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Effects of bait-station design on the uptake of baits by non-target animals during control programmes for foxes and wild dogs

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Abstract. The removal of non-toxic baits was monitored during a simulated trail-baiting programme for foxes and wild dogs in the central tablelands of New South Wales. Ninety-one buried baits were removed by a number of species including spotted-tailed quolls, Australian brush-turkeys, superb lyrebirds, small mammals, wild dogs and a red fox. Spotted-tailed quolls were significantly less likely to remove baits buried under the ground surface than baits buried in raised mounds of soil. By means of remote photography, individual quolls were identified removing 3–4 baits in one night from bait stations 400 m apart. The results of this study show that spotted-tailed quolls and other non-target species may face substantial risk of consuming baits intended for wild dogs and foxes. However, the risk of poisoning spotted-tailed quolls may be significantly reduced by appropriate planning. Recommendations are made to increase the target-specificity of baiting programmes in areas with populations of spotted-tailed quolls.

Introduction

European red foxes (*Vulpes vulpes*) and wild dogs (including dingoes (*Canis lupus dingo*), feral dogs (*Canis lupus familiaris*) and their hybrids) are the subjects of widespread pest-control programmes in Australia, many of which involve the distribution of baits containing sodium monofluoroacetate (1080) (Saunders *et al.* 1995; Fleming *et al.* 2001). Control of introduced predators can have substantial benefits for populations of native fauna (e.g. Kinnear *et al.* 1988; 1998), and is also a priority for the grazing industry, which suffers financial losses due to predation on livestock (Saunders *et al.* 1995; Fleming *et al.* 2001).

Despite the benefits of controlling foxes and wild dogs, concern has been expressed by a number of authors over the potential effects of poisoning programmes on native, non-target animals (e.g. McIlroy 1981*a*, 1981*b*, 1986; McIlroy *et al.* 1986; Calver *et al.* 1989*a*, 1989*b*; Belcher 1998). Pest-control programmes are seeking increasingly to reduce the environmental and economic damage caused by pests, while minimising impacts on non-target species (Braysher 1993; NPWS 2001). Various studies have recorded the removal of baits by non-target animals including birds (e.g. Allen *et al.* 1989; Dexter and Meek 1998), quolls (e.g. Fleming 1996; Belcher 1998), native rodents (e.g. McIlroy 1982) and reptiles (e.g. Short *et al.* 1997). Of these, particular concern has been expressed over the possible effects of 1080 baiting on the spotted-tailed quoll (*Dasyurus maculatus*) (Belcher 1998; Murray 1998; NPWS 2001).

The burial of baits may reduce their removal by non-target animals (e.g. Allen *et al.* 1989), although some non-target individuals have still been observed to excavate buried baits (e.g. Fleming 1996; Belcher 1998; Dexter and Meek 1998). This paper reports on the removal of non-toxic baits by target and non-target animals during a simulated trail-baiting programme, and compares two alternative designs of bait station in terms of target-specificity.

Materials and Methods

Study site

A simulated trail-baiting campaign was carried out in Chichester and Fosterton State Forests, 20 km north of Dungog in the Barrington Tops region of New South Wales (32°10′S, 151°50′E). Elevation is 200–1000 m above sea level, and forest types include moist hardwood, cool temperate and mixed rainforest, wet sclerophyll and dry sclerophyll forest (D. Burt, State Forests of NSW, personal communication). The study was conducted between November 2000 and February 2001, with baiting conducted on a total of 29 nights.

Comparison of bait-station designs

Fifty-seven bait stations were constructed at intervals of 400–600 m along roads and trails, and the removal of non-toxic Foxoff® free-feed baits (Animal Control Technologies Pty Ltd) was monitored simultaneously by remote photography and identification of animal tracks on the bait stations by an experienced observer (ASG). The methods used for monitoring bait removal are described in detail in Glen and Dickman (2003).

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Two designs of bait station were used. Twenty-nine bait stations (all those with an odd number) consisted of a bait buried 7 cm beneath the ground surface. A sand plot consisting of a pad of raked soil (1–2 cm thick) was placed above the buried bait for identification of tracks. This design is referred to here as a flat bait station. The remaining 28 bait stations (all those with an even number) consisted of a raised mound in which the bait was covered by 7 cm of soil, but was not buried beneath the existing soil surface. This design is henceforth referred to as a mound. All bait stations were constructed using a mix of loam and fine river sand, and were approximately 1 m in diameter. Bait stations were checked and raked daily, and any baits that had been removed were replaced.

Analysis of data

To maximise temporal independence of data, repeated bait takes from the same bait station by the same species were excluded from the analysis. Such data could not be considered independent, due to the possibility that individual animals had become habituated to the bait stations. To maximise spatial independence, records of bait removal from neighbouring bait stations by the same species on the same night were also discarded.

Data were analysed using a Chi-square contingency test. Yates' correction for continuity was applied due to the small samples obtained. This correction leads to a more conservative Chi-square test with a lower probability of Type I error (Sokal and Rohlf 1995).

When bait takes by quolls were recorded from adjacent bait stations on the same night, the resulting photographs were examined to determine, where possible, whether the same individual was responsible. The pattern of spots in the fur of quolls was used to identify individuals, which have unique markings and may be reliably identified in this way (C. A. Belcher, personal communication).

Results

From a total of 659 bait-nights, removal of a bait was recorded on 91 occasions (13.8%). The numbers of baits removed by respective species are shown in Table 1. Where possible, identification was made from photographs. When these were not available identification was based on tracks in the sand plots. On the occasions when baits were removed by unidentified animals, no tracks were identified on the sand plot due to heavy rain, and no photograph was taken due to failure of the flash.

Table 1. Numbers of baits removed from bait stations by different species

Small mammals have been grouped as identification of individual species was not possible. Data shown are raw totals, including bait takes that were deemed non-independent

Species	Mound	Flat	Total
Spotted-tailed quoll (*Dasyurus maculatus*)	33	13	46
Australian brush-turkey (*Alectura lathami*)	6	6	12
Wild dog (*Canis lupus*)	4	0	4
Red fox (*Vulpes vulpes*)	1	0	1
Superb lyrebird (*Menura novaehollandiae*)	2	0	2
Small mammals	11	3	14
Unknown	7	5	12
Total	64	27	91
No. of bait-nights	341	318	659

On four occasions, the same individual quoll was identified removing baits from more than one bait station during a night. For example, the same quoll was photographed removing baits from three consecutive bait stations, spaced at 400 m. A quoll also removed the bait from a fourth consecutive bait station. However, exposure of the film caused this photograph to be lost, so that it is not known whether the same individual was responsible for all four consecutive takes.

Excluding repeated takes from the same bait station, or takes from consecutive stations on the same night, 16 baits were removed by quolls from mounds (in 341 bait-nights) and two from flat bait stations (in 318 bait-nights). Thus, significantly more baits were removed from mounds than from flat bait stations ($\chi^2 = 8.75$, d.f. = 1, $P < 0.005$). Only one bait was recorded to have been removed by a fox, and four baits were removed by wild dogs. Although all five baits removed by wild dogs and foxes were taken from mounds, this sample size is too small for rigorous analysis.

Discussion

We have shown that free-living spotted-tailed quolls have the ability to locate and remove baits buried at a depth of 7 cm, either beneath the ground surface or in a mound. This supports the results of Belcher (1998), who found that captive spotted-tailed quolls excavated baits from a depth of 10 cm, and wild spotted-tailed quolls took buried baits from a depth of 7.5 cm. Fleming (1996) recorded the removal of one bait by a spotted-tailed quoll from a depth of between 1 and 5 cm. Further, the results of this experiment show that spotted-tailed quolls in the study area were significantly more likely to remove Foxoff® baits from mounds than from flat bait stations.

Due to the small number of baits removed by wild dogs and foxes in this experiment, firm conclusions cannot be drawn as to whether mounds are more or less effective than flat bait stations in terms of uptake by target animals. Repetition of the experiment in an area where wild dogs and foxes are more abundant may clarify this question.

The present study has also shown that, with baits placed at intervals of 400 m, individual quolls can remove baits from multiple bait stations on the same night: one individual quoll was recorded removing baits from at least three, and possibly four, consecutive bait stations on the same night. This indicates that the animal moved at least 800–1200 m between bait stations. This is an issue of considerable concern in the planning of 1080 baiting programmes. Although some spotted-tailed quolls may survive the dose of 1080 contained in a single Foxoff® bait (based on a bait containing 3 mg 1080 and sensitivity data in McIlroy 1981*b*), the chances of survival after consuming two or more baits would be greatly reduced.

Increasing the separation of bait stations should reduce the likelihood of individual quolls encountering more than one bait. However, bait stations placed at large intervals may be ineffective in reducing fox populations (NPWS 2001). A more desirable solution is to present the baits in such a way that quolls are unlikely to take baits if they are encountered.

Repetition of the experiment described here is required to determine the generality of our result in other areas and at other times of the year. However, some recommendations can be made on the basis of the present data. First, mound bait stations should not be used in areas where populations of spotted-tailed quolls occur. Baits should be buried below the ground in these areas. Secondly, to reduce the likelihood of individual quolls taking multiple baits, bait stations should be spaced further apart than 400 m. A period of free-feeding should precede the use of toxic baits where quolls may be present, and any bait station visited by a non-target animal should be abandoned. In addition, toxic baits should not be placed in bait stations neighbouring those where non-target animals are recorded.

In conclusion, this study showed that spotted-tailed quolls and other non-target animals may remove buried baits intended for wild dogs and foxes. However, the risk of poisoning spotted-tailed quolls may be significantly reduced by burying baits under the ground surface as opposed to the use of mounds. Further testing is required to determine whether this method is as effective as the use of mounds in controlling pest animals.

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