FACTORS AFFECTING THE EFFICIENCY OF FOX (*VULPES VULPES*) BAITING PRACTICES ON THE CENTRAL TABLELANDS OF NEW SOUTH WALES

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This thesis is my own original work except where specifically acknowledged,

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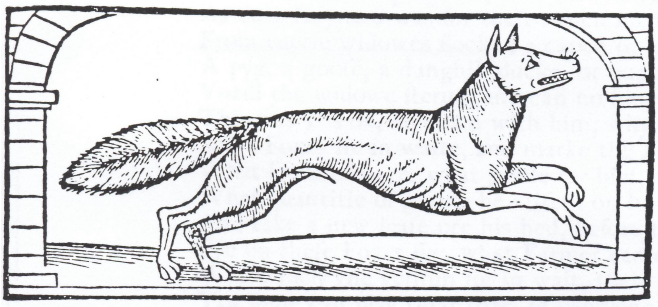
Of the Foxe



"Raynerd the Foxe am I, a craftie childe well knowne,
Yea better known than credited, wᵗ more than is mine own:
A baftard kind of curre, mine eares declare the fame,
And yet my wit and pollicie haue purchaft me great fame."

George Turbivile, The booke of Hunting, 1576.

ABSTRACT

The European red fox (*Vulpes vulpes* L.) is a well known predator of native species and domestic stock, and is recognised as one of Australia's most devastating vertebrate pests. Current fox management relies heavily on poisoning using baits impregnated with sodium monofluoroacetate (1080). This reliance on 1080 is likely to continue given the lack of viable alternatives for controlling foxes, so that, in the meanwhile, it is important to improve the efficiency of the current techniques. Factors affecting the susceptibility of individual foxes to bait include their ability to locate it, as well as the bait's palatability and toxicity. The economic costs associated with using different bait types, the pattern and density of their distribution will also affect the efficiency of control programs. It is essential to examine and refine all such issues to ensure efficient use of the 1080 baiting technique.

This thesis focuses generally on problems associated with management of the fox in eastern Australia. More specifically, I investigate the factors affecting the efficiency of fox baiting practices on the central tablelands of New South Wales.

The study was conducted largely on agricultural lands near the town of Molong ($33^0$10' 37"S, $148^0$87'15"E) on the central tablelands of New South Wales. This area was chosen as it is broadly representative, in terms of land use, of a large region of eastern Australia. The highly modified, predominantly agricultural landscapes near Molong are well suited to foxes, and conflict with the predominantly pastoral community means that fox management is widely undertaken.

I determined the persistence of 1080 in two commonly used bait types, Foxoff® and chicken wingettes, under different climatic and rainfall conditions. The rate of 1080 degradation did not change significantly between the central tablelands and the relatively hotter and drier western slopes. Foxoff® baits remained lethal for longer than wingettes under all conditions, although their rate of degradation generally increased with increasing rainfall. I confirmed the presence of defluorinating micro-organisms in the

soils of eastern Australia for the first time, and suggest that, following removal from the bait, 1080 would not persist in the environment for long.

Bait should be attractive and highly palatable to ensure that the target species will find and consume it upon discovery. Caching, where discovered food is removed but not immediately consumed, may potentially reduce the efficacy and cost-effectiveness of baiting campaigns. I quantified the caching of chicken wingette, day-old chick and Foxoff® baits by inserting transmitters into bait material and assessing whether it was eaten or cached following removal. The intensity of caching did not change significantly between seasons. Type of bait had the largest influence on caching intensity, with a greater percentage of non-toxic Foxoff® baits (66.9%) being cached than either wingettes (5.7%) or day-old chicks (4.5%). The percentage of toxic (1080) baits cached was even greater, suggesting that 1080 bait may be less palatable, and detectable to foxes.

I also investigated the use of conditioned taste aversion to reduce multiple bait uptake by foxes. Levamisole, an illness-inducing chemical, was added to bait and the fate of removed bait was again monitored via radio-telemetry. Following consumption of a levamisole-treated bait, foxes avoided eating treated baits but consumed untreated baits. I concluded that a reduction in bait consumption was achieved through learned aversion to levamisole rather than via conditioned taste aversion to baits. Adding levamisole to baits, especially non-toxic bait such as rabies vaccines, could potentially be used to reduce bait monopolisation by individual foxes.

Fox density and den site preferences were assessed by investigating the distribution and density of fox natal dens on one property (9.6 km^2) over three consecutive years. A total of 9 natal dens were located in 2000 and 2001, declining to 6 in 2002. No preference was shown for den sites on the basis of habitat, slope or aspect, but more dens were located under, or adjacent to cover. Assuming that each natal den represents a breeding pair and that the population sex ratio did not differ from parity (1:1), the site contained a pre-breeding density of 1.9 foxes/km^2 in 2000 and 2001, and 1.25 foxes/km^2 in 2002. Given that the mean number of cubs is 4.0, the post-breeding density was estimated at 5.6 and

3.75 foxes/km^2 in 2000/2001 and 2002, respectively. The results demonstrated that high densities of foxes occur on agricultural lands. The success and likely accuracy of the technique to monitor fox density suggests that it may be used to calibrate more efficient abundance estimates that will be essential for the strategic management of foxes in future.

Pest animal management strategies are traditionally assessed for their effectiveness, with less consideration being given to the efficiency or cost of achieving the desired effect. I used cost-effectiveness analyses to compare between different baiting strategies based on the longevity, palatability and handling/replacement costs associated with each bait type. The results indicated that, when measured on a total cost-per-bait-consumed basis, wingettes and day-old chicks were the most cost-effective baits for campaigns of up to 4 weeks duration. This demonstrates the importance of including the longevity, and particularly the palatability of bait, when assessing cost-effectiveness. However, it is recognised that other factors, including the consistency of dosage and uptake by non-target species, may be equally or more important in deciding the appropriate baiting strategy.

The spatial and temporal application of fox baiting in the region overseen by the Molong Rural Lands Protection Board was examined between January 1998 and December 2002 as a case study to evaluate the apparent effectiveness of cooperative management practices. Most landholders (78.8%) did not bait for foxes during this period. Based on known dispersal distances, the effect of fox immigration into baited areas was determined. The results indicated that no areas baited for foxes were separated by a sufficient buffer distance (>9.58 km) from unbaited areas to be protected from fox immigration. This suggests that, at current levels of coordination, the effectiveness of most baiting operations in eastern Australia is compromised over the long term by fox immigration. However, it is recognised that short-term reductions in fox density may sometimes be all that are required to reduce predation to acceptable levels, especially for seasonally-susceptible prey. Ultimately, the cost-effectiveness of control should be evaluated in terms of the response of the prey rather than that of the predator.

This study has highlighted deficiencies in current ‘best-practice’ baiting techniques. Specific recommendations for current baiting practices, in addition to future research, are also given. In brief, these include minimising free-feed baiting, increasing the minimum distance between bait stations, and, where possible, presenting the most palatable bait. Continued research into conditioned taste aversion, aerial baiting, and techniques to reduce caching are recommended as potential techniques to improve the efficiency of baiting practices.

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