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Traps for killing stoats (Mustela erminea): improving welfare performance

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Abstract

*Fenn traps are widely used in New Zealand for control of small predators. Introduced stoats (*Mustela erminea*) pose a significant risk to many indigenous New Zealand bird species, and the Department of Conservation (DOC) has used Fenn traps to reduce their numbers over the last 20–30 years. Changes to New Zealand animal welfare legislation in 1999 focused attention on whether this trap killed quickly and consistently and, therefore, pen tests were carried out to assess their killing performance. A guideline for testing traps was developed for the National Animal Welfare Advisory Committee, and to meet the guidelines kill traps must render all ten test animals irreversibly unconscious within three minutes. Testing is stopped as soon as three animals fail the criterion. New Mk IV and MkVI and used MkVI Fenn traps were tested. With the exception of one stoat captured in a new MkVI trap, all stoats remained conscious until euthanased at 5 minutes, and consequently only three stoats were used in each test. In response to these results, a new series of traps was developed (DOC 150, 200, and 250). These killed all 10 test animals, with all rendered irreversibly unconscious within 3 minutes and most unconscious in less than 20 seconds. The new DOC traps have also been tested for their efficacy at killing other small mammals including rats, ferrets, and hedgehogs, which are often captured as non-target species. As these new traps replace Fenn traps in Department of Conservation stoat control operations, significant improvements in the welfare of trapped stoats should result.*

Keywords: *animal welfare, Fenn traps, kill traps, non-target species, stoats, trap standards*

Introduction

Fenn traps are widely used for the control of small predators in New Zealand, such as stoats. Here, introduced stoats (*Mustela erminea*) pose significant risks to species such as kaka (*Nestor meridionalis*) (Wilson *et al* 1998), mohua (*Mohoua ochrocephala*) (O'Donnell *et al* 1996), kiwi (*Apteryx* spp) (McLennan *et al* 1996) and whio (*Hymenolaimus malacorhynchos*) (Brown 2002). The Department of Conservation (DOC), which has the legal mandate to protect endangered species, has relied upon Fenn traps, developed in England in the 1950s, to control stoats and weasels (Bateman 1979). The adoption of Fenn traps as the preferred trap for controlling stoats came about primarily from the results of field trials that showed them to be more humane than the gin (leghold) trap (King 1981).

New Zealand's animal welfare legislation was updated in 1999 (Animal Welfare Act [Government of New Zealand 1999]) and this amended legislation now allows kill traps to be left set for extended periods of time between checks. As there is an increased cost effectiveness associated with less frequent checking, DOC developed a standard practice of leaving Fenn traps set for periods of up to one month between checks. The extension of the checking time in the legislation was based on the assumption that as kill traps kill quickly any increase in checking time poses no additional animal welfare risk to trapped animals in comparison with daily checking. However, the speed and consistency that Fenn traps killed stoats was unknown. Until it could be shown that they did kill quickly and consistently, the ethical support for their use, particularly with infrequent checking, remained questionable.

The International Organization for Standardization (ISO) developed a standard for testing kill traps (Jotham & Phillips 1994; Warburton 1995; ISO 1999) and this has now been developed as a National Animal Welfare Advisory Committee (NAWAC) guideline for testing traps in New Zealand (NAWAC 2005). For kill traps, the testing guideline requires captured animals to be rendered irreversibly unconscious in less than 3 min, 70% of the time and in less than 5 min, 80% of the time. Traps that perform to this level with 90% confidence are considered acceptable (note 'acceptable' does not imply 'humane'). For a sample size of 10 animals, all must be rendered irreversibly unconscious within 3 min to meet the statistical requirements of

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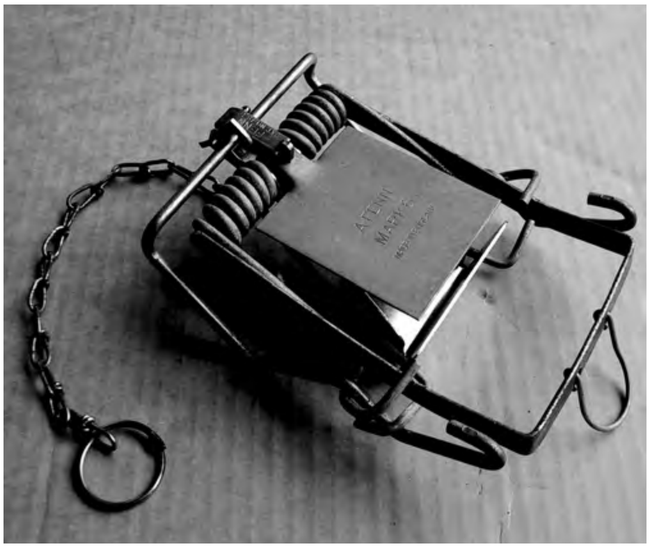
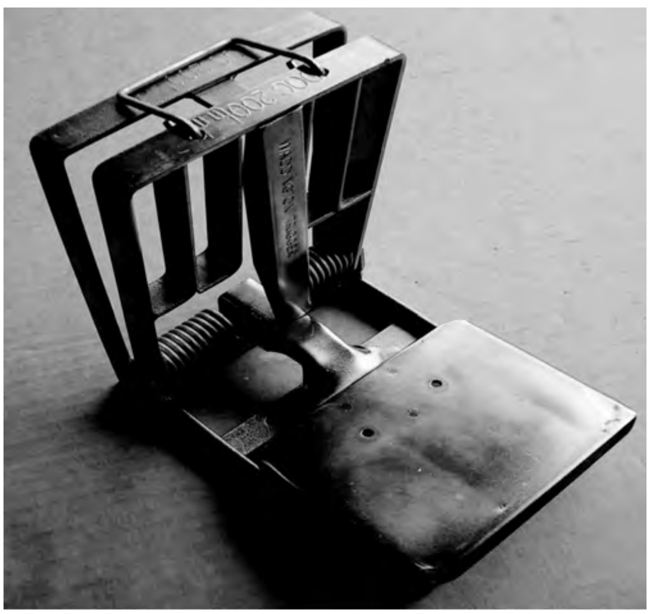
Figure 1



Fenn trap set showing the two striking bars: a rectangular bar on the right with thumb loop for setting and a cylindrical (rod-shaped) bar on left (set under trap dog and safety catch).

Figure 2



DOC 200 trap showing the large treadle plate and the vertically set striking frame. Note the striking frame has six parallel striking bars.

the test. Consciousness is determined using the palpebral (blinking) and corneal reflexes that cease when the animal has lost consciousness (Rowsell *et al* 1981).

In response to concerns that Fenn traps were not always killing captured stoats quickly, a new series of traps were developed (DOC 150, 200 and 250) to provide a humane alternative. The three traps were developed by DOC in collaboration with Phil Waddington, who developed the traps' trigger mechanism.

Figure 3

DOC trap set with an egg placed at the closed end of the tunnel and showing the entrance hole at the far end. Top of tunnel removed for access.

Materials and methods

Five different trap types were tested: Fenn Mk VI (used and new), Fenn Mk IV new, and DOC 150, 200, and 250. Used Fenn traps had had at least 12 months of field use and were tested to assess whether the killing performance of these traps had declined in comparison with new traps.

The Fenn traps (Figure 1) are triggered by a treadle plate that activates two striking (clamping) bars that rotate upwards from the side to clamp the captured animal laterally. Depending on how far the animal is into the trap when it is triggered, captures can be from single or double strikes and can be anywhere from head to tail.

The DOC 150, 200, and 250 traps (see Figure 2) have six parallel strike bars, powered by two coil springs. When set, the strike bars are in a vertical position, and when the trap is triggered the strike bars rotate down through 90° to close on and strike the animal across the dorsal surface. The DOC 150 and DOC 200 have treadle trigger plates of

Table 1 Test results of stoats captured in used and new Fenn MkVI and new MkIV traps.

Trap model	Weight (g)	Sex	Strike location	Palpebral reflex	Heart stop	Notes
Used Fenn MkVI						
F6U	250	Male	Neck and abdomen	> 5 min		Euthanased
F6U	348	Male	Head (dorsoventrally) and chest	> 5 min		Euthanased
F6U	312	Male	Front of shoulder to rear of shoulder	> 5 min		Euthanased
New Fenn MkVI						
F6N	251	Male	Chest, behind shoulders and front of hinquarters	> 5 min		Euthanased
F6N	245	Male	Head behind eyes (dorsoventrally) and rear of chest	52 s	1 min, 38 s	
F6N	297	Male	Across one shoulder, behind other	> 5 min		Euthanased
New Fenn MkIV						
F4N	257	Male	Chest, behind shoulders	> 5 min		Euthanased
F4N	332	Male	Chest, behind shoulders	> 5 min		Euthanased
F4N	265	Male	Chest, behind one shoulder, in front of other	> 5 min		Euthanased

120 × 90 mm (length × breadth), and the DOC 250 has a treadle plate of 160 × 140 mm. The fact that these traps have six strike bars means the trap has a very high probability of striking an animal across the head and potentially across multiple sites along the body depending on how far into the trap the animal has progressed prior to it being triggered.

For testing the Fenn traps and the DOC 250 traps, wild-caught stoats that had been acclimatised to captivity for at least 8 weeks were transferred from cages to outside observation pens (10 × 5 × 2 m; length × breadth × height) for the tests, with one trap system placed in each pen. Stoats were transferred in their nest boxes and had continued access to these whilst in the pens. Stoats had freedom to move around the pen and to enter the trap when they chose to. When acclimatising to the pens (2–3 days) they were provided with approximately 60 g of minced meat and water was available *ad libitum*. On the test night food was withheld until after the testing was completed (usually up to 4 h), and animals not captured were then fed.

The traps and the accompanying trap set system were supplied by DOC and were representative of those used in field operations. Traps were set in a wooden tunnel of varying dimensions depending on the trap being tested (ie DOC 150, tunnel: 400 × 200 × 150 mm [length × breadth × height]; DOC 200 [and both Fenn models], 400 × 250 × 200 mm; DOC 250, 400 × 300 × 250 mm). Tunnel entrances were restricted at each end with a wire-mesh baffle that had offset holes to reduce the risk of non-target species such as kiwi from gaining access to the traps. The top of the tunnel was removable so that the operator could gain access easily. The three DOC trap types were single sets, ie tunnels had an entrance through a wire-mesh baffle on one end only and one trap was set in the tunnel with bait (an egg) placed at the closed end (Figure 3). When testing the Fenn traps, two traps were set in each tunnel with an intact raw hen's egg placed in the centre of the tunnel as bait.

Due to the time taken for stoats to enter a trap tunnel, the last three stoats in the DOC 200 trap test and all stoats in the DOC 150 traps underwent testing by placing the trap tunnel close to the nest box in order that the stoats would investigate the tunnels as soon as they emerged from their nest boxes. This change, from providing stoats with free access to the total area of their pen and the choice of when to enter the tunnels, to constraining their choice to enter the tunnels when leaving their nest boxes, did not appear to change the animals' behaviour when in the trap tunnel as their movements when moving through the baffles onto the trap plate were similar whether entering immediately or through choice.

Each stoat was observed from an observation hut and, when a stoat entered the tunnel and triggered the trap, the observer got into position quickly to monitor the palpebral (blinking) and corneal reflexes by blowing on and/or touching the edge of the eye or, at later stages of consciousness, the cornea. The heart rate of the trapped stoat was auscultated with a stethoscope to confirm cessation of the heartbeat. The time to loss of the blinking reflex and time for the heart to stop beating were recorded as well as the strike location(s) of the trap on the animal. Stoats that were still conscious after 5 min were euthanased with an intracardiac (0.5 ml kg^{-1} bodyweight) injection of pentobarbitone. All work was carried out with approval from the Landcare Research Animal Ethics Committee.

As the chosen sample size was 10 stoats, failure to meet the NAWAC guidelines would occur once one captured stoat remained conscious beyond the 3-min threshold. This meant that if the first capture event failed to render the stoat unconscious within 3 min, the test would be stopped and the trap failed. However, to increase the robustness of the trial, it was decided that in the event of a failure early in the trial (ie captured animals remaining conscious longer than 3 min), another two animals would be tested to gain an indication of

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Table 2 Capture performance of DOC 150 traps with stoats. Strike locations refer to impact of trap strike bar on up to six locations on the animal, anterior to posterior.

Weight (g)	Sex	Strike location				Loss of palpebral reflex	Heart stop
		1	2	3	4, 5 and 6		
335	Male	Shoulders	Shoulder	Chest	Chest, abdomen, abdomen	40 s	40 s
300	Male	Across eyes	Between ears and eyes	Neck		< 9 s	4 min, 4 s
385	Male	Across eyes	Rear skull	Neck	Neck	< 10 s	1 min, 52 s
300	Male	Between ears and eyes	Neck	Neck	Shoulders	< 10 s	2 min, 38 s
190	Female	Between ears and eyes	Neck	Shoulders	Rear shoulders	< 10 s	2 min, 30 s
200	Female	Nose	Between ears and eyes	Rear skull		< 10 s	1 min, 56 s
180	Female	Between ears and eyes	Neck	Forward of shoulders	Rear of shoulders, ribcage, ribcage	< 10 s	2 min 50 s
340	Male	Between ears and eyes	Neck	Neck	Shoulders	< 10 s	3 min, 9 s
240	Male	Across eyes	Ears	Neck	Shoulders, shoulders	< 10 s	2 min, 42 s
400	Male	Abdomen	Abdomen	Hindquarters		> 3 min	Euthanased*
210	Female	Between ears and eyes	Rear skull	Neck		< 10 s	2 min, 50 s

* Excluded from sample (see text).

the likelihood of the trap passing the standards had a greater sample size been chosen (eg a sample size of 20 allows for three failures), and a better understanding of the reasons for trap failure so that potential improvements could be identified.

Results

Fenn traps

Apart from one stoat captured in a new MkVI Fenn trap, all animals remained conscious for 5 min and had to be euthanased (Table 1). Strike locations ranged from the head to the abdomen, with most animals having two strike locations. The only stoat that was rendered unconscious within 3 min was struck dorsoventrally, which probably enabled more complete occlusion of the trachea or carotid artery.

DOC traps

The DOC 150 trap rendered the first nine tested stoats unconscious within 40 seconds. Eight of these animals received head strikes and skull fractures (Table 2). The first stoat tested was not struck on the head or neck, but was still rendered unconscious within 3 min. The 10th stoat tested was struck on the abdomen and hindquarters only and was not rendered unconscious within 3 min. Analysis of video footage showed that this animal was aware and very nervous of the scent of previously caught stoats on the trap treadle, and as a result, attempted to jump over the treadle, triggering the trap with its hind feet. Because the trap plate had excessive scent on the treadle and because the stoat's behaviour was atypical, this animal was removed from the sample. Once the trap was cleaned a further stoat was tested and rendered unconscious within 10 seconds.

The DOC 200 trap successfully rendered all stoats unconscious within 48 seconds (Table 3). All stoats tested received head strikes that caused significant fractures of the skull.

The DOC 250 trap rendered all 10 stoats tested, unconscious within the 20 seconds it took an observer to enter the pen and monitor the animal (Table 4). All stoats tested received head strikes that caused significant skull fractures.

Discussion

The results indicate that even if the sample size was doubled (ie 20 animals tested), the Fenn MkIV and MkVI traps would have still failed to meet the NAWAC trap-testing guidelines. A sample size of 20 animals allows for one test to exceed the 5-min threshold, but all tests of Fenn traps exceeded that criterion. The one strike that did result in loss of consciousness within 3 min resulted from a dorsoventral head strike, which is not the typical strike location with Fenn traps. The Fenn trap typically strikes animals laterally, and in this trial six of the nine strikes were on or to the rear of the shoulders. Lateral strikes result in muscle damage and perhaps vertebral fractures but do not cause a quick death (Benn 1981). Furthermore, abdominal killing thresholds are higher than those for head and neck strikes (Benn 1981), so in order for Fenn traps to kill quickly they would have to deliver significantly higher clamping forces. Some trappers

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Table 3 Capture performance of DOC 200 traps with stoats. Strike locations refer to impact of trap strike bar on up to six locations on the animal, anterior to posterior.

Weight (g)	Sex	Strike location				Loss of palpebral reflex	Heart stop
		1	2	3	4, 5 and 6		
335	Male	Nose	Top of skull	Behind skull	Neck, shoulders	< 29 s	3 min, 23 s
340	Male	Across eyes	Behind ears	Neck	Neck	< 24 s	2 min, 57 s
255	Male	Nose	Skull, between ears and eyes			< 25 s	3 min, 7 s
280	Male	Nose	Forward of ears	Behind ears	Neck	< 26 s	2 min, 49 s
290	Male	Above eyes	Behind ears	Immediately behind skull	Shoulders, shoulders, chest	< 30 s	2 min, 55 s
345	Male	Forward of ears	Rear skull			48 s	3 min, 15 s
290	Male	Nose	Across ears,	Rear skull	Neck	< 24 s	3 min 5 s
310	Male	Nose/face	Across one ear, forward of other			< 30 s	3 min, 12 s
300	Male	Nose	Between ears and eyes	Immediately behind skull	Base of neck, shoulder	< 23 s	1 min, 40 s
270	Male	Nose	Behind eyes	Rear of skull	Neck, shoulders, shoulders	> 20 s	2 min, 58 s

Table 4 Capture performance of DOC 250 traps with stoats. Strike locations refer to impact of trap strike bar on up to six locations on the animal, anterior to posterior.

Weight (g)	Sex	Strike location				Loss of palpebral reflex	Heart stop
		1	2	3	4		
400	Male	Forward of eyes	Across ears	Neck	Longitudinal head*	< 20 s	3 min, 20 s
273	Female	Across eyes	Rear skull	Neck	Neck	< 20 s	< 40 s
208	Female	Nose	Across ears	Neck		< 20 s	2 min, 39 s
395	Male	Between eyes and ears				< 26 s	3 min, 28 s
365	Male	Between eyes and ears	Neck	Longitudinal head		< 20 s	3 min, 50 s
340	Male	Between eyes and ears	Neck	Base of neck	Longitudinal head	< 20 s	< 50 s
350	Male	Across ears	Neck, 1 mm behind skull			< 20 s	1 min 50 s
205	Female	1 mm forward of eyes	Rear skull			< 20 s	3 min, 5 s
240	Female	Between eyes and ears	Neck			< 20 s	< 50 s
310	Male	Across eyes	Behind ears	Neck	Longitudinal head	> 20 s	3 min, 46 s

* Struck by outer edge of strike bars.

have modified the Fenn trap with more powerful springs, but they found that the frame of the trap became distorted, preventing the trap from closing when sprung. In New Zealand, anecdotal field evidence suggests some stoats survive in these traps for extended periods (ie for at least 24 h), and the pen results suggest that very few are killed quickly (ie in less than 5 min). Consequently, the Fenn traps tested are clearly not acceptable in terms of the NAWAC trap-testing guidelines and should be phased out of routine operational use as quickly as possible.

Although Fenn traps are yet to be prohibited, DOC staff were concerned about their performance and responded by developing an alternative trap with potentially better performance. The test results of the DOC 150, 200, and 250 traps show that these traps kill very quickly and may, in a significantly high number of instances, meet the ideal performance of achieving almost instantaneous unconsciousness. Due to the practicalities of remotely observing the stoats and then monitoring the captured animals for loss of the blinking response, observers could not confirm loss of consciousness for at least 10–20 seconds. Consequently, many of the stoats that were recorded as having lost consciousness within 20–30 seconds might have done so considerably sooner. This conclusion is supported by the injury caused to captured stoats, with most struck across the head resulting in significant trauma (ie crushed cranium) that would have resulted in rapid loss of consciousness.

The one failure in the test of the DOC 150 alerted test personnel to the issue of trap maintenance between captures. In this trial the scent from captured stoats was allowed to accumulate on the trigger plate (treadle) and video footage indicated that such an accumulation changed the behaviour of the stoats, encouraging them to attempt to avoid contact with the treadle. Given the much lower frequency of stoat captures in an individual trap in the field, stoats are less likely to encounter a trap with this amount of accumulated scent on it. The anomaly of this capture is confirmed by field results with the DOC 200 (which has the same-sized trigger plate as the DOC 150) where all stoats caught in trials and in subsequent control operations have triggered the trap with their front legs (D Peters personal communication 2007). Nevertheless, this result indicates the importance of trap maintenance and the need to clean trigger plates between captures, and to also ensure, wherever possible, that insufficient space exists beyond the trap, to allow stoats to jump across the trap and avoid the treadle.

A criticism of kill traps is that they can never be totally species specific and, therefore, if they do not kill a captured non-target species quickly there may still be undesirable animal welfare implications. Target specificity can be controlled, to a limited degree, by excluding species larger than the target animals through use of mesh baffles with appropriately-sized offset holes for access. Ground-dwelling animals can be excluded by setting traps above ground level. Nevertheless, certain species such as rats are extremely difficult to exclude. Consequently, the effectiveness of the DOC 150, 200, and 250 traps for killing the main non-target species (rats [*Rattus norvegicus*] and hedgehogs [*Erinaceus europaeus occidentalis*]) were tested following the same methods outlined above, and all three traps passed with both species (B Warburton unpublished data). If hedgehogs need to be excluded (in New Zealand they are a conservation pest and can therefore be legitimately targeted), this could be easily achieved by reducing the size of the entrance hole in the mesh covering the wooden trap tunnel and/or extending the distance between the front mesh and the trap so this species cannot reach the trap.

Animal welfare implications

The results of these tests show that Fenn traps performed poorly and adversely affect the welfare of captured stoats. In contrast, the DOC traps killed quickly and consistently. Another significant predator pest in New Zealand is the ferret (*Mustelo furo*), and the DOC 250 trap has been successfully tested on this species (B Warburton unpublished data). As these DOC traps replace Fenn traps significant improvements in the welfare of trapped stoats and ferrets will result.

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