGA: 666500, 6082850). Habitat: Broad moist gully in tall open forest of *E. Fastigata* with shrub layer of *Acacias*, *Pomaderris* and *Bedfordia*.

Mt Kelly

Trapped individual. 1987. Near the summit of Mt Kelly, at 1800 m asl. Approximate MGA coordinates: 669800, 6046210. Vegetation was most likely rocky heath.

Mt Namadgi

Probable hair sample. 1994. Approximate MGA coordinates: MGA: 669913, 6049584. Vegetation was most likely rocky heath.

Conservation Status

The Smoky Mouse is listed as Endangered in the ACT, Victoria and nationally, and Critically Endangered in NSW.

The Smoky Mouse occurs as widespread small isolated populations that appear to be somewhat ephemeral. The species has not been detected in the ACT since the 1990s. The presence of Smoky Mouse sub-fossil deposits on the surface layers of all karst areas in the South-eastern highlands in association with radiocarbon dated bones that are less than 200 years old (e.g. Aplin et al. 2011) indicates the decline in the species range occurred after European settlement (F. Ford pers. comm. 2012). The cause of population declines is not well understood, but is thought to be related to habitat loss or changes in habitat (for example, as a result of altered fire regimes) and excessive predation by introduced predators (Lee 1995; Menkhorst and Broome 2008a, 2008b).

Habitat

The Smoky Mouse has been recorded from coastal and subalpine heath, dry eucalypt forest (Broad-leaved Peppermint *Eucalyptus dives*, Brittle Gum *E. mannifera*), wet eucalypt forest, montane forest (Mountain Gum *E. dalrympleana*, Alpine Ash *E. delegatensis*), subalpine woodland (Snow Gum *E. pauciflora*) and damp drainage systems including wet fern gullies. Surveys undertaken in eastern Victoria and south-eastern NSW (e.g. Menkhorst and Seebeck 1981; Cockburn 1995; Jurskis et al. 1997; Ford 1998a, Ford 1998b; Ford et al. 2003) indicate that important habitat is ridge-top sclerophyll forest with a diverse understorey of heathy shrubs of which the plant families Epacridaceae, Fabaceae and Mimosaceae are well represented. Adequate ground cover (low heath, grass tussocks, logs, rocks or leaf-litter) and soil conditions conducive to growth of hypogeous fungi (a major component of the diet) are also likely to be critical habitat elements (Menkhorst and Broome 2008b; Burns et al. 2015).

Diet

The diet of the Smoky Mouse appears to largely comprise seeds and fruits from shrubs (legumes and epacrids) and underground fungi, though they are also known to eat aestivating bogong moths (Cockburn 1981a, 1995; Ford 1998a; Ford et al. 2003). Habitat preference for the species has been found to be related to its dietary preference for legume seed and epacrid fruits during summer months (Ford 1998a, Ford 2008). In winter and early spring, when few seeds and fruits are available, the Smoky Mouse switches to hypogeous truffle-like fungi that are common around the roots of certain shrubs and grasses (Cockburn 1995; Ford 1998a; Ford et al. 2003; Ford 2008).

Breeding biology

The Smoky Mouse breeds during the spring and summer months. Females may cohabit breeding burrows and a high degree of breeding synchrony has been observed within nests (Ford 1998a, 1998b; Woods and Ford 2000). Females produce one or two litters, each with three to four young. Females may live to breed a second year in higher quality habitats (Cockburn 1995). Survivorship of juveniles and adults appears to be low in all but the best quality habitat (Cockburn 1981b; Ford 1998b).

Population Dynamics

The Smoky Mouse occurs in small colonies that are widely dispersed, and that tend to be ephemeral, both spatially and temporally (Ford 2008). Colonies often comprise a male and several females, typically inhabiting a burrow system in dense heath (Woods and Ford 2000; Ford et al. 2003; Menkhorst and Macak 2013). Smoky Mouse populations are subject to large annual fluctuations in abundance (Cockburn 1981b; Ford 1998a) that may be related to resource availability (Cockburn 1981b; Menkhorst 2003). Cockburn (1981b) attributes population fluctuations to a decline in available food sources during late spring. Ford (1998a) considers the causes to be unclear, but suggests that males may decline due to social conflict. Other possible factors include predation and low availability of food resources due to low rainfall in previous months (Ford et al. 2003).

Threats

The main threats to the species are vegetation clearance, inappropriate fire regimes and predation by introduced predators (Lee 1995; Menkhorst and Broome 2008a, 2008b).

Smoky Mouse colonies are small, ephemeral and widely dispersed, suggesting vegetation clearance that reduces habitat connectivity is likely to profoundly affect the species' ability to recolonise habitat patches and probably to maintain genetic diversity (Saunders et al. 1991; Fahrig and Merriam 1994).

The floristic composition and structure of heath communities (preferred habitat for the Smoky Mouse) is influenced by time since fire and fire regime. Infrequent fire can lead to senescing of heath and a higher likelihood of large-scale, severe wildfire (Catling 1986, 1991), whereas frequent fires favour early vegetation succession characteristics and tend to reduce species diversity and structure of vegetation communities, including heath. Frequent fire may also reduce abundance and diversity of hypogeal fungi, which prefer well developed litter layers (Claridge and Cork 1997; Menkhorst and Broome 2008b) and may remove ground cover (bushes and hollow logs) that act as a refuge from predators. Fire regimes of moderate frequency (15 to 20 year intervals) and low to moderate severity are probably the most appropriate for maintaining suitable habitat (understorey structure and floristics) at most Smoky Mouse sites (Lane 1997; Ford et al. 2003; Menkhorst and Broome 2008b).

Predation, particularly from introduced predators, is likely to be a key threat to the Smoky Mouse because of its small colony size, low reproductive rate, preference for open heathy habitats and use of communal burrows that can be staked out by 'sit and wait' predators (such as feral cats) (Menkhorst and Broome 2008b).

3 Methods

Survey Sites

The survey was undertaken in Namadgi National Park in the Australian Capital Territory between October 2013 and April 2014. Survey sites (Figure 1) were located in potential Smoky Mouse habitat. Previous studies in Victoria and NSW show the species uses a range of vegetation types which often have heathy plants (legumes, epacrids) present. In the ACT the Smoky Mouse has been recorded from a moist gully within wet montane forest, and from heath vegetation on rocky mountain tops. The presence of the following plants in the understorey were considered to be indicators of potential Smoky Mouse habitat: epacrids, legumes (Faboideae, Mimosoideae, including *Acacia*, *Oxylobium*, *Pultanaea*, *Daviesia*, *Pteridium*, *Kennedia*), *Xanthorrhoea*, *Lomandra*, *Bursaria* and *Cassinia*. Potential survey sites were identified from topography, vegetation maps, aerial photographs, ground inspections and local knowledge.

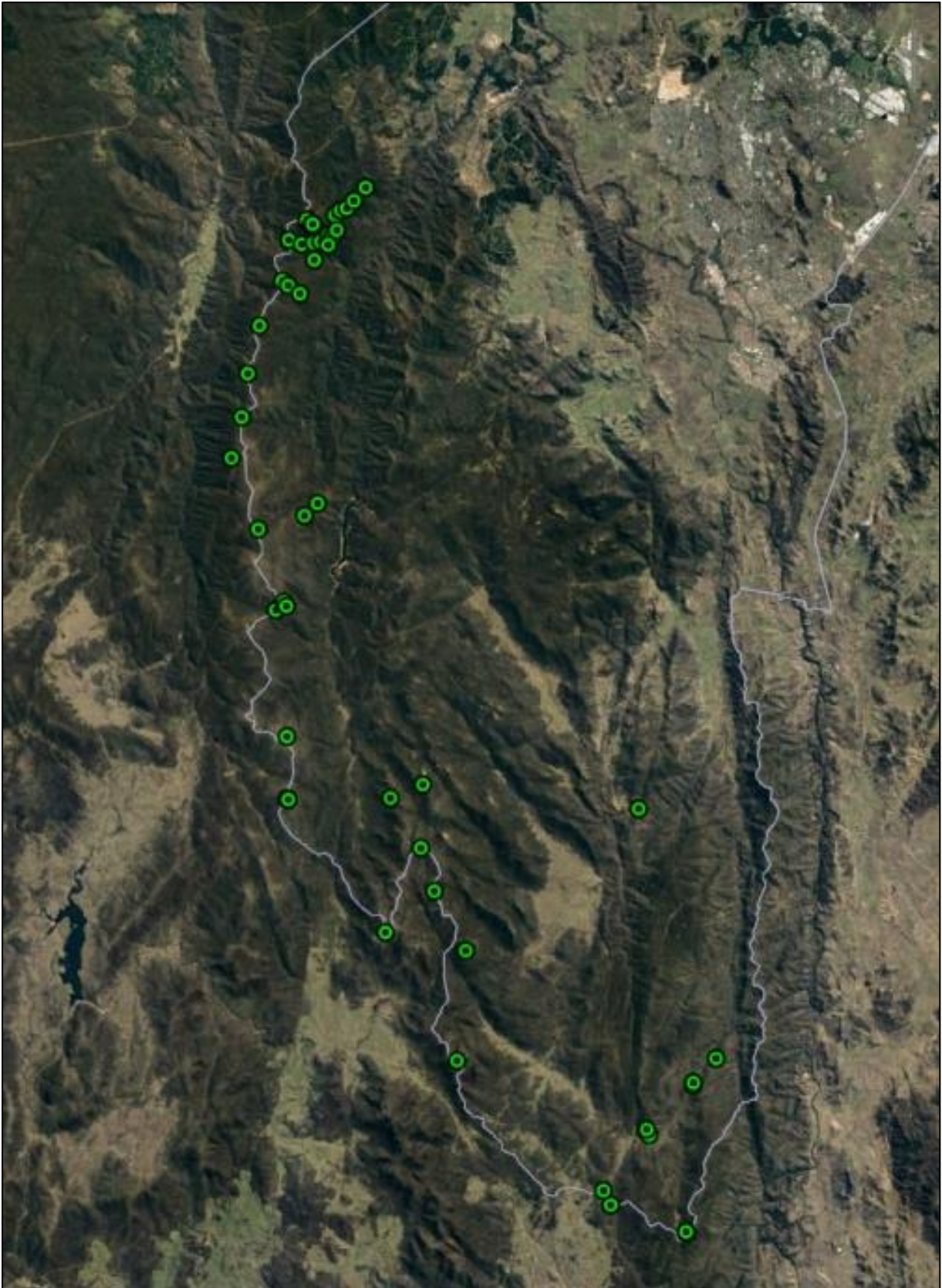


Figure 1. Map showing border of the ACT/NSW and the 50 survey sites in Namadgi National Park.

Vegetation types

Survey sites were located in dry sclerophyll forest (17 sites), wet sclerophyll forest (12 sites), grassy woodland (12 sites), and rocky alpine heath on mountain tops and ridges (9 sites). Locations in Namadgi National Park of confirmed records of the Smoky Mouse (Bulls Head, Mt Kelly) or unconfirmed records (Mt Namadgi) were included in the survey. Sites were accessed by vehicle and then walking, or by helicopter (mountain top and mountain ridge sites).

Dry sclerophyll forest

The dry sclerophyll forest (Figure 2) sites in this survey were in montane tall open eucalypt forest dominated by either Broad-leaved Peppermint (*Eucalyptus dives*), Mountain Gum (*E. dalrympleana*), Apple Box (*E. bridgesiana*) or Candlebark (*E. rubida*), usually with a shrub layer dominated by Silver Wattle (*Acacia dealbata*), Black Wattle (*A. melanoxylon*), Shiny Cassinia (*Cassinia longifolia*), Blackthorn (*Bursaria spinosa*) and Bitter Pea (*Daviesia mimosoides*). The ground layer comprised bark and leaf litter, or was dominated by Poa grasses, often with Spiny Mat-rush (*Lomandra longifolia*) and forbs including epacrids.



Figure 2. Dry Sclerophyll forest in Namadgi National Park.

Wet sclerophyll forest

Wet sclerophyll forest (Figure 3) sites were in montane tall moist eucalyptus forest, typically found in gullies and south facing aspects. The upper storey is dominated by Alpine Ash (*Eucalyptus delegatensis*), Ribbon Gum (*E. viminalis*), Mountain Gum (*E. dalrympleana*), Narrow-leaved Peppermint (*E. radiata*), with patches of Snowgum (*E. pauciflora*) dominant in some areas. The shrub layer is dominated by Black Wattle (*Acacia melanoxylon*), Silver Wattle (*A. dealbata*), Common Cassinia (*Cassinia aculeata*), Long-leaf Lomatia (*Lomatia myricoides*), Large-leaf Daisy Bush (*Olearia megalophylla*), Currant-bush (*Coprosma quadrifida*) and Coffee-berry (*C. hirtella*). The moist ground layer is a mix of forbs, ferns, climbers and grasses.



Figure 3. Wet Sclerophyll forest, Bendora Rd, Namadgi National Park.

Subalpine grassy woodland

Subalpine grassy eucalypt woodland (Figure 4) sites were dominated by Snowgum (*Eucalyptus pauciflora*), which in some areas occurred with Mountain Gum (*E. dalrympleana*) and to a lesser extent Narrow-leaved Peppermint (*E. radiata*). The shrub layer is generally patchy, with areas of no shrub layer, areas of dense low shrub dominated by Leafy Bossia (*Bossiaea foliosa*) and Shaggy-pea (*Oxylobium ellipticum*), and areas of sparse shrub layer comprised of the occasional Silver Wattle (*Acacia dealbata*), Alpine Hovea (*Hovea montana*), Daisy Bush (*Olearia erubescens*), Alpine Pepperbush (*Tasmannia xerophila*) and Mountain Flat-pea (*Platylobium montanum*). The ground layer is a dense sward of Poa grasses (mainly *Poa sieberiana*) often with various forb species.



Figure 4. Subalpine grassy woodland, Mt Murray, Namadgi National Park.

Rocky alpine heath

Rocky alpine heath (Figure 5) occurs on rocky mountain tops and mountain ridges, where there are very few trees (mainly Snowgums) and dense heathy areas are interspersed with boulders and rocky outcrops. Dominant shrub species are Alpine Teatree (*Leptospermum micromyrtus*), Alpine Pepperbush (*Tasmannia xerophila*), Burgan (*Kunzea ericoides*), Mueller's Kunzea (*Kunzea muelleri*), Common Fringe Myrtle (*Calytrix tetragona*), Shiny Phebalium (*Leionema lamprophyllum*), Shaggy-pea (*Oxylobium ellipticum*) and Epacrids including *Epacris robusta*. In some areas Mountain Plum Pine (*Podocarpus lawrencei*) is present.



Figure 5. Rocky alpine heath on mountain tops in Namadgi National Park.

Survey method

Sites were sampled using weatherproof Reconyx HC550 wildlife cameras located at bait stations. These cameras use a passive infrared sensor that is triggered by a combination of heat and movement. The Reconyx model used in this survey has a white flash (as opposed to the infrared flash on some models) which produces colour night-time photographs to aid the identification of small mammals. Previous surveys for small mammals (Evans unpublished data) using a sequence of photos taken in short succession indicated that white flash does not appear to significantly disturb animals, including small ground-dwelling mammals. Cameras were attached to a tree trunk or wooden stake using an elastic cord and positioned about 1 m above the ground pointing downward at a bait station about 1.5 m away on the ground. The bait station acted as an attractant to lure animals into the detection field of the cameras sensor.

The bait station consisted of a 50 mm diameter air-vent cowl (Figure 6) for PVC pipe. The cowl is made of PVC and steel mesh, to which a hole was drilled through the top to enable a steel peg (15-20 cm long tent peg) to pass through the vent cowl to peg it securely to the ground. Bait was placed on the ground and the vent cowl was pegged over it (Figure 7). The mesh vent allowed the scent of the bait to disperse but prevented animals eating the bait, so that the bait continued to attract animals for several days. The use of a vent cowl has been used in other surveys for the Smoky Mouse (e.g. NSW Forestry Department).



Figure 6. Air vent cowl used to hold bait.

Two types of bait were used at each bait station. One bait consisted of balls (about 2 cm diameter) made of peanut butter and rolled oats (a commonly used bait for small mammals). Honey is often added to this 'standard' mixture but was not added in this study to reduce its attraction to ants. At each bait station a small cotton pad (face make-up removal pad), to which a few drops of aromatic truffle oil were added, was also placed under the vent cowl together with the 'bait balls'.

At each survey site one bait station and one Reconyx camera were used (Figure 7). The cameras were set to take a series of five photos with a 3 second interval between each photo. The camera settings are given in Appendix 1. The photos were stored on a memory card with the date and time of each photo, temperature and camera ID number. Around 8000 photos were able to be stored on a 4 GB memory card. Wind-blown (moving) vegetation or its shadow can trigger the camera, and so to prevent false triggers, loose vegetation (long blades of grass, small branches) were removed from around the bait station or between the bait station and the camera. Ten Reconyx cameras were used which enabled ten sites to be surveyed concurrently. Cameras were left at each site for 10 nights, after which they were moved to different sites. Remote mountain top sites were accessed by helicopter, and other sites were accessed by 4WD vehicle and walking.



Figure 7. Typical setup of a camera and bait station at each site.

4 Results

Survey timing and effort

Survey of the 50 sites in Namadgi National Park was undertaken during the warmer months, from October 2013 to March 2014. Cameras were left at each site for 10 consecutive nights within this period. The total survey effort was 500 camera trap-nights (50 sites x 10 nights).

Species identification

Animals captured in photographs were able to be identified to species in almost all cases. Animals in photographs that were unable to be identified to species were all small ground-dwelling mammals. Photographs of unidentified small ground-dwelling mammals accounted for less than 5% of all photographs of small ground-dwelling mammals. The same animal species was often photographed on more than one night at a site, and in some cases different individuals could be identified (for example, different markings on macropods or male and female possums). However, in most cases it was not known whether multiple images of the same species at a site were of the same individual or different individuals. Therefore, the presence or absence of a species was recorded for a site rather than counts of photographs of a species (Table 1).

Smoky Mouse detection

No Smoky Mice were detected at any of the 50 sites during this survey.

Small ground-dwelling native mammals

The survey detected all four species of native small ground-dwelling mammals known to be present in Namadgi National Park (Table 1, Appendices). The Agile Antechinus was relatively ubiquitous, being recorded at 15 sites (30% of all sites) and in all four vegetation types. Bush Rats were almost as ubiquitous as Agile Antechinus, being recorded at 13 sites and in all vegetation types. The Dusky Antechinus was recorded at two sites, both in sub-alpine Snowgum woodland along the Mt Franklin Road. The elusive Eastern Pygmy Possum was detected at one site (summit of Mt Murray) in rocky alpine heath.

Other native mammals

Common Brushtail Possums and Swamp Wallabies were the most widespread species in the survey, and were recorded in all vegetation types, though least in rocky alpine heath. The Mountain Brushtail Possum was found in all vegetation types but was less frequently observed than the Common Brushtail Possum. Red-necked Wallabies were observed in all vegetation types except alpine heath. Eastern Grey Kangaroos and Wallaroos were relatively rare in the survey, and were observed only in dry sclerophyll forest. Common Wombats and Echidnas were found in all vegetation types except alpine heath, though they were infrequently observed.

Table 1. Number of sites each species was detected in each vegetation type. RAH = Rocky Alpine Heath, SGW = Subalpine Grassy Woodland, DSF = Dry Sclerophyll Forest, WSF = Wet Sclerophyll Forest.

| Species | RAH | SGW | DSF | WSF | Total sites |
|---|-----|-----|-----|-----|-------------|
| Small ground-dwelling mammals | | | | | |
| Agile Antechinus (<i>Antechinus agilis</i>) | 3 | 5 | 2 | 5 | 15 |
| Bush rat (<i>Rattus fuscipes</i>) | 4 | 4 | 3 | 2 | 13 |
| Dusky Antechinus (<i>Antechinus swainsonii</i>) | | 2 | | | 2 |
| Eastern Pygmy Possum (<i>Cercartetus nanus</i>) | 1 | | | | 1 |
| Smoky Mouse (<i>Pseudomys fumeus</i>) | | | | | 0 |

| Species | RAH | SGW | DSF | WSF | Total sites |
|--|-----|-----|-----|-----|-------------|
| Other native mammals | | | | | |
| Common Brushtail Possum (<i>Trichosurus</i>) | 1 | 7 | 11 | 5 | 24 |
| Swamp Wallaby (<i>Wallabia bicolor</i>) | 1 | 5 | 7 | 7 | 20 |
| Mountain Brushtail Possum (<i>Trichosurus</i>) | 1 | 2 | 2 | 4 | 9 |
| Red-necked Wallaby (<i>Macropus rufogriseus</i>) | | 3 | 3 | 2 | 8 |
| Wombat (<i>Vombatus ursinus</i>) | | 2 | 1 | 3 | 6 |
| Echidna (<i>Tachyglossus aculeatus</i>) | | 1 | 1 | 1 | 3 |
| Common Ringtail Possum (<i>Pseudocheirus</i>) | | 2 | | | 2 |
| Eastern Grey Kangaroo (<i>Macropus</i>) | | | 2 | | 2 |
| Wallaroo (<i>Macropus robustus</i>) | | | 1 | | 1 |
| Non-native mammals | | | | | |
| Cat (<i>Felis catus</i>) | 3 | 1 | 1 | 1 | 6 |
| Fox (<i>Vulpes vulpes</i>) | 3 | 1 | | | 4 |
| Pig (<i>Sus scrofa</i>) | | 1 | | | 1 |
| Reptiles | | | | | |
| Black Rock Skink (<i>Egernia saxatilis</i>) | 2 | | | | 2 |
| Blue-tongue Lizard (<i>Tiliqua nigrolutea</i>) | | | | 1 | 1 |
| Birds | | | | | |
| Various species | 3 | 7 | 5 | 6 | 21 |

Non-native mammals

Feral cats and European Red Foxes were found to be widespread in Namadgi National Park (Table 1, Appendices). Feral cats were found in all vegetation types, whereas foxes were observed in more open habitats (alpine heath and sub-alpine Snowgum woodland). One fox was photographed with a freshly killed Bush Rat in its mouth. Feral pigs were observed at one site in sub-alpine Snowgum woodland, whereas wild dogs and rabbits were not observed at any sites although they are known to be present in the park.

Birds

Thirteen species of birds were identified from photographs. Most species were observed in forest and woodland vegetation types. The species observed at the highest number of sites were Grey Shrike-thrushes (*Colluricincla harmonica*) (8 sites), White-browed Scrubwrens (*Sericornis frontalis*) (6 sites) and Superb Lyrebirds (*Menura novaehollandiae*) (5 sites).

Reptiles

Reptiles were rarely observed in photographs, and only two species were detected: the Blotched Blue-tongue Lizard and the Black Rock Skink.

5 Discussion

The Smoky Mouse was not detected at any of the 50 sites in Namadgi National Park during this survey, which included two sites where the species had been previously trapped and a third site where probable Smoky Mouse hair samples had been found.

It is possible that the species was present at one or more survey sites and the survey method failed to detect it, although this appears to be unlikely because other small mammals such as *Antechinus*, Bush Rats and Eastern Pygmy Possums were detected, and Smoky Mice have been captured on wildlife cameras in other studies (e.g. Nelson et al. 2009; Nelson et al. 2010) using the standard small-mammal bait (peanut butter and rolled oats). Nelson et al. (2009) found the first detection of a Smoky Mouse on remote wildlife cameras could be up to 18 days after the camera was placed at a site, although almost all first detections were on or before the 10th day. In this study cameras were left at sites for 10 days, a period that should allow a high chance of detecting the species if present. A small proportion (< 5%) of images of small ground-dwelling mammals were unable to be confidently identified to species (usually because the animal's rapid movement caused some blurring of the image), though in each case the animals' appearance more closely resembled an *Antechinus* than a rodent.

Smoky Mouse colonies are known to be small, isolated and somewhat ephemeral (Cockburn 1981b; Woods and Ford 2000; Ford et al. 2003; Ford 2008) and so survey sites may not have been located where colonies were present at the time of the survey. Nevertheless, the survey was undertaken at 50 sites in potential habitat for the species in a range of vegetation types, including sites where the species has been previously recorded, and thus the lack of detection suggests that the Smoky Mouse is either absent in Namadgi National Park or present at very low abundance.

The conclusion that the Smoky Mouse is absent or occurs at very low abundance in Namadgi National Park is supported by the lack of detection of the species in other surveys for small mammals in Namadgi National Park since the 1990s, which have been undertaken in a range of vegetation types (except rocky alpine heath). In 2003 the ACT Government used Elliot traps to survey eight sites in Namadgi National Park following the 2003 wildfire (Carey et al. 2003). At each site Elliot traps baited with peanut butter and rolled oats were arranged in a transect of 25 traps spaced about 10-15 m apart and checked on four consecutive mornings. In 2004, five sites were surveyed using the same method (N. Scarimolo and ACT Government, unpublished data), and the ACT Government used the same method to survey 19 sites in the park between 2004 and 2008 (unpublished data). In addition to the Smoky Mouse survey reported here, between 2014 and 2018 the ACT Government undertook camera surveys for small mammals at another 50 sites in Namadgi National Park, and a PhD study (K. Dixon, ANU, in prep) involved a camera survey of around 100 sites in the park. The Smoky Mouse was not detected in any of these surveys. The absence or low abundance of the Smoky Mouse in the ACT reflects the situation for the species in NSW and Victoria, where it is rare and has apparently disappeared from much of its former range.

The reason for the apparent absence or low abundance of the Smoky Mouse in Namadgi National Park is unclear. In other parts of the species' range suggested causes of local population declines include drought, habitat loss, changed habitat characteristics resulting from altered fire regimes, and high predation rates from introduced predators (Ford et al. 2003; Menkhorst 2003; Menkhorst and Broome 2008a).

Large areas of Namadgi National Park appear to be suitable habitat for the species, which is thought to be vegetation communities that include heaths (Epacridaceae) and legumes (Fabaceae and Mimosaceae), and ground cover such as rocks, logs, grass tussocks or dense low shrubs (e.g. Menkhorst and Seebeck 1981; Ford et al. 2003; Menkhorst and Broome 2008b). These vegetation communities are strongly influenced by fire and may not develop for a decade or more after fire

(Ford 2008). The widespread wildfire in Namadgi National Park in 2003 promoted a low shrub layer of mostly legumes over much of the park, and there are extensive areas of rocky mountain tops and rocky ridges, often with a cover of low dense shrubs. Whilst the 2003 wildfire may have enhanced the habitat for the Smoky Mouse (promoted legumes and other heathy plants), the high severity of the fire and its large scale (160,000 ha or 90% of the park) (Carey et al. 2003) may have resulted in the loss of some or all Smoky Mouse colonies from the park, either as a direct result of the fire or from lack of cover and food sources in the weeks following the fire. The species has been found to persist at burnt sites in Grampians–Gariwerd National Park (Victoria) for at least 21 months following wildfire, though this may have been facilitated by the predator baiting program and the boulder scree habitat, which could have provided cover from the fire and from predators after the fire (Burns et al. 2015). The Smoky Mouse is likely to be at high risk of extirpation during severe and widespread fires because colonies are small and isolated (Menkhorst 2003; Menkhorst and Broome 2008a, 2008b), and for similar reasons, post-fire re-colonisation is likely to be slow.

The Smoky Mouse is particularly susceptible to predation because it has a relatively low reproductive rate, frequently uses vegetation with an open ground layer, and relies on shallow burrows and surface nests for shelter (Menkhorst 2003; Menkhorst and Broome 2008b). In this survey feral cats were detected at 12% of sites and in all vegetation types, and foxes were detected at 8% of sites. Sites where either of these predators were present accounted for 16% of all sites. Notably, the highest number of sites where these predators were observed was on remote rocky mountain tops in alpine heath that is thought to be preferred habitat for the Smoky Mouse. The results of this survey indicate feral predators (cats and foxes) are widespread in Namadgi National Park and therefore have the potential to be a significant threat to the Smoky Mouse.

This survey successfully detected all four small native ground-dwelling mammals known to be present in the park. The number of sites where each species was observed broadly reflects their abundance in previous surveys using Elliot traps (ACT Government unpublished data). This survey confirms that Agile Antechinus and Bush Rats continue to be widespread and abundant in the park whereas the Dusky Antechinus is uncommon and the eastern Pygmy Possum is rarely observed.

6 Conclusion and Recommendations

This survey did not detect the Smoky Mouse, and the species has not been detected in any of the other small mammal surveys undertaken in Namadgi National Park following the initial records of the species (trapped individuals 1985, 1987; probable hair samples 1994), suggesting the species is either absent or extremely rare in the park.

There are large areas of apparently suitable habitat and it is possible that the Smoky Mouse has not yet recolonised these areas since they were burnt in the severe wildfire in 2003. Areas identified as suitable habitat should be surveyed every 10 years or more frequently. Camera survey for this species is an effective and efficient method (Nelson 2009, 2010), and surveys targeting the Smoky Mouse could form part of a broader program to monitor abundances of small mammals and feral predators. Predator control should be undertaken at any location where the Smoky Mouse is detected.

7 References

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