# Behavioural Ecology of New Zealand Invasive Rodents (*Rattus norvegicus* and *Mus musculus*): Implications for Rodent Control

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**FRONTISPIECE**


**Walter**: And let's also not forget… let's not forget, Dude… that keeping wildlife, an amphibious rodent, for uh, domestic, you know, within the city… that isn't legal either.

**Dude**: What're you, a fucking park ranger now?

(Ethan and Joel Coen, "The Big Lebowski")

## ABSTRACT

Biological invasions are natural phenomena that have occurred throughout the natural history of earth. The highly negative context of the term biological invasion is associated with the fact that many modern invasive processes are anthropogenically driven. Indeed, human affiliated invasions are among the primary drivers of the current biodiversity crises. Murid rodents (Rodentia: Muridea) of the genus *Rattus* and *Mus* have become among the worst vertebrate invasive species and apart from man are the most widespread mammals on earth. Invasive rodents have severe and negative effects on human health, agricultural systems, and natural environments. The practice of rodent control is extensive and substantial attempts are made to decrease rodents' severe impacts on the environment. However, although these attempts are largely successful, there are still issues in the control of invasive rodents and new methodologies, whether at a macro or micro scale are actively pursued.

Behavioural conservation attempts to understand and improve conservation processes and practices through the study of animal behaviour. Indeed, it is becoming increasingly apparent that the behaviour of animals can be a strong tool for conservation. The control of invasive species has the goal of reducing predatory or competition pressure on species of conservation concern and advocates for behavioural conservation acknowledge the importance of behavioural studies of invasive species that can directly benefit or inform control measures. In this thesis, I explore several aspects of behavioural ecology in the Norway rat *R. norvegicus* and the house mouse, *M. musculus*, with the overarching aim of informing and improving rodent control.

I conducted a series of laboratory and field experiments focused on rodent behaviour and pest control. 1) I tested whether laboratory rats can act as effective lures for wild Norway rats and hence overcome the problem of rats avoiding food baits. This field experiment was based on the highly social behaviour exhibited by this species. I found that live traps containing live lures were significantly more effective than those with food baits at capturing wild Norway rats. In a second series of tests, I found that live lures were more efficient than food baits at attracting rats to kill traps. A study of radio-collared rats released onto a rat-free island produced inconclusive but promising results on the potential of live lures to be used to control incursions. I suggest that the use of laboratory rats as lures should be considered as an additional tool for use in future pest control management plans for invasive Norway rats. 2) I used Y-maze laboratory experiments to examine the attractiveness of urine from mice fed high and low protein diets to male and female wild mice, whether the protein content of the diet of mice affected their response and the strength of attraction of wild mice towards wild and laboratory live lure conspecifics of the opposite sex. I found that mice preferred to spend more time close to urine from donors that had eaten a high protein diet, that mouse strain did not affected conspecific attraction and that males were more active than females toward the urine of the opposite sex. These results may have implications for improving mouse capture and control. 3) I assessed the impacts of mammalian odours (specific direct cues of predation or competition) and illumination intensity (a general indirect cue of predation) on the foraging of free-ranging mice that are naïve to mammalian predators, using feeding trials in the field. Here I found that phases of the moon, but not odour, had significant effects on mouse foraging behaviour. I suggest that repeating the study over multiple lunar cycles is required to confirm this influence and, if confirmed, recommend coordinating management efforts according to the phases of the moon to improve mouse bait take and reduce bait wastage. 4) I tested for the responces of rat-naïve mice to scent cues from rats, which are competitors and potential predators in laboratory experiments, in a Y-maze apparatus. Mice behaviours revealed unexpected differences in male and female responces to rat scent. Male mice showed preference to control over rat scented food trays, while females were indiference in their preferation or even prefered rat scented food trays over control ones. These sex-based differences can suggest that males and females might be under different evolutionary pressures in regard to novel scents. 5) I looked at macronutrient selection in wild caught mice, under controlled laboratory conditions. I found that mice consumed more of diets with a high carbohydrate/protein ratio, but were highly generalist and opportunistic feeders, in general prioritising energy over macronutrients. These results demonstrate that the pattern of macronutrient selection is sensitive to ecological circumstances, and associates an opportunistic strategy with successful invasion by a small mammal in a temperate environment.

The understanding and improvement of conservation practices directly through the study of animal behavioural processes is an emerging and rapidly growing science, but relatively little attention is given to the benefits that we can draw from incorporating and understanding of invasive species behaviour into their control. To maintain an effective and continuous control of invasive species, managers need comprehensive knowledge of the behaviour of the species they target. This can be achieved only through targeted behavioural research of invasive species that is directed at improving pest control. In this thesis I have attempted to do just this.

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"One of the symptoms of an approaching nervous breakdown is the belief that one's work is terribly important".

(Bertrand Russell)

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