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The effect of handling under anaesthetic on the recapture rate of wild ship rats (Rattus rattus)

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Abstract

This paper describes a two-part study of small predators in New Zealand forests. First, during 12 days of live-trapping, 31 wild ship rats were captured, tagged and released: 9 were handled while anaesthetised using halothane and 22 were handled while conscious using gloves. There was a significant difference between the two groups of ship rats in live-recapture rate: 4 out of 9 rats that had been handled while anaesthetised were recaptured alive, compared with 0 of 22 that were handled while conscious. Second, during 12 days of removal-trapping, 23 ship rats were killed, of which 6 were tagged, including 4 of the 9 that had been previously handled while anaesthetised (2 of which had also been recaptured alive during the live-trapping) and 2 that had previously been handled while conscious. These observations have implications for the statistical estimation of population density from capture-mark-recapture data and for the development of protocols for minimising stress in captured animals, especially nocturnal species released from traps in daylight.

Keywords: *anaesthesia, animal welfare, capture probability,* Rattus rattus*, ship rat, trap avoidance*

Introduction

Common uses of capture-mark-recapture data for estimating population size, such as the Petersen method, assume that recaptures are random, that is, that all animals in the population have an equal chance of being recaptured whether or not they have been marked (Krebs 1998). In this paper we report an unusually clear violation of this assumption.

Introduced stoats, *Mustela erminea*, and rats, especially *Rattus rattus*, are serious pests in New Zealand (Innes & Hay 1991) and large-scale management of both species is required to protect the nests of vulnerable native fauna (Innes *et al* 1995; Dilks *et al* 2003); however, the animal welfare aspects of conventional pest control operations are coming under increasing scrutiny (Littin *et al* 2004). Our research group has been developing a bait delivery system that could eventually enable the humane fertility control of mustelids and rodents, under at least some conditions in New Zealand. Purdey *et al* (2004) described the first field trial of the Scentinel®, an experimental bait station for mustelids and rodents, conducted in summer 2000/01 in a forest of southern beech, *Nothofagus* sp, on South Island. This paper describes a second study, conducted in winter 2001, which set out to repeat the same procedure but in a mixed podocarp forest on North Island.

Materials and methods

This study was carried out in the Hunua Ranges Regional Park (37°05'S, 175°15'E), an area of 16 000 hectares (ha) of predominantly regenerating podocarp forest, which protects a water catchment area for the Auckland Regional Council. The study was approved by the University of Waikato Animal Ethics Committee (protocol number 486) and the Auckland Regional Council.

Twenty-nine observation stations were marked out at approximately 1 km intervals along gravel access roads. At each observation station two sites were located on opposite sides of the road, approximately 10 m apart, preferably situated in natural runways used by small mammals but out of view of the public. The study design required 12 days of live-trapping, for tagging and/or the fitting of radio-collars, followed two weeks later by 12 days of removal-trapping, to recapture marked animals.

During the live-trapping phase of the study (18–29 June 2001), a tracking tunnel was set up at one site at each observation station, and a wooden Edgar live-trap (King & Edgar 1977) was set up at the opposite site (King & Edgar 1977). Edgar traps are designed to minimise the discomfort experienced by the captured animal by providing food (eg a dead laboratory mouse) and a warm, dark nest box full of hay bedding. Two days after the tunnels and traps had been set up, they were baited with fresh meat; thereafter, both the tunnels and traps were inspected daily, and the bait was replaced either when it had been taken or if it was untouched after 2–3 days. On day 7, the tunnels and traps at each observation station were swapped to control for location differences between the sites.

Because the primary aim of this study was to repeat the observations on stoats made by Purdey *et al* (2004), the main target species was the stoat. Therefore, a supply of veterinary anaesthetic was always carried during the daily inspections of the traps; live-captured stoats and weasels are too nervous and aggressive to restrain while conscious, so they must be handled while unconscious. Lockie and Day (1964) used a simple bubble-jar to vaporise anaesthetic ether and blow it into a small anaesthetising box while in the field. At the time of this study, it was still permissible to use the same method to deliver the more modern agent, halothane (active ingredient: 2–bromo–2–chloro–1,1,1–trifluorothane). The risk to the operator of an un-metered delivery of gaseous anaesthetic was considered minimal while in the open air, and the responses of the animals were continually observed as described by King (1973). After training, as required under the then-current legislation, the veterinary officer supervising this project issued 150 ml of 4% halothane BP (1 ml ml^{-1}), which was sufficient to anaesthetise 10–12 animals of stoat/rat size with up to 15 ml each.

For the first two days, only ship rats were caught; although rodents can be handled while conscious, these were anaesthetised before ear tagging. However, the capture rates of rats were much higher than expected, and after day 2 it was clear that the stock of halothane would need to be conserved for use on mustelids; consequently, from day 3 rats were handled using leather gloves while conscious.

All live-trapped animals were ear-tagged, weighed, sexed (Cunningham & Moors 1983) and then released at the site of capture; no unusually invasive procedures, such as branding or toe-clipping, were used.

During the removal-trapping phase of the study (19–30 July 2001), steel Fenn traps were set up at both sites, at the 19 observation stations where animals had been live-captured. In order to collect as many marked animals as possible, 48 Fenn traps were distributed along the trap-line as follows: 14 observation stations had a single trap at each site (n = 28), and five observation stations had two traps at each site (n = 20).

Results

Altogether, 38 individual animals were captured during live-trapping. Of these, 31 were ship rats, *Rattus rattus*, (22 female, 8 male; 1 escaped before sexing); 4 were Norway rats, *Rattus norvegicus* (1 female, 3 male); and 3 were weasels, *Mustela nivalis* (1 female, 2 male). All three weasels, and the nine ship rats caught during the first two days (18–19 June), were handled while anaesthetised using halothane (Table 1). The remaining halothane was kept in reserve in case some stoats were caught alive, but none was. The 22 ship rats captured from 20 June onwards, and all 4 Norway rats, were handled with gloves while conscious.

Of the 31 ship rats, four were recaptured alive within three days; therefore, the total number of ship rat captures was 35. None of the other 26 rats, of either species, was recaptured in a live-trap. One weasel was also captured a second time, on day 9. The live-recapture rate of the ship rats handled under anaesthetic was four out of nine, or 0.44 with 95% confidence interval of 0.14–0.79, compared with 0 live-recaptures of the 22 ship rats handled with gloves (Fisher exact test, $P = 0.004$); rats were never captured at more than one station.

During the 12 days of removal-trapping, 23 ship rats were killed. Of these, 6 were tagged and 17 were untagged (Table 1). The 6 tagged rats included 4 of the 9 that had been previously handled while anaesthetised (2 of which had also been subsequently recaptured alive) and 2 that had been handled while conscious. In addition, 1 Norway rat, 1 weasel (neither tagged), and the first and only stoat were killed. The difference between the kill rates of the two groups of rats (4 out of 9 previously handled while anaesthetised, compared with 2 out of 22 previously handled with gloves while conscious) was also significant (Fisher exact test, $P = 0.043$).

Discussion

This study suggests one rather obvious hypothesis: that handling wild rats without anaesthetic may affect the recapture rate. To examine this hypothesis an experiment would be required that was designed to meet at least the following conditions. (1) Observation stations should be spaced widely enough to make the individual capture records at each station independent of the others; for rats in New Zealand, whose home ranges are usually between 0.3 and 1.1 ha (Dowding & Murphy 1994; Hooker & Innes 1995), stations should be at least 1 km apart. (2) Captured rats should be randomly allocated to one of the two possible handling treatments. (3) The results should be collected over a short period to minimise any potential variations in trap response attributable to population density, season or the hunger of rats. The experimental design of this study, although unintended, meets most of these conditions, and supports the above hypothesis sufficiently to justify further research.

Alternative explanations, such as significant differences in ambient temperature, the time spent confined or a lack of food in the traps are implausible. It could be argued that the two rats 997 and 990, which were captured alive twice (initially handled while anaesthetised and then handled while conscious) (Table 1), were 'trap-happy' individuals that should be removed from the analysis. Individual heterogeneity of trap response in small predators is well known (King *et al* 2003), but is not always attributable to individual behavioural choice. A more parsimonious explanation is that there is a correlation between the frequency of capture of a given individual and the position of the trap relative to the centre of that individual's home range; a larger scale study could be designed to account for such variations.

Support for our hypothesis is provided in the published literature, from which a comparison can be made of the behaviour and recapture rate of rats handled without anaesthetic (Daniel 1972; Innes & Skipworth 1983; RH Taylor unpublished, cited by Innes 2005) or with anaesthetic (Dowding & Murphy 1994; Hooker & Innes 1995).

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Table 1 Capture and recapture records of 31 ship rats caught in live-traps and released, and of 23 ship rats caught in removal-traps during this study (numbers refer to ear tag numbers).

Live-trapping					Fenn Trapping
Handled under halothane		Handled with gloves while conscious			
Day 1	Day 2	Day 3	Day 4	Days 5–12	Days 1–12
997			997		997
	990		990		990
995		995			
992		992			
993					
	989				
	987				
994					994
	991				991
				967	967
				969	969
9 tagged under halothane		4 recaptures and 2 new captures of ship rats handled with gloves plus 20 other ship rats never recaptured			6 tagged ship rats killed plus 17 others not tagged

Early field studies of live rats did not use anaesthetic during handling. For example, Daniel (1972) handled conscious, live-captured ship rats using a sleeve of wire and canvas. Of 124 ship rats (55 females, 69 males) exposed to traps each month, from March 1966 to July 1968, 53% were never recaptured. Daniel also observed what each rat did as it left the live-trap: of 178 rats released, 71 ran along the forest floor until out of sight, 69 climbed trees or supplejack (a climbing, woody plant) within approximately 10 m of Daniel, and 26 rats began vigorous grooming and face-washing after running a few metres. Twelve rats ran a short distance, then sat and swayed back and forth and went into convulsions; these were picked up, kept warm and massaged. After 10–15 min, seven recovered and ran off normally (three were recaptured at a later date), but the other five died (Daniel 1972, p 328).

Innes and Skipworth (1983) handled 51 ship rats without anaesthetic, of which 58% were never recaptured. Two females that were eventually recaptured had not been seen in a cage-trap for more than five months.

An even clearer example is given by RH Taylor (unpublished, cited by Innes 2005). In 1991, an eradication operation was planned on Haulashore I (6 ha, near Nelson, New Zealand). During the pilot study, rats were so abundant that seven ship rats were caught in 18 cage traps on the first night. These seven rats were never seen again, despite a high capture rate (16 different rats caught in 20 traps the next night, then two weeks later another 19 rats caught over two nights in 40 snap-traps). The total ship rat population at the time of eradication was estimated to be between 150 and 300 rats (25–50 rats ha^{-1}) (RH Taylor unpublished, cited by Innes 2005).

Studies in which captured animals were always handled while under anaesthetic have reported much higher recapture rates. Dowding and Murphy (1994) used halothane, and reported that all 14 rats caught between 23 and 30 September 1993 were recaptured in October, some of them up to 11 times. Hooker and Innes (1995) used ether to handle and mark 24 live rats, and later recovered 8 out of 9 rats fitted with radio-collars among 20 rats captured in kill-traps.

These two groups of published studies were carried out during different seasons and probably at different levels of population density and food resources, which (among other factors) are likely to affect the recapture rate. The clear difference in recapture rate between the studies suggests that the effect of handling technique on the response of rats to traps is strong enough to be detected despite the influence of other variables.

Ship rats are strictly nocturnal, and one of the best recapture rates was reported by Hooker and Innes (1995), who cleared the traps during the hours of darkness. Any future experiment should also attempt to distinguish between the effects on nocturnal animals of handling while conscious and of release during daylight.

Two key implications of these observations are that: (1) confinement in a live-trap is a frightening experience that at least some animals appear to remember and try to avoid repeating; (2) this reaction can be prevented or minimised by the use of anaesthesia during handling. Moreover, fear has neuroendocrine consequences that can be measured directly; therefore, any experiment investigating the extent to which handling of conscious wild rats affects recapture rate could be supported by appropriate physiological sampling. The results of such an experiment could lead to improvements in the welfare of animals involved in capture-mark-recapture studies and in the accuracy of the resulting population analysis.

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