Department of Sustainability and Environment

Action Statement

Flora and Fauna Guarantee Act 1988 No. 196

Smoky Mouse

Pseudomys fumeus

Description and distribution

The Smoky Mouse *Pseudomys fumeus* is a small native rodent about 2-3 times the size of the introduced House Mouse. Its fur is pale smoky grey above and whitish below. The tail is long, narrow, flexible and sparsely furred. The tail colour is pale pinkish grey with a narrow dark stripe along its upper surface. The ears and feet are flesh-coloured with sparse white hair.

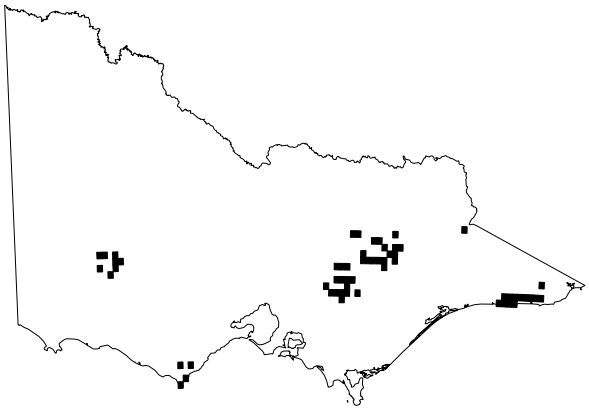
Total length varies from 180 mm to 250 mm with the tail accounting for more than half of this. The ears are 18-22 mm long and the hind feet 25-29 mm. Adult weight varies widely, from 25 g to 86 g. Animals from The Grampians and Otway Range in western Victoria tend to be larger and darker than those from east of Melbourne (Menkhorst and Knight 2001, Menkhorst and Seebeck unpublished data).

Victorian records of the Smoky Mouse fall into five distinct Victorian biogeographic regions: Greater Grampians, Otway Ranges, Highlands (both northern and southern falls), Victorian Alps and East Gippsland Lowlands. It is not certain that the species persists in all of these regions, as recent targeted surveys have failed to detect it in the East Gippsland Lowlands and the Otway Ranges (Menkhorst and Homan unpublished).

Habitat

The precise habitat requirements of the Smoky Mouse are far from clear. A wide range of vegetation communities are occupied, from damp coastal heath to sub-alpine heath. However, most records are from ridgeline dry heathy open-forest in the Highlands and The Grampians (Menkhorst and Seebeck 1981, Menkhorst 1995).

Smoky Mouse (*Pseudomys fumeus*)
(Photo: DSE/McCann)



Smoky Mouse *(Pseudomys fumeus)*
Distribution in Victoria
DSE (2004)

Victoria
The Place To Be

Smoky Mice have also been trapped in wet forest communities. Indeed, the type locality at Turtons Pass in the Otway Ranges is surrounded by some of the wettest forest communities in Victoria, and vegetation mapping shows only wet forest or temperate rainforest vegetation classes for many km in all directions (DSE BioMap database). There is evidence that some of the records from forest gullies may represent dispersing animals rather than locally-resident populations. However, in The Grampians, resident colonies are known from damp gully communities in two different locations (Silverband Falls and Victoria Range Road). The Victoria Range Road site has been trapped on two occasions, 27 years apart, in September 1974 and April 2002. Smoky Mice were captured in good numbers on both occasions. The Silverband Falls site produced captures, including breeding females, between October 1962 and June 1971 but no captures were recorded in 2002 (*Atlas of Victorian Wildlife* unpublished data, DSE 2004).

A characteristic of Smoky Mouse localities, except those in wet gullies, is a floristically diverse shrub layer with members of the Families Epacridaceae, Fabaceae and Mimosaceae well represented (Menkhorst and Seebeck 1981, Cockburn 1981a, Ford 1998a, 1998b, Ford *et al.* 2003). Ground cover is also likely to be critical and can be in the form of dense low vegetation, such as occurs in heaths, or grass tussocks, rocks and logs in more open habitats. Soil conditions also need to be conducive to burrowing and growth of hypogeal fungi, a major component of the diet.

Life history and ecology

Life history studies have been conducted at two sites – in montane heath on Mt William in the Grampians (Cockburn 1979, 1981a, 1981b) and in heathy dry forest in the Eden Hinterland, NSW (Ford 1998b, Ford *et al.* 2003). Although Ford's study spanned only one breeding season, a number of commonalities occur in the findings of the two studies.

At these sites, Smoky Mice occurred in small discrete colonies based around patches of dense heath. They sheltered in small groups, sometimes comprising a male and up to five breeding females, in a burrow system up to one metre in length (Ford *et al.* 2003, Woods and Ford 2000). Breeding occurred in the warmer months (September-April) and 1-2 litters, each of 3-4 young, were produced. At Mt William, lactation was observed in October, November or December, depending on the year. Only those females occupying the best quality habitat survived to breed in a second year. Young were forced to vacate their natal territory during autumn as food resources dwindled. Only those that found high quality habitat were expected to survive the winter.

The two studies that have followed populations through a breeding season have both shown a marked population reduction in spring. In The Grampians this decline mostly involved males and was attributed to a nutritional crisis due to the decline in available fungi in sub-optimal habitat, mostly occupied by males, during late spring. Fluctuations for females were not so large because of female-biased sex ratios in habitat where fungi persisted, and flowers and seed provided sufficient nutrients for breeding (Cockburn 1981b). However, near Eden, NSW, after initial female-biased sex ratios in spring 1997, female numbers also declined. No adults were trapped by February 1998 and none have been captured subsequently (Mills and Broome unpublished). Reasons for this decline were not elucidated but may have included predation.

Population size and dynamics

Almost nothing is known about the population number and dynamics of the Smoky Mouse. Trapping rates are usually low – 3-4% or less (Menkhorst and Seebeck 1981, Ford 1998a, Mills and Broome unpublished), but can be quite high in quality habitat when conditions are good.

A characteristic of Smoky Mouse colonies is their ephemeral nature, both spatially and temporally. There are numerous examples of unsuccessful attempts to locate the species at sites where it had been found only a few months previously and where there were no obvious changes to habitat quality (Lawrence 1986, Lintermans 1988, Ford *et al.* 2003, Mills and Broome unpublished). This may be due to shifts in home range following fluctuations in resource availability due to climatic events, or to differences in trappability, or, in the longer-term, to vegetation succession. An alternative explanation for such population fluctuations may be excessive predation by foxes and cats.

Where there is a sufficient extent of habitat to support natural population dynamics, *Pseudomys* species generally show population pulses in response to changes in resource availability. Between these pulses they persist at low population densities, except where resource-rich habitat patches allow higher densities (Watts and Aslin 1981, Brandle and Moseby 1999, Townley 2000). This pattern of distribution appears to be shown by the Smoky Mouse and, when combined with the identification of transient males that may represent individuals moving between sub-populations in search of mates (Ford 1998b), suggests that Smoky Mice exist in an area as a metapopulation. Long-term survival of the population would therefore be contingent on recruitment and immigration between sub-

populations, and the regional dynamics of resource availability in the patches of habitat.

Foraging behaviour and diet

The Smoky Mouse is primarily herbivorous but also eats some arthropod material. The diet varies seasonally according to availability and energetic demands. At the summit of Mt William, Cockburn (1981a) found that the fruiting bodies of underground fungi predominated in the diet in winter and early spring, with seed and soil invertebrates making up the rest. There was a sudden switch to flowers, seeds and Bogong Moths *Agrostis infusa* in late spring-early summer, and seeds predominated through summer and autumn. A similar pattern was found near Eden, NSW (Ford 1998b, Ford *et al.* 2003) but without the invertebrate component. The Smoky Mouse may be more dependant on the fruiting bodies of hypogeal fungi than are other *Pseudomys* species, and leaf material may be less important in its diet than in the diet of other large species of *Pseudomys* (Ford *et al.* 2003).

Conservation status

National conservation status

The Smoky Mouse is listed as endangered at the national level under the Commonwealth **Environment Protection and Biodiversity Conservation Act 1999**.

Victorian conservation status

The Smoky Mouse is listed as a threatened species under the **Flora and Fauna Guarantee Act 1988**.

The Smoky Mouse is considered endangered in Victoria according to 'The Advisory List of Threatened Vertebrate Fauna in Victoria – 2003' (DSE 2003).

Decline and threats

While a clear decline in population numbers has not been shown for the Smoky Mouse, the available evidence suggests that the species has recently disappeared from three regions – the Otway Ranges, East Gippsland Lowland and Namadgi National Park in the ACT. There have been no records from the vicinity of the type locality in the Otway Range since 1937 despite considerable survey effort (Emison *et al.* 1975, Seebeck unpublished, Menkhorst and Homan unpublished). Further, there have been no records in coastal heath or lowland forest in the Otway Ranges since the 1980s despite intensive trapping searches by several workers (Conole and Baverstock 1983, Moro 1991, Westbrooke and Prevett 2002, Menkhorst and Homan unpublished). In coastal East Gippsland the species was readily captured during the 1970s (DSE unpublished data) but recent searches have failed to locate it and the last capture came from south of Cabbage Tree Creek in 1990. The two largest, studied populations, at Mt William (Cockburn 1981a,b) and near Eden, NSW (Ford 1998b, Ford *et al.* 2003) also appear to have declined in recent years.

There are several obvious potential causes of the apparent decline in Smoky Mouse populations and these are further elucidated below. Introduced predators and changed fire regimes are likely to be acting throughout the species distribution. Timber harvesting, roading and habitat fragmentation are all potential threats in areas of State Forest managed for timber production. The threat due to habitat degradation by the Cinnamon Fungus is likely to be patchier, but has not yet been adequately assessed.

Introduced Predators

The review of Smith and Quin (1996) provides a helpful framework within which to assess the impact of introduced predators on the Smoky Mouse. They suggest that, in areas where predator abundance has been greatly elevated and sustained by the introduction and spread of the European Rabbit and the House Mouse, the primary cause of decline in native rodents such as the Smoky Mouse is direct predation by the introduced Red Fox and House Cat.

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. These factors leave it more exposed to predators than species that construct deep burrow systems or inhabit dense vegetation. Thus, even in areas where exotic prey species are scarce, predation by foxes and cats could still result in a decline in Smoky Mouse numbers. Native predators including quolls, pythons and owls could also be a threat to some colonies of Smoky Mice.

There is evidence that predation by the House Cat is a particular threat to *Pseudomys* species, with cats able to 'stake out' communal nests and potentially eliminate small breeding populations within a very short time (Risby *et al.* 2000, Ford *et al.* 2003). Predator-control aimed only at the Red Fox could result in increased populations of European Rabbits, and stimulate an increase in other predators (Dingo, House Cat, quolls, and goannas). Therefore, on-going monitoring will be necessary to determine whether predator-control programs are achieving the desired outcome.

Inappropriate fire regimes

The floristic composition and structure of heath and heathy-forest plant communities are strongly influenced by fire regimes. Too frequent burns, such as repeated prescribed burns, are likely to simplify the heath understorey in dry forests towards early successional species, encourage ingress of predators, and may result in loss of *Pseudomys* species (Catling 1986, 1991). Frequent burning is also likely to result in a low abundance and diversity of fungal food resources, most of which prefer developed litter layers (Claridge and Cork. 1997). Repeated burning can also remove hollow logs, which were used as bolt holes by radio-tracked Smoky Mice (Ford 1998b), and may help provide protection from predators. On the other hand, lack of burning can result in senescence of the heathy vegetation, loss of floristic diversity and hence food sources, and lead to intense, large-scale wildfires that are likely to eliminate metapopulations.

Smoky Mice have been trapped in vegetation ranging from early to senescent seral stages following fire (2-40 years). Insufficient data exist to determine the optimal successional stage(s), and these may differ between vegetation communities. It has been suggested that the understorey floristics and density at most Smoky Mouse sites in heath and dry forests can be maintained by fire regimes of moderate frequency (15 – 20 but up to 40 year intervals) and intensity (Lane 1997, P. Catling, D. Keith *pers comm.* 2000, Ford *et al.* 2003). The Smoky Mouse does not have the demographic characteristics of smaller, invasive post-fire specialists such as the New Holland Mouse and Silky Mouse which reach maximum abundance a few years post fire. Rather, it seems to have a relatively low reproductive potential and appears to be most abundant in relatively stable habitats, with access to well-developed, diverse, heathy understoreys. However, the specific needs of the Smoky Mouse require further research, including the scale, intensity and timing of burning that might best suit the Smoky Mouse in different parts of its range.

Timber harvesting

Clear-fell logging, and the associated soil disturbance and regeneration burns, destroy Smoky Mouse habitat within the logging coupe. Therefore, it is essential that logging plans and prescriptions leave adequate habitat patches, in a suitable conformation to sustain metapopulation dynamics and to provide a source of animals to recolonise the logged area if suitable habitat returns.

Roads and tracks

Roads and tracks associated with timber harvesting or fire control are often constructed along ridgelines in dry forest. In some areas there are few substantial ridges that do not have roads or tracks constructed on them. This is potentially a threat to a ridge-dependant species such as the Smoky Mouse, because the ridgeline habitat is often narrow and can be greatly reduced and fragmented by road construction. Roads can fragment habitat by interrupting movement patterns of small mammals (Andrews 1990). Roads and tracks are also likely to facilitate movement of foxes (Catling and Burt 1995) and cats within an area, creating further predator pressure on local populations of the Smoky Mouse.

Habitat fragmentation

The Smoky Mouse occurs in small, isolated populations that are probably restricted to patches of quality habitat that combine a diverse range of food items with adequate shelter from wildfire and predators. In many cases opportunities for gene flow between these populations are likely to be declining due to loss of populations and partitioning of the habitat. The effects of this process on population viability are unknown but cannot be positive.

Proximity to cleared freehold land and intensive logging was associated with increased abundance of Red Foxes in forest areas in eastern NSW (Catling and Burt 1995), and this was an important variable in determining the likelihood of locating the Hastings River Mouse *P. oralis*. Populations of Hastings River Mouse are generally absent from potential habitat that have areas with more than 10% clearing within a 2 km radius, and this was attributed to penetration of the forest edge by foxes and rabbits (Smith *et al.* 1996).

Dieback caused by Cinnamon Fungus *Phytophthora cinnamomi*

Many of the plant families and genera characteristic of Smoky Mouse habitat are particularly susceptible to the root-rot fungus *Phytophthora cinnamomi*. These include the Epacridaceae (*Epacris, Monotoca Leucopogon*), Fabaceae (*Daviesia, Pultanaea*), Dillenaceae (*Hibbertia*), Tremandraceae (*Tetratheca*) and Xanthorrhoeacae (*Xanthorrhoea, Lomandra*). The disease has the potential to have a very large impact on populations of the Smoky Mouse - it is present in East Gippsland at known Smoky Mouse sites and in The Grampians.

Existing conservation measures

Population Studies

- Two studies of Smoky Mouse population dynamics, habitat requirements and diet have been undertaken – a PhD study by Cockburn (1979, 1981a,b) and a BSc Hons study by Ford (1998b, Ford *et al.* 2003). Jurskis *et al.* (1997) briefly investigated habitat usage at the original NSW site and this work was expanded by Ford (1998b).

Surveys

- Baseline surveys for the Smoky Mouse in Victoria were summarised by Menkhorst and Seebeck (1981). Subsequently, surveys were undertaken by Kambouris (1999) and Menkhorst and Homan (unpublished). These have been complemented in New South Wales and the ACT by studies undertaken by Broome *et al.* (unpublished), Jurskis *et al.* (1997), Ford (1998a) and Mills and Broome (unpublished), State Forests of New South Wales (unpublished), Lawrence (1986) and Lintermans (1988).
- Surveys for Smoky Mouse have also been undertaken by Parks Victoria staff to determine the presence of Smoky Mouse in the Point Hicks area and Shipwreck creek areas of the Croajingolong National Park. No animals were caught.

Habitat management

- Ecological burning is undertaken within Croajingolong National Park to encourage Smoky Mouse habitat.

Habitat Reservation

- Writing in 1982, Cockburn (1983) correctly stated that none of the known Smoky Mouse localities were protected in conservation reserves. That situation has changed dramatically. All Smoky Mouse localities in The Grampians, the Otway Ranges and Victorian Alps are now within conservation reserves, as are most localities in the East Gippsland Lowlands, and many of those in the Highlands. See Table 1 (Page 7).

Management Planning

There has been little management planning specifically for the Smoky Mouse (Lee 1995) but a national recovery plan is being prepared (Menkhorst & Broome in prep.). In Victoria, management plans for relevant National Parks list the Smoky Mouse as a threatened species that occurs within the park but rarely include specific management actions.

Conservation objectives

Long term objective

To ensure that the Smoky Mouse can survive, flourish and retain its potential for evolutionary development in the wild in Victoria.

Objectives of this Action Statement

- In two years, at a majority of known populations in each Smoky Mouse region, secure the habitat with an appropriate land-use zone, depending on the land management agency involved.
- Instigate targeted research to elucidate habitat requirements in each broad vegetation type utilised by the Smoky Mouse, then develop management strategies to maintain their habitat requirements.

Intended management actions

Liaison

1. Participate in the national Smoky Mouse Recovery Team.

   Responsibility: DSE Biodiversity & Natural Resources Division, Parks Victoria

Population Management

2. Designate Smoky Mouse Protection Zones around known sites in appropriate area management plans, followed by targeted control of introduced predators.

   Responsibility: DSE Biodiversity & Natural Resources Division, Parks Victoria

3. Construct trial small-mammal refuges at two sites and monitor population numbers inside and outside the refuges.

   Responsibility: DSE Biodiversity & Natural Resources Division, Parks Victoria

Research

4. Develop and instigate a valid population monitoring protocol.

   Responsibility: DSE Biodiversity & Natural Resources Division, Parks Victoria

5. Conduct further research into the floristic composition (including hypogeal fungi) of Smoky Mouse habitat in each region.

   Responsibility: DSE Biodiversity & Natural Resources Division

6. Develop ecological burning regimes aimed at providing continuity in availability of patches of high quality habitat.

   Responsibility: DSE Biodiversity & Natural Resources Division, Parks Victoria

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Further information can be obtained from Department of Sustainability and Environment Customer Service Centre on 136 186.

Flora and Fauna Guarantee Action Statements are available from the Department of Sustainability and Environment website: http://www.dse.vic.gov.au

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Table 1: Victorian conservation reserves in which the Smoky Mouse has been recorded, and the year of the most recent record.

Region	Conservation reserve with Smoky Mouse record	Year of last record
The Grampians	Grampians National Park	2002
Otway Ranges	Otway National Park	1985
	Olangolah Flora and Fauna Reserve	1937
Victorian Alps	Alpine National Park	2002
	Baw Baw National Park	1978
Highlands	Lake Eildon National Park	1989
	Yarra Ranges National Park	1988
	Mt Terrible Natural Features Scenic Reserve	1989
East Gippsland Lowlands	Cape Conran Coastal Park	1979
	Croajingalong National Park	1979