

Foraging preference of the smoky mouse, *Pseudomys fumeus*, in south-eastern New South Wales: an examination of sampling strategies

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Summary

Two studies of foraging preference of the smoky mouse at the same site in south-eastern NSW reached distinctly different conclusions. The first found that the smoky mouse foraged on relatively bare exposed slopes but not in heath. The second study concluded that the smoky mouse foraged and nested in heath. This article examines the sampling strategies and results in terms of vegetation patterns and nest locations. It concludes that the results of the second study reflected the placement of traps in relation to nests rather than foraging preferences. It also questions another conclusion of the second study, that it may be necessary to reserve large areas of undisturbed vegetation to conserve the smoky mouse. This conclusion was not supported by the data presented.

Keywords: habitats; foraging; trapping; sampling; *Pseudomys fumeus*

Introduction

Jurskis *et al.* (1997) trapped smoky mice, *Pseudomys fumeus*, during spring on exposed rocky slopes with low densities of ground cover and shrubs, but not in dense heath. They also trapped smoky mice in a nearby logged and burnt area that was not rocky and exposed.

Ford *et al.* (2003) intensively trapped a smaller site within the area previously sampled by Jurskis *et al.* (1997). They concluded that the preferred spring and summer foraging area for the smoky mouse was ridgetop heath; that is, a finding distinctly different from that of Jurskis *et al.* (1997). This article explores the reasons for the different conclusions.

Comparison of findings

Trapping strategies

Jurskis *et al.* (1997) used 25 trap sites in an area of about 30 ha. Two Elliot traps were set at each site over eight nights in September 1994. The density of trap sites was less than one per hectare and of traps was less than two per hectare. Ford *et al.* (2003) used a grid of 120 trap sites systematically located 25 m apart in an area of about 7.5 ha at a density of 16 traps per hectare. Their sampling area was entirely within the wider area sampled by Jurskis *et al.* (1997). Ford *et al.* (2003) set traps for three consecutive nights

during at least one trapping session in September 1997, and for two consecutive nights during at least one trapping session each month from October 1997 to February 1998. Thus Ford *et al.* (2003) used a uniformly high density of traps in a small area whereas Jurskis *et al.* (1997) had used a low density of traps in a stratified random sample of a more extensive area.

Vegetation, nesting sites and captures

Within the 7.5 ha area common to both studies, Jurskis *et al.* (1997) caught smoky mice at four non-heath sites, but no smoky mice at three sites within heath. They also trapped smoky mice at three sites immediately to the east of the common area. No smoky mice were trapped in heath within their wider 30 ha sampling area, all captures being in non-heath vegetation. Since 1994, State Forests' ecologists have trapped 21 smoky mice on 10 other exposed, relatively bare sites in the Nullica area (State Forests unpublished data). One smoky mouse was captured on a recently logged and burnt site where none had been captured prior to logging. Another was captured on a recently burnt site where a mouse had also been captured before the burn.

Ford *et al.* (2003) captured smoky mice in five different heathy vegetation groups (Ford *et al.* 2003, Table 3). Eleven plant species were associated with capture sites, and these plants were particularly prevalent in the 'rich heath' floristic group V. Of traps in group V heath, 72% caught smoky mice (Ford *et al.* 2003, Table 3). Two of the four smoky mouse communal nests located in their grid were in the middle of group V heath. Of traps in group II heath, 60% caught mice; this group was located between three nests to the west and one to the east. Of traps in group I heath, 40% caught mice; this group was on the eastern corner of the grid, immediately to the east of one nest. Of traps in group IV heath, 30% caught mice; this group was located close to the west and south of one nest. Only 11% of traps in the heath group III, on the western edge of the grid, caught mice. Group III heath was further from nests (Ford *et al.* 2003, Fig. 4).

Ford *et al.* (2003) did not use captures per trap site to analyse habitat preference because of the 'disproportionate success of traps on the edge of the grid'. They noted that the edge traps 'potentially sample a larger area'. Although three floristic groups (I, III, VII) were situated mostly at the edge of their grid, only group I traps had a high success rate (Ford *et al.* 2003, Table 3, Fig. 4).

Jurskis *et al.* (1997) found that the legume *Kennedia rubicunda* was present with relatively high cover values at all seven trap sites where smoky mice were caught, but was absent from the three nearby trap sites where smoky mice were not caught. In contrast, Ford *et al.* (2003) found a strong negative association of *Kennedia rubicunda* with smoky mouse capture sites. They stated that the plant is characteristic of non-heath vegetation at the site.

Nutrition

Ford *et al.* (2003) stated that the proportion of seed, especially legumes, in the diet of smoky mouse increased from spring to summer. They suggested that seed may be consumed only on the ground, and not when attached to shrubs. They also cited studies associating decline in smoky mouse populations with lack of nitrogen-rich forage, and successful breeding with access to nutritious forage.

During the course of trapping, all 21 'resident' smoky mice, including 15 females, disappeared at the study site of Ford *et al.* Most animals had disappeared by the end of spring. Their analysis of trapping results for the summer months refers to an average population of one only mature mouse and two juvenile mice each month (Ford *et al.* 2003, Fig. 1). No smoky mice have since been caught in several trapping sessions at the site (L. Broome, *pers. comm.*). Ford *et al.* (2003) speculated that predation, or delayed fruiting due to drought, may have been responsible for the demise of the smoky mouse population.

Disturbance

Jurskis *et al.* (1997) reported that a haphazard sample detected seven smoky mice in an area that had recently been logged and burnt, and that contained moderately dense ground cover as well as *Rattus fuscipes*. Ford *et al.* (2003) found two smoky mouse nests outside their grid in the logged coupe. They suggested that it may 'be necessary to preserve large areas that include undisturbed vegetation' to conserve the smoky mouse.

Discussion

Two studies of the same population at the same site reached diametrically opposed conclusions regarding the spring foraging preferences of the smoky mouse. Jurskis *et al.* (1997) concluded that the smoky mouse foraged in bare, rocky areas whilst Ford *et al.* (2003) concluded that it foraged in dense heath. The sampling strategies were quite different. Ford *et al.* (2003) implied that the Jurskis *et al.* (1997) study may have undersampled 'preferred' heath habitat and oversampled 'non preferred' habitat. However, the density of traps used by Jurskis *et al.* (1997) was low in both heath and non-heath areas. In contrast, Ford *et al.* (2003) used a uniformly high density of traps in a smaller area. Smoky mice were caught in a high proportion of sites near the middle of their grid, around most of the communal nests.

Where there is a high density of traps around nests, animals would be likely to pass close to a trap within a short distance of emerging from a nest. Logically, the probability of success at a trap site is a function of both the probability of an animal passing close enough to detect the bait and the probability that the animal, having detected the bait, is attracted to it. With the high density of traps

used by Ford *et al.* (2003), there was a high probability of trap success around the nests, irrespective of foraging preferences.

Although more trap sites around the nests were successful, the individual trap success rates were greater at the edge of their grid (Ford *et al.* 2003, Table 3), particularly in floristic group I. Of the three groups (I, III, VII) that occurred mostly at the edge of their grid (Ford *et al.* 2003, Fig. 4), both proportional success rate and individual trap success rate (Ford *et al.* 2003, Table 3) appeared to decline with increasing average distance of the floristic group from the nearest nest.

Ford *et al.* (2003) considered that the 'floristically determined habitat preference' of the smoky mouse was for rich heath habitat, and listed eleven characteristic plant species. Two of the edge groups (I, III) had similarities with the 'rich heath community' group V. There were strong contrasts, however, in both trap site success and trap capture rates between these two groups. Sites in group I had about three times the trapping success of sites in group III by either measure (Ford *et al.* 2003, Table 3). The average distance from trap sites in group I to the nearest nest was probably about half that for sites in group III (Ford *et al.* 2003, Fig. 4). Nearly all (nine) of the characteristic heath species were more prevalent in group III. Seven were not even present in group I. On the other hand, *Kennedia rubicunda* was present in group I and absent from group III.

Ford *et al.* (2003) did not discuss possible reasons for the lower capture success in the supposedly more preferred heath that was further away from the nests, and in the opposite direction from the non-heath foraging habitat identified by Jurskis *et al.* (1997). A likely explanation is that success was largely determined by trap position relative to nests rather than by presence of heath. In any case, the grid did not sample the full range of habitats available to the population. In contrast, trap site success and trap success rates of Jurskis *et al.* (1997) were greatest in a central part of their larger survey area, and tapered off to zero at the edges. This central part was near the eastern edge of the grid of Ford *et al.*, about 100 m from the nests.

The extensive stratified random survey by Jurskis *et al.* (1997) sampled the full range of environments available to the population, including rainforest gullies, sheltered slopes, ridgetop heath, and the exposed northerly slopes, at a uniformly low intensity. With the low density of traps, the probability of a smoky mouse foraging close to a trap would be lower than in the study of Ford *et al.* However, the probability of a smoky mouse foraging near a trap would be relatively much higher for traps located in preferred foraging areas than for traps not in preferred foraging areas. Thus success of trapping would more reliably indicate natural foraging patterns. A survey about 3 km further north, in September 1997, revealed a similar foraging pattern (State Forests unpublished data). Smoky mice were captured only on an exposed northerly aspect.

It seems most unlikely that artificial baits used at low densities would be sufficiently detectable and attractive to lure smoky mice long distances through naturally preferred foraging habitat into non-preferred habitat as implied by Ford *et al.* (2003). Furthermore, this scenario cannot explain the lack of success of traps placed by Jurskis *et al.* in heath near the communal nests. Trapping success in the study by Ford *et al.* (2003) appears to reflect proximity to nests.

Catling *et al.* (1997) compared techniques for the survey of mammals, including small ground mammals, in similar forests. They recommended stratified sampling with Elliott traps for small mammals, but they did not consider or compare different methods or densities of trap placement within strata. They used relatively dense, systematic placement. I am not aware of any other studies that contrast results obtained by using different strategies to place Elliott traps.

Stratification based on broad environmental parameters, and random placement of traps at low densities, may have allowed Jurskis *et al.* (1997) to accurately identify spring foraging areas. It did not allow them to identify nesting areas. Systematic placement of traps at a high density in a small area by Ford *et al.* (2003) may not have reliably identified spring foraging patterns because foraging naturally occurs over long distances relative to their trap spacing, and traps were concentrated around nests. Elliott trapping does not provide information on nesting habitat.

This raises the question of nest selection by the smoky mouse. It would probably be more efficient to nest close to forage, rather than away from forage. However, dense heath on friable soil provides substantially more shelter from weather and predators, as well as much better burrowing opportunities, than bare, rocky foraging areas. The heath habitat may also provide more fungal forage that may be important to sustain smoky mice outside the spring breeding season.

The demise of the smoky mouse population during the study by Ford *et al.* (2003) might be related to their trapping strategy. Access by female animals to nitrogen-rich food is critical during gestation and lactation (White 1993). They typically produce large numbers of young but, even under favourable conditions, few survive (White 1993). Only four juveniles were known to have been weaned, from a population of at least 21 mature animals (Ford *et al.* 2003). The placement of high numbers of traps between nests and preferred foraging areas may have reduced access by the mouse population to a critical resource.

For example, the ripening legumes of *Kennedia rubicunda* may possibly be a critical resource to the population. Ripening seeds may support successful breeding of mice where mature seeds cannot (White 2002). There was a stark contrast between the results of the two studies in respect of *Kennedia rubicunda*. Jurskis *et al.* (1997) found that it was prevalent at all sites where smoky mice were caught, but absent from nearby trap sites where smoky mice were not caught. Ford *et al.* (2003) found that it was negatively associated with smoky mouse capture sites, but their highest site capture rates were obtained in group I, where this plant was much more prevalent than in the other, supposedly more preferred, heath groups.

Kennedia rubicunda flowers in late winter (Harden 1991). It scrambles on the ground, making its nitrogen-rich, developing seeds readily accessible to smoky mice in bare rocky areas during spring. Jurskis *et al.* (1997) nominated this plant as an example of a food source that might drive a foraging preference for bare rocky areas and might be favoured by ground disturbance.

Ford *et al.* (2003) found no direct evidence of predation, nor is it likely that soil moisture deficits would delay the flowering and fruiting of smoky mouse food plants, since this timing is usually governed by photoperiodism (Keeton 1972). The sudden demise of this smoky mouse population, three years after it was discovered, was probably a result of nutritional crisis, since availability of nitrogen governs all animal populations (White 1993). This crisis may have resulted from artificial constraints to foraging.

Jurskis *et al.* (1997) did not 'report a preference ... for the relatively undisturbed edge of the logged coupe' as suggested by Ford *et al.* (2003). They noted that similar numbers of smoky mice were trapped in the logged and unlogged coupes, but captures in the logged coupe were not in bare rocky habitat. Also, it was only in the disturbed area that both smoky mice and rats were captured at the same site, suggesting that disturbance to the heath in the logged coupe may have rendered it suitable, at least temporarily, for foraging by smoky mice.

As well as favouring *Kennedia rubicunda*, soil disturbance might have made underground fungi more accessible to smoky mice. The fungus *Endogone* sp. was relatively common in the diet of smoky mice captured in the logged coupe compared to other areas (Ford *et al.* 2003). Ford *et al.* (2003) indicated that there were two smoky mouse communal nests in the logged coupe. Their statement that 'in order to ensure survival of regional populations it may therefore be necessary to preserve large areas that include undisturbed vegetation' was not supported by their data.

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