Manaaki Whenua
Landcare Research

Pen testing the kill efficacy of nine predator traps, 2023/24

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Pen testing the kill efficacy of nine predator traps, 2023/24

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Summary

Project and client

- Manaaki Whenua – Landcare Research, Lincoln, was contracted by the Department of Conservation (DOC), through DOC's Tools to Market programme, to assess the killing performance of nine predator kill traps. The work was undertaken between September 2023 and August 2024.

Objective

- To assess the killing performance of selected kill traps against feral cats, Norway rats, ship rats, hedgehogs, and ferrets using the National Animal Welfare Advisory Committee (NAWAC) trap-testing guideline.

Methods

- DOC provided kill traps sourced from various manufacturers. The traps and species tested were:
  - Rewild hedgehog
  - Sentinel cat
  - Flipping Timmy cat
  - Trapinator cat
  - AT220 cat
  - A24 in Professional Trap Kit Norway rat
  - Trapinator Fusion ship rat
  - SA4 ferret.
  - Nooski rat trap ship rat, Norway rat.
- Wild-caught animals were penned individually and trialled in a free-approach test. Traps were set as per the manufacturer's instructions in combination with consultation with the DOC technical review group. Two versions of the AT220 and Trapinator Fusion traps were tested.
- Once an animal was struck by the trap, the time to loss of palpebral (blinking) reflex was measured to determine whether the trap had rendered the captured animal irreversibly unconscious within 3 min. For the trap to pass the NAWAC trap-testing guidelines, 10 of 10 animals need to be rendered irreversibly unconscious within 3 min.
- This work was carried out with the approval of the Manaaki Whenua – Landcare Research Animal Ethics Committee (AEC 21/11/04).

Results

- Ten out of eleven hedgehogs were killed successfully with the Rewild trap. The fifth hedgehog captured regained consciousness and revived when removed from the trap for assessment 3 min after capture. The following six captures were assessed *in situ* as it appeared that compression for longer than 3 min was required for successful kills.
- Four feral cats were killed successfully with the Sentinel trap before the fifth pawed at the trap bait, was struck on the lower face when the trap fired and escaped. Testing ceased.
- The first feral cat tested with the Flipping Timmy pawed at the trap bait until the trap fired, and escaped. Testing ceased.
- Five feral cats were killed successfully with the Trapinator trap before the sixth pawed at the trap bait and triggered the trap. This cat was held briefly then escaped and testing ceased.
- One feral cat was killed successfully with the AT220 trap before the second was caught by the neck but was still able to breathe. This cat was euthanised and testing ceased. The trap was modified by changing the shape of the keyhole (the part of the trap that presses against the cat's throat when it is caught) and changing the trap firing software by delaying triggering by 1.5 s. Four cats were killed successfully before the fifth was caught by the neck and continued to breathe. The cat was euthanised after 3 min and testing ceased.
- One Norway rat was successfully killed by the A24 trap set in a Professional Trap Kit before the second was struck by the trap and sustained survivable injuries. The rat was euthanised after 3 min and testing ceased.
- One ship rat was successfully killed and one was missed by the Trapinator Fusion trap before inconsistency of trap trigger weights was identified. Testing ceased and the trap was modified by refining the setting of the trap plate. Testing restarted and six rats were successfully killed and three triggered the trap and escaped uninjured. The twelfth rat tested was caught by the hindquarters with its upper body beyond the front edge of the trap plate. It remained conscious beyond 3 min and was euthanised. Testing ceased.
- Six ferrets were killed successfully with the SA4 trap before the seventh entered the trap tunnel and turned around in front of the trap. After 5 minutes it backed into the trap and was caught by the hindquarters. It was still able to breathe and remained conscious beyond 3 min and was then euthanised. This capture was atypical, so testing continued. Two more ferrets were killed successfully before the tenth ferret was caught by the neck and front left leg and continued breathing. The ferret was euthanised and testing ceased.
- Ten of eleven ship rats were killed successfully with the Nooski rat trap. The sixth rat tested triggered the trap but escaped unharmed.
- Seven of 13 Norway rats were killed successfully with the Nooski rat trap. Five rats entered the trap and triggered it but escaped unharmed. The thirteenth rat was caught by the nose and remained conscious beyond 3 min and was euthanised. Testing ceased.

Conclusions

- The Rewild trap passed the NAWAC trap-testing criterion when tested on hedgehogs.
- The Sentinel, Flipping Timmy, and Trapinator traps did not pass the NAWAC trap-testing criterion with feral cats, with all failing because some cats used their paw instead of their mouth to attempt to remove the trap bait. This behaviour has been documented before with other trap designs baited with a piece of meat.
- The AT220 did not pass the NAWAC trap-testing criterion with feral cats for both versions of the trap tested. The shape of the keyhole (the part of the trap that presses against the cat's throat when it is caught) inconsistently occluded the airway, depending on the orientation of the captured cat. A continuous curve rather than an inset keyhole may be more reliable and may deal effectively with the different orientation of captures. Trigger delay may contribute to poor targeting, as the animal has time to shift from where it was originally detected and can be struck sub-optimally.
- The A24 trap did not pass the NAWAC trap-testing criterion for Norway rats when used in a Professional Trap Kit. A rat survived the impact because it was positioned to the side of the path of the impactor when it fired.
- The Trapinator Fusion trap did not pass the NAWAC trap-testing criterion for ship rats. The testing highlighted improvements that could be made to the trap, including increasing robustness, reducing the gap in front of the trap plate, and increasing consistency of plate set-off weight.
- The SA4 trap failed to pass the NAWAC trap-testing criterion. The tenth ferret tested, which survived, was the smallest tested, which may indicate small ferrets caught in this trap are at risk of being mis-caught.
- The Nooski rat trap passed the NAWAC criterion for ship rats. Nine traps were sprung by rats on top of the bait chamber, indicating that the trap needs to be shrouded/boxed to prevent this happening.
- The Nooski rat trap failed to pass the NAWAC criterion for Norway rats. There were five misses when rats entered and fired the trap but were not caught by the rubber ring. The design is probably too small to effectively trap larger Norway rats.

Recommendations

- DOC should consider which of the traps tested here that failed the NAWAC criterion are suitable for further investigation, taking into consideration likely uptake and utility, then liaise with trap manufacturers to see if they are willing to modify traps and resubmit them for NAWAC testing.
- DOC should consider testing the killing efficacy of new trap models if they appear useful for conservation gains.
- DOC could consider testing the utility of different trap designs in a controlled pen-testing environment to better inform trap configuration requirements (e.g. tunnel entrance size, approach angles) for different species.

1 Introduction

Manaaki Whenua – Landcare Research, Lincoln, was contracted by the Department of Conservation (DOC), through DOC's Tools to Market programme, to assess the killing performance of nine predator kill traps. The work was undertaken between September 2023 and August 2024 and was the final year of a 3-year contract.

2 Background

In 2000 the National Animal Welfare Advisory Committee (NAWAC) approved 'NAWAC guideline 09: Assessing the welfare performance of restraining and kill traps' to guide the testing of animal traps in New Zealand. Since then, many traps used for capturing vertebrate pests in New Zealand have been assessed against the guideline's performance criteria.

Predator Free 2050 (PF2050) is a coordinated, nationwide programme with the goal of eradicating mustelids (stoats, ferrets, and weasels), rats, and possums from mainland New Zealand by 2050. There has been a groundswell of support for PF2050 across the country, with many groups initiating pest control operations.

DOC's trap welfare best practice guidance (DOC 2021) makes the following recommendations:

i Traps that have met the current NAWAC guideline tests should be used in preference to those that have not (either untested or failed).

ii Staff should apply this consideration to traps used in DOC operations, including collaborative operations with other agencies or community groups.

iii Approving managers should apply the same preference when considering applications by other agencies, community groups, or individuals to use traps on public conservation land. To facilitate this, a best practice guide was created: *PF2050 – A Practical Guide to Trapping*.[1]

DOC's Tools to Market programme was created to invest in the development of new predator control tools and technology to support PF2050. This programme has been used to fund the testing of different types of trap each year for 3 years from 2021. Selected traps are being tested against the NAWAC guidelines to increase the number of commercially available NAWAC-tested predator traps in the marketplace. Compliance with NAWAC will assure the PF2050 community, and the public in general, that the traps are killing the targeted species as humanely as possible.

[1] https://www.doc.govt.nz/globalassets/documents/conservation/threats-and-impacts/pf2050/pf2050-trapping-guide.pdf (accessed 16 August 2024).

Four predator traps were tested in 2021/22, with all failing to pass the NAWAC trap-testing criterion (Morriss 2022). The testing process showed poor capture outcomes and helped to identify changes that could be made to trap designs to increase the likelihood of successful kills. Six predator traps were tested in 2022/23, with the Rewild trap passing the NAWAC trap-testing criterion for stoats, and Norway and ship rats (Morriss 2023).

The test results reported here are for the third tranche of 12 trap tests (nine different trap types) funded by the Tools to Market programme. The DOC technical review group decided to include species beyond those listed by PF2050, because some PF2050 operations also target feral cats and hedgehogs where they threaten specific site-based biodiversity values the projects are aiming to protect and restore. Also, several of the trap systems used for rats, mustelids, and possums regularly trap feral cats or hedgehogs, so the welfare of these species also needs to be considered.

3 Objective

To assess the killing performance of selected kill traps against feral cats, Norway rats, ship rats, hedgehogs, and ferrets using the NAWAC trap-testing guideline.

4 Methods

DOC provided traps sourced from various manufacturers (Table 1). The different trap types were tested on species nominated by DOC (Table 1), with traps set as per the manufacturer's instructions and with direction from the DOC technical review group (outlined in the following test descriptions).

Table 1. Manufacturer, trap type, and species tested

Manufacturer	Trap type	Species tested
Rewild	Rewild	Hedgehog
Kiwicare	Sentinel	Feral cat
Envirotools	Flipping Timmy	Feral cat
CMI Springs	Trapinator	Feral cat
NZ Auto Traps	AT220	Feral cat
Goodnature	A24 in Professional Trap Kit	Norway rat
CMI Springs	Trapinator Fusion	Ship rat
Steve Allan	SA4	Ferret
Nooski Trap Systems	Nooski rat trap	Ship rat, Norway rat

Prior to animal testing each trap was set and fired 10 times using a substitute target, as recommended in the trap test preparation steps in the NAWAC trap-testing guideline (NAWAC 2019).

All trap testing was carried out with the approval of the Manaaki Whenua – Landcare Research Animal Ethics Committee (AEC 21/11/04).

4.1 Test 1. Rewild trap on hedgehogs

Hedgehogs were acclimatised to captivity in outdoor pens for at least 2 weeks before being transferred to observation pens for the trap testing. They were penned individually, and the trap was tested in a free-approach test. In each pen one trap was placed near the pen side and baited with a combination of chicken mince, dog roll, and cat biscuits placed in the bait well (Figure 1). The hedgehogs were pre-fed for at least one night with the trigger mechanism left unset and bait replenished daily, if required, before lethal testing commenced.

When a hedgehog was struck by the trap, the time to loss of palpebral (blinking) reflex was measured to determine whether the trap had rendered the captured animal irreversibly unconscious within 3 min. Additional unconscious (reflex) movement was also recorded. The top cover of the Rewild trap is attached to the kill bars,[2] so opening this raises the kill bars off a trapped animal. This could influence killing performance, particularly if compression by the trap kill bars contributes to the kill.

To avoid prematurely releasing trapped animals, the trap sides were cut and duct-taped back in place to allow access to evaluate trapped animals *in situ*. The traps were opened after 3 min to determine cessation of heartbeat of trapped animals using a stethoscope. For the trap to pass the NAWAC (2019) trap-testing guideline, 10 of 10 hedgehogs need to be rendered irreversibly unconscious within 3 min.

[2] https://rewild.nz/wp-content/uploads/2022/12/Quick-Start-guide.pdf accessed 22 April 2024;

Figure 1. Unset Rewild kill trap deployed in observation pen. The raised pink flag on top of the trap indicates that the trap is unset or has fired. The trap was baited with a combination of chicken mince, dog roll, and cat biscuits placed in the bait well of the trap, located behind the trap treadle at the rear of the trap (not visible).

The fifth hedgehog tested was unconscious when removed from the trap 3 min after being struck. Soon after this a resumption of breaths spaced 30 to 40 s apart was detected, followed by partial return to consciousness 18 min after being struck. This hedgehog was euthanised and testing ceased.

In consultation with the DOC technical review group it was concluded that if the trap had been left closed the additional compression would have killed the hedgehog successfully. The testing methodology was changed, with traps opened at 3 min to confirm unconsciousness, but if breaths were detected the trap was closed on the hedgehog again and reopened to assess the animal at 2–6 min intervals. Testing restarted.

4.2 Test 2. Sentinel trap on feral cats

Feral cats were acclimatised to captivity in outdoor pens for at least 2 weeks before being transferred to observation pens for the trap testing. Within each observation pen a trap was attached to a post with the upper part of the trap 50 cm above the ground (Figure 2). The rodent-resistant bait clip on the trap was removed and replaced with rabbit meat secured in the same position with lacing wire (Figure 3), with care taken to keep the bait flush to the plate so cats would need to reach well into the mouth of the trap to bite the bait. Cats were pre-fed for at least two nights with the trap unset and the rabbit meat wired on and positioned as it would be when the trap is set, to encourage cats to put their heads into the mouth of the trap. An additional fragment of rabbit meat was placed on the post under the trap to encourage interaction.

When the traps were set for lethal testing they were baited the same way as in pre-feeding. When a cat was caught, it was assessed according to the method described in Test 1, differing only in that cats remained held in the trap until cessation of heartbeat was verified.

Figure 2. Sentinel trap as deployed for Test 2. The top of the trap (obscured by the coreflute cover) was 50 cm above the ground.

Figure 3. Rodent-resistant bait clip in Sentinel trap (L) removed and replaced with rabbit meat attached with lacing wire (R). Note that the meat is secured flush to the plate so that cats will reach well into the trap when biting the bait, increasing the probability of a successful capture.

4.3 Test 3. Flipping Timmy trap on feral cats

Feral cats were acclimatised, housed, and tested as described in Test 2. Flipping Timmy traps were pinned to the ground in each pen (Figure 4) and baited with a piece of rabbit meat impaled on the trigger rod. Cats were pre-fed for at least one night with the trap unset before lethal testing commenced.

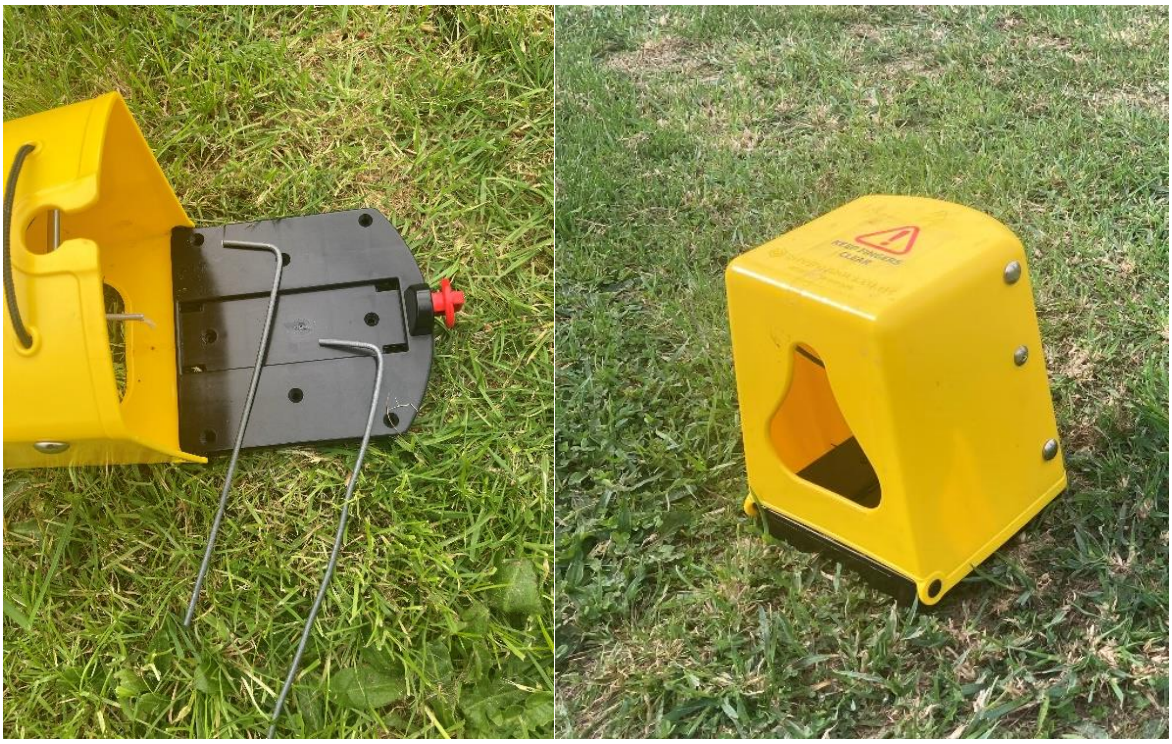

Figure 4. Flipping Timmy trap used for Test 3. Two 20 cm pins were used to secure the trap to the ground. The trap was baited with a piece of rabbit meat impaled on the trigger rod.

4.4 Test 4. Trapinator trap on feral cats

Feral cats were acclimatised and housed as described for Tests 2 & 3. As in these previous tests, cats were confined individually in each arena and a free-approach set-up was used. Initially traps were secured to posts with the trap base 45 cm above the ground. The traps were baited with pieces of rabbit meat but unset, and cat interaction with the trap was videoed. Four individual cats used their paw to grab the bait which, if the trap was set, would have resulted in poor capture outcomes.

In consultation with the DOC technical review group the set was changed to a raised set, with the expectation that there would be less pawing at the bait if the cats were climbing a ramp. The traps were attached to the top of a ramp (L 1.4 m, W 7 cm), which was screwed to a post 1 m above the ground (45º angle) (Figure 5). The traps were baited with a piece of rabbit meat impaled on the trigger wire (Figure 6), with care taken to avoid trailing strands of meat so that cats would need to reach well into the mouth of the trap to bite the bait. The traps were pre-fed for at least one night with the trigger mechanism unset before lethal testing commenced.

Figure 5. Unset Trapinator kill trap mounted on a ramp (L 1.4 m, W 7 cm) 1 m above the ground.

Figure 6. Set Trapinator kill trap showing position of rabbit meat bait. This photo was taken during initial non-lethal testing when the trap was secured 45 cm above the ground.

4.5 Test 5. AT220 trap on feral cats

Feral cats were acclimatised and housed as described for Tests 2, 3, & 4. Traps were secured to posts with the trap base 40 cm above the ground. The unset traps were baited with sardines, which were smeared on the kill bar closest to the bait trough, and the cat's interaction was videoed. During the first night four of six cats put their head in the trap to access the bait whereas the other two did not interact. There was no evidence of cats using their paw to grab the bait with this baiting method so, after three nights' pre-feeding, lethal testing commenced.

One cat was successfully caught. The second cat was caught by the neck but was still able to breathe because its airway was positioned in one corner of the keyhole (Figure 7). This cat remained conscious beyond 3 min; it was then euthanised and testing ceased. In consultation with the DOC technical review group the manufacturer modified the trap by changing the shape of the keyhole (Figure 7). In addition, the trap software was changed to delay firing by 1.5 s once the IR trigger beam was broken, with the aim of reducing the risk of paw captures. Testing restarted.

Figure 7. Underside of unset AT220 kill traps showing keyhole position. Blue arrows indicate corners in the original keyhole design (L), which were removed for trial 2 (R).

All captures in Tests 1 to 5 were videoed using a digital video system (GeoVision DVR) with infrared illumination. Video footage was reviewed using GeoVision EZView software.

4.6 Test 6. A24 trap in Professional Trap Kit on Norway rats

Wild-caught Norway rats were acclimatised to captivity in cages before being transferred to test arenas (L 2.5 m, H 1.0 m, W 0.8 m) for the trap testing. Rats were confined individually in each arena and tested in a free-approach test during the evening. In each arena a trap box was secured against the side of the arena (Figure 8). Following the manufacturer's instructions, the traps were baited with the chocolate-based rodent paste that was dispensed from an automatic lure pump provided with the trap.[3] Rats were acclimatised to the unset but baited traps for five nights before CO_2 canisters were attached to the traps (Figure 8) and lethal testing commenced.

[3] Goodnature Quick Start Guide | Installing Your A24 Trap (accessed 30 April 2024).

Figure 8. A24 in Professional Trap Kit. The trap box was screwed to a vertical board. The trap was baited with the chocolate-based rodent paste deployed in an automatic lure pump, as per the manufacturer's instructions. A Protecta EVO Ambush bait station (top, in background) was provided as a secondary nest box.

4.7 Test 7. Trapinator Fusion on ship rats

Wild-caught ship rats were acclimatised and housed as described for Test 6 above. The trap was placed against the side of the arena (Figure 9) and baited with standard feed pellets (Teklad Global 18% protein rodent diet, Envigo, WI, USA) coated with peanut butter or bacon fat; these were placed in the bait cup of the trap tunnel and a small dab of peanut butter was placed in the entrance tunnel. The rats were pre-fed with the trigger unset for at least two nights before commencing testing.

The first ship rat was killed successfully before a second triggered the trap and escaped unharmed. Another rat was able to cross over the trap plate without triggering the trap. Testing ceased and the set-off weights of the trap plates were measured and found to vary from the recommended settings (28% greater than when measured prior to testing). The set-off weights were recalibrated, but further testing revealed that they did not remain consistent between consecutive setting and resetting of the traps.

The DOC technical review group was advised and agreed that the manufacturer could modify the traps and resubmit them for testing. The trap trigger length was shortened, the height of the sear reduced, the spring under the plate shortened, and the set-off weight calibrated at 95–100 g. The modified traps were set and fired 10 times using a substitute target, and then the set-off weight was checked to ensure it had not changed from the original calibration. Set-off weights remained consistent, so testing restarted.

Figure 9. Trapinator Fusion kill trap deployed in test arena: trap tunnel closed (L) and trap tunnel opened showing unset trap (R). The traps were baited with feed pellets coated with peanut butter or bacon fat placed in the bait cup on the near side of the trap. A small dab of peanut butter was placed in the tunnel entrance to encourage entry. A Protecta EVO Ambush bait station (in background) was provided as a secondary nest box.

4.8 Test 8. SA4 trap on ferrets

The SA4 trap was tested in 2022/23 but did not pass the NAWAC trap-testing criterion (Morriss 2023). The trap was subsequently modified by bending the trigger bar back and orienting it more vertically so that ferrets would be further into the trap before it fired. The trap was resubmitted for testing.

Ferrets were penned individually and trialed in a free-approach test during the day. In the observation pen a trap was set and baited with a cube of rabbit meat impaled on the bait spike at the rear of the trap (Figure 10). A small amount of rabbit meat was placed inside one of the side entrances of the tunnel to encourage entry by ferrets.

Figure 10. Unset SA4 trap deployed in an observation pen. The trap tunnel has mesh front and rear and 70 mm diameter entrances on each side (L). The tunnel cover was secured with a hex-head screw to the base. The screw was loosened to pivot open the tunnel cover (R) to access the trap and assess captured ferrets. The trap was baited with a cube of rabbit meat secured on a bait spike at the rear of the trap (not visible).

4.9 Test 9. Nooski rat trap on ship rats

Wild-caught ship rats were acclimatised and housed as described for Tests 6 & 7 above. The trap was screwed to a 7 mm plywood board (L 60 cm, W 13 cm; Figure 11) placed against the side of the arena. The trap was secured to a board to increase stability and prevent rats tipping it over or moving it around when they interacted with it. This represented the stability that would be achieved by securing the trap to the ground with pins. Traps were baited with a mix of smooth peanut butter and Nutella® in the integral bait well. A small dab of peanut butter was placed in the entrance tunnel to encourage entry. Water was available *ad libitum*. The traps were pre-fed with the trigger unset for at least one night before commencing testing.

Figure 11. Nooski rat trap as deployed for testing. The trap was screwed to a 7mm plywood board to increase stability.

4.10 Test 10. Nooski rat trap on Norway rats

Wild-caught Norway rats were acclimatised, housed, and tested as described for Tests 6, 7, & 9 above. Traps were baited with bacon fat in the integral bait well. A small dab of fat was placed in the entrance tunnel to encourage entry. Water was available *ad libitum*. The rats were pre-fed with the trap unset for at least one night before commencing testing. Rats set off the trap and were missed on multiple occasions, but because no welfare compromise was observed testing continued.

During lethal testing rat interaction with traps in Tests 6, 7, 9, & 10 were viewed remotely on an iPad or smart phone by an observer in the adjacent corridor using TP-Link Tapo WiFi cameras with IR illumination. The last seven rats tested in Test 10 were also videoed using BOVLOV Body Cams in an attempt to determine the reason why the Nooski rat trap was missing Norway rats.

Any animals in Tests 1 to 10 that were caught by a trap, injured and survived were euthanised using standard operational procedures. They were then necropsied to identify the injuries.

5 Results

5.1 Test 1. Rewild trap on hedgehogs

Ten out of eleven hedgehogs were killed successfully with the Rewild trap. The fifth hedgehog captured was removed from the trap for consciousness assessment 3 min after capture. It was assessed as unconscious, but once removed from the compression of the trap kill bars it partially revived, with breaths every 30–40 s. After 18 min it showed signs of regaining consciousness and was euthanised soon after. The method of monitoring was adapted (see Methods, section 4.1) and the following six captures were assessed *in situ*. The hedgehogs were successfully killed. (see Table 2 in Appendix 1; Appendix 2).

5.2 Test 2. Sentinel trap on feral cats

Four feral cats were killed successfully with the Sentinel trap before the fifth pawed at the trap bait, was struck on the lower face when the trap fired and escaped. Testing ceased (see Table 3 in Appendix 1; Appendix 3). Three of the five cats tested were observed using their paw to grab at the bait, but of these the first two also used their mouth and bit the bait and pulled, resulting in successful captures.

5.3 Test 3. Flipping Timmy trap on feral cats

The first feral cat tested with the Flipping Timmy trap pawed at the trap bait for about 25 s until the trap fired. It was hit on the paw but not held, and therefore escaped. Because it remained conscious beyond 3 min, testing ceased (see Table 4 in Appendix 1).

5.4 Test 4. Trapinator trap on feral cats

Five feral cats were killed successfully with the Trapinator trap before the sixth pawed at the trap bait and triggered the trap. This cat was held briefly (2 s) then escaped; testing ceased (see Table 5 in Appendix 1; Appendix 4). All six cats tested used their paw to access bait, either during pre-feeding or during lethal testing, even though they were climbing a ramp (Figure 12).

Figure 12. Feral cat using its paw to access bait in a Trapinator kill trap. This cat was caught by the paw, held briefly, then escaped.

5.5 Test 5. AT220 trap on feral cats

One feral cat was killed successfully with the AT220 trap before the second was caught by the neck but was still able to breathe. This cat was euthanised after 5 min and testing ceased. The trap was modified by changing the shape of the keyhole (see Methods, section 4.5). Four cats were killed successfully before the fifth was securely held by the neck but continued to breathe and remained conscious beyond 3 min; it was then euthanised. Testing ceased (see Table 6 in Appendix 1; Appendix 5). During lethal testing of the modified trap one cat used its mouth or paw to access bait (three and two times, respectively) without the trap firing.

5.6 Test 6. A24 trap in Professional Trap Kit on Norway rats

One Norway rat was successfully killed by the A24 trap set in a trap box. The second rat was struck by the trap and sustained survivable injuries, with a damaged forepaw and bruising around one eye. It remained conscious beyond 3 min and was euthanised. Testing ceased (see Table 7 in Appendix 1). The rubber anvil in the traps (i.e. the pad the striker fires against) was gnawed by rats, both during pre-feeding and when the traps were set. With the trap angled back in the Professional Trap Kit mount, lure was dripping down the inner body of the trap and onto the anvil, which may have precipitated this damage (Figure 13).

Figure 13. Underside of A24 kill trap showing Norway rat chewing damage on anvil. Note that chocolate-based rodent paste has dripped down the inside of the trap.

5.7 Test 7. Trapinator Fusion trap on ship rats

One ship rat was successfully killed and one rat was missed by the Trapinator Fusion kill trap before inconsistency of trap trigger weights was identified. Testing ceased and the trap was modified by refining the setting of the trap plate (see Methods, section 4.7). Testing restarted and two rats were successfully killed before the following two triggered the trap and escaped uninjured, but because no welfare compromise had occurred with these individuals testing continued. One of the traps that had missed a rat (i.e. 'dry-fired') failed when it was being reset with a plastic part fracturing, which decreased spring tension (Figure 14). This trap was excluded, and testing continued. Four rats were successfully killed before another rat triggered the trap and escaped unharmed. Testing continued and the twelfth rat triggered the trap and was caught by the hindquarters with its upper body beyond the front edge of the trap plate. It remained conscious beyond 3 min and was euthanised. Testing ceased (see Table 8 in Appendix 1; Appendix 6).

Figure 14. Springs of Trapinator Fusion kill trap, with broken parts that were previously encasing the underside of the right spring.

5.8 Test 8. SA4 trap on ferrets

Six ferrets were killed successfully with the SA4 trap before the seventh entered the trap tunnel and turned around in front of the trap. After 5 min it backed into the trap and was caught by the hindquarters. It was still able to breathe and remained conscious beyond

3 min and was then euthanised. Because this capture was considered to be atypical, testing continued. Two more ferrets were killed successfully before the tenth ferret was caught by the neck and front left leg and continued breathing. The ferret was euthanised after 5 min and testing ceased (see Table 9 in Appendix 1; Appendix 7).

5.9 Test 9. Nooski rat trap on ship rats

Five ship rats were successfully killed before the sixth rat triggered the trap and backed out before the rubber ring closed. Because no welfare compromise had occurred with this individual, testing continued. An additional five rats were successfully killed. All ten successful kills were caught around the neck, but four of these were also caught by one of their front paws. Rats caught by neck and paw were rendered irreversibly unconscious in a similar time to those caught by the neck only (see Table 10 in Appendix 1; Appendix 8). During testing, ship rats fired the trap nine times by climbing on top of the bait chamber and investigating the recessed trigger arm and trigger pivot (Figure 15). Ship rats gnawed on parts of the unset trap during acclimatisation and pre-feeding, including the trigger components, outer rim of the bait chamber, and tunnel. If the damage prevented the trap from being set a new bait chamber was used for lethal testing.

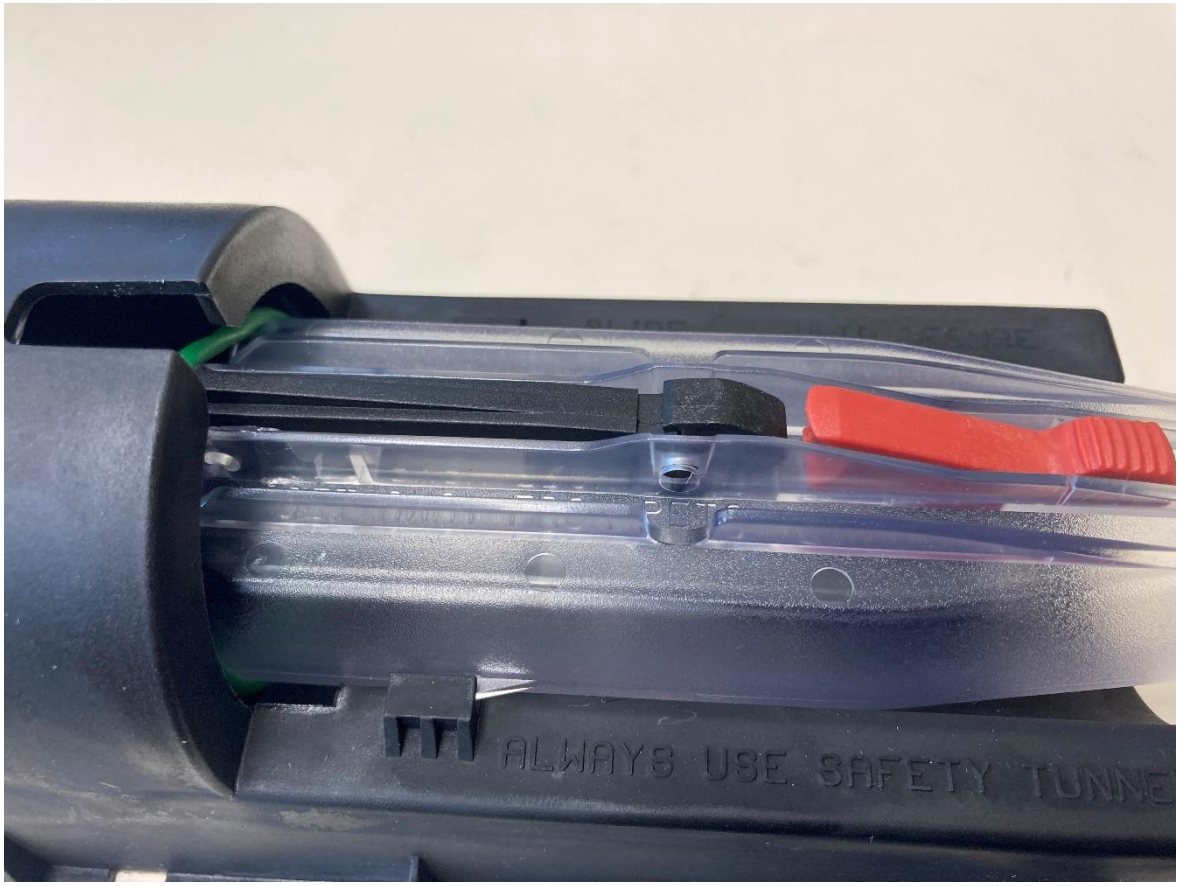

Figure 15. Nooski rat trap with close-up of the clear bait chamber. The black trigger arm and trigger pivot on top of the chamber were interfered with by ship rats, resulting in traps misfiring nine times during testing. The green rubber ring, which is the killing mechanism, can be seen on the left.

5.10 Test 10. Nooski rat trap on Norway rats

The first two Norway rats tested triggered the trap but backed out of the trap tunnel before the rubber ring closed. Testing continued and the next two rats were killed successfully before another two rats triggered the trap and escaped unharmed. Two more rats were killed successfully, and then another rat triggered the trap and escaped unharmed. A further three rats were killed successfully before the 13th rat tested sprung off the trap by interfering with the trigger arm and trigger pivot. The trap was reset, and after about 15 min this rat entered the trap, was caught by the nose, remained conscious beyond 3 min and was euthanised. Testing ceased (see Table 11 in Appendix 1; Appendix 9). Some traps were gnawed by rats when they were left unset during acclimatisation and pre-feeding, with one extensively damaged (Figure 16). This unit was replaced with a new trap for subsequent testing.

Figure 16. Nooski rat trap with gnawing damage from a Norway rat after being left unset during the acclimatisation and pre-feeding period.

6 Conclusions

6.1 Rewild trap

The Rewild trap passed the NAWAC trap-testing criterion when tested on hedgehogs. The testing revealed that compression for longer than 3 min was required to successfully kill hedgehogs. This trap design has high clamping force when closed, so it appears unlikely that hedgehogs could regain consciousness once struck and held by the trap.

The Rewild trap has now passed the NAWAC trap-testing criterion for ferrets, stoats, Norway rats, ship rats (Morriss 2023), and hedgehogs. Currently the only other trap design that has passed for all these species is the DOC250 kill trap.[4]

6.2 Sentinel, Flipping Timmy, and Trapinator traps

The Sentinel, Flipping Timmy, and Trapinator traps did not pass the NAWAC trap-testing criterion with feral cats, with all failing because some cats used their paw instead of their mouth to attempt to remove the trap bait. This behaviour has been documented before with other trap designs baited with a piece of meat (i.e. the Possum Master and Set n Forget traps; unpubl. data). The behaviour was also noted with the SA2 Kat trap, which passed the NAWAC trap-testing criterion (Morriss 2017).

The welfare compromise of cats that escape from Sentinel, Flipping Timmy, and Trapinator traps would probably be low, with no obvious injuries observed in the three cats that escaped during this test. More of concern would be a reduction in cat control efficacy, as cats that escape are likely to become harder to catch.

6.3 AT220 trap

Both the original and modified versions of the AT220 trap failed to pass the NAWAC criteria for feral cats. In both failures a trapped cat was held securely by the kill bars, but their airway was positioned in line with the inset keyhole allowing them to breathe freely. The efficacy of the AT220 trap for possum control was assessed by MWLR for OSPRI in 2020 (Yockney et al. 2020). There were 107 possums killed but an additional 20 escaped (16%) when the trap reset. The possums that escaped were still able to breath even though pinned in the trap. Although the trap passed the NAWAC criteria for possums in 2018, with 10 of 10 possums rendered irreversibly unconscious in under 3 min, these more recent field data are concerning and this testing on feral cats points to the same issue. The manufacturer should consider redesigning the shape of the bar that captured animals are pressed against. A continuous curve rather than an inset keyhole may more reliably

[4] Bionet trap testing summary table. Trap-summary-table-DOC-3174743-21-Nov-2023-update.pdf (bionet.nz) (accessed 2 May 2024).

occlude the airway of both cats and possums and deal effectively with the different orientation of captures observed.

As with the other trap designs tested, a cat using its paw to access the bait was observed. This occurred with the modified AT220 and the trap didn't fire, presumably because of the 1.5 s trigger delay. Ironically this cat used its mouth at least three times before resorting to pawing at the bait. If there wasn't a delay it probably would have been caught by the neck. Trigger delay is probably not the best idea for consistent targeting because the animal has time to shift from where it was originally detected and can be struck sub-optimally.

6.4 A24 trap in Professional Trap Kit

The A24 trap in the Professional Trap Kit failed to pass the NAWAC trap-testing criterion for Norway rats in the same way as when the trap by itself was tested in 2023 (Morriss 2023). Having the trap tilted back in the Professional Trap Kit did not change the approach angle, and the second rat tested survived because it was positioned to the side of the path of the impactor when it fired. The rat tested weighed 239 g, which is average for Norway rats but larger than most ship rats (Morriss 2019). How frequently this type of escape occurs when these traps are used in the field is unknown because injured rats will move away from the trap site.

6.5 Trapinator Fusion trap

The Trapinator Fusion trap failed to pass the NAWAC trap-testing criterion for ship rats. The testing highlighted some faults that need to be rectified for this trap design to succeed. The plastic part fracturing when attempting to reset after the trap dry fired indicates that the type of plastic used is too fragile for sustained field use. Traps will inadvertently be dry fired when used, so the trap needs to be robust enough to absorb the impact forces and retain structural integrity.

It was difficult to achieve consistent set-off weights with the trap plates. It was more consistent with the final testing, but it is unclear if this consistency can be maintained with prolonged field use. There was a 28 mm gap from the outer edge of the kill bars to the wall of the tunnel, which provides clearance for the kill bar handle to come down when the trap fires. The final rat capture indicates this gap is too wide, with the rat being mis-struck as it tried to enter the trap tunnel around the front edge of the trap. Traps of similar design (i.e. DOC 150 and DOC 200) have a gap in front of the plate closer to 5 mm when deployed in double-mesh baffle tunnels, which prevents rodents entering the tunnel without going across the plate.

6.6 SA4 trap

The SA4 trap failed to pass the NAWAC trap-testing criterion for ferrets. The tenth ferret tested was caught by the foreleg and neck and somewhat surprisingly was still able to breathe. Presumably being caught by the foreleg as well reduced the pressure exerted on its airway. The ferret was securely held and would not have been able to pull out, but death would have been prolonged if this had happened in the field. It was the smallest

ferret tested, so this may indicate small ferrets caught in this trap are at risk of being mis-caught, which is contrary to many other ferret trap tests, where large males have been the most difficult to kill.

6.7 Nooski rat trap

The Nooski rat trap passed the NAWAC criterion for ship rats. All kills were consistent with rapid unconsciousness. Four of the ten were caught by the front paw also, which didn't influence the rapidness of the onset of unconsciousness. There were nine spring-offs during testing, when rats were on top of the bait chamber and interfered with the trigger arm. Operationally this would indicate that the traps need to be shrouded/boxed, with enough clearance for the trigger arm to pivot, to reduce the proportion of spring-offs.

The Nooski rat trap failed to pass the NAWAC criterion for Norway rats. The eighth rat was caught by the nose and remained conscious beyond the 3 min threshold. There were also five misses, when rats entered and fired the trap but were not caught by the rubber ring. The original Nooski rat trap passed the NAWAC criterion for Norway rats in 2007 (unpubl. data), but since then the design has been changed, with a different triggering system and a reduction in the size of the baiting chamber (height reduced from 38 mm to 30 mm). Although the triggering system has improved, with less force required to set off the trap, the reduction in size of the baiting chamber means the design is probably too small to effectively trap larger Norway rats. Review of the video of the last six captures and one miss was not able to clarify the reason for the misses. The missed rats and final rat caught by the nose were at the larger end of the range used, so this probably indicates that they squeeze into the baiting chamber entrance, which interrupts the pivot of the trigger arm when it fires, resulting in a triggering delay and giving the rats time to back out.

7 Recommendations

- DOC should consider which of the traps tested here that failed the NAWAC criterion are suitable for further investigation, taking into consideration likely uptake and utility, then liaise with trap manufacturers to see if they are willing to modify traps and resubmit them for NAWAC testing.
- DOC should consider testing the killing efficacy of new trap models if they appear useful for conservation gains.
- DOC could consider testing the utility of different trap designs in a controlled pen-testing environment to better inform trap configuration requirements (e.g. tunnel entrance size, approach angles) for different species.

8 Acknowledgements

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Appendix 1 – Results tables

Table 2. Outcome of Test 1 using the Rewild kill trap for capturing hedgehogs

Test date	Weight (g)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
18/10/2023	978	M	<3 min	<4 min 44 s	1st bar skull.	Trap opened at 3 min. No noise or movement detected prior. No heartbeat detected.
19/10/2023	994	M	<2 min	6 min 16 s	1st bar neck / rear of skull.	Trap opened at 3 min. Intermittent breaths heard until c. 2 min.
19/10/2023	779	M	<3 min	<4 min 47 s	1st bar rear of skull.	Trap opened at 3 min. Some noise of spines rubbing on trap up to 2 min 30s (this could be reflex movement). No heartbeat detected.
21/10/2023	767	M	<3 min	5 min 44 s	1st bar rear of skull.	Trap opened at 3 min. No noise or movement detected prior.
21/10/2023	684	M	<3 min	-	1st bar rear of skull.	Unconscious when removed from trap at 3 min. Breathing restarted with breaths spaced 30–40 s apart. Partial return to consciousness at 18 min. Euthanised at 20 min. If left in trap, compression is likely to have resulted in a quicker death.
23/10/2023	857	F	<3 min	<6 min 44 s	1st bar shoulder/neck; 2nd bar skull.	Trap opened at 3 min. Hedgehog unconscious, but a breath detected soon after. Trap closed so that compression aided death. No further breaths detected. No signs of life when trap reopened at 6 min.
23/10/2023	933	M	<3 min	6 min 12 s	1st bar shoulder/neck; 2nd bar skull.	Trap opened at 3 min. No noise or movement detected prior.
26/10/2023	812	M	<3 min	5 min 3 s	1st bar skull; 2nd bar muzzle.	Trap opened at 3 min. No noise or movement detected prior. Bleeding from right ear.
26/10/2023	831	M	<3 min	<4 min 32 s	1st bar skull.	Trap opened at 3 min. No noise or movement detected prior. Skull crushed.
26/10/2023	657	M	<3 min	<12 min 25 s	1st bar shoulder/neck; 2nd bar skull.	Trap opened at 3 min. Hedgehog unconscious, but a breath detected soon after. Trap closed so that compression aided death. Trap reopened at 6 min with hedgehog unconscious, but another breath detected. Trap closed and reopened at 12 min. No sign of life detected.
26/10/2023	732	F	<3 min	<8 min 45 s	1st bar shoulder/neck; 2nd bar skull.	Trap opened at 3 min. Hedgehog unconscious, but a breath detected soon after. Trap closed so that compression aided death. No further breaths detected but minor movement observed up to 6 min. No signs of life when trap reopened at 8 min.

Table 3. Outcome of Test 2 using the Sentinel kill trap for capturing feral cats

Test date	Weight (kg)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
3/10/2023	3.83	M	<48 s	3 min 36 s	Neck.	During struggles trap dislodged from bracket and post; unconscious when first assessed; no breaths detected.
4/10/2023	3.66	F	<59 s	3 min 46 s	Neck.	Used paw at least 4 times to access bait; initial vocalisation after capture (<5 s); trap dislodged from lower part of bracket but remained in place; unconscious when first assessed; no breaths detected.
5/10/2023	2.97	M	<1 min 2 s	5 min 4 s	Neck.	Paw up in trap when it bit the bait and fired the trap; trap remained fixed to bracket top and bottom; unconscious when first assessed; no breaths detected.
6/10/2023	3.57	F	2 min 58 s	6 min 27 s	Neck.	Approached trap from the side and initially caught by the neck laterally; struggles dislodged trap from bracket and post; vocalisation and breathing until 2 min, then repositioned and fully occluded airway.
7/10/2023	4.32	M	-	-	Paw/forehead/lower face.	Used paw at least 4 times to access bait; trap fired when both paw and upper head in trap; escaped instantly; video shows upper kill bar struck cat on top of head; no injury detected.

Table 4. Outcome of Test 3 using the Flipping Timmy kill trap for capturing feral cats

Test date	Weight (kg)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
12/10/2023	5.10	M	-	-	Paw.	Didn't put head in trap; pawed at bait for c. 25 s until the trap eventually fired; not held; no injury observed.

Table 5. Outcome of Test 4 using the Trapinator kill trap for capturing feral cats

Test date	Weight (kg)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
25/01/2024	3.30	M	<49 s	4 min 13 s	Neck.	Reflex movement until 3 min 30 s; no breaths detected.
25/01/2024	2.94	F	<53 s	3 min 29 s	Neck.	Reflex movement until 3 min; no breaths detected. Post-capture movement pulled trap off bottom retention screw.
27/01/2024	3.67	M	1 min 16 s	4 min 57 s	Neck.	Vocalisation at 30 s; reflex movement until 4 min.
29/01/2024	3.17	M	2 min 24 s	5 min 43 s	Neck.	Reflex movement until 3 min.
29/01/2024	3.25	F	1 min 53 s	5 min 7 s	Neck	Reflex movement until 3 min 50 s.
31/01/2024	4.61	M	-	-	Right front paw.	Only held briefly. No damage to the paw observed.

Table 6. Outcome of Test 5 using the AT220 kill trap for capturing feral cats

Test date	Weight (kg)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
Trial 1						
5/02/2024	4.29	M	1 min 17 s	3 min 41 s	Neck.	No breaths detected; reflex movement until 2 min 55 s.
5/02/2024	3.22	M	-	-	Neck.	Securely held in trap with head slightly rotated so that airway positioned in corner of keyhole. Vocalising and restricted breathing.
Trial 2						
9/05/2024	2.27	F	<1 min 43 s	4 min 26 s	Neck; lateral-facing springs.	Initial brief vocalisation; reflex movement until 3 min 20 s; airway blocked by keyhole.
9/05/2024	3.35	M	1 min 14 s	5 min 12 s	Neck in outer curve of bar.	Initial brief vocalisation; reflex movement until 3 min; airway blocked by outer curve of kill bar.
10/05/2024	2.60	F	38 s	4 min 57 s	Neck in inner keyhole.	Reflex movement until 2 min 40 s.
12/05/2024	2.97	M	48 s	6 min 26 s	Neck in inner keyhole.	Reflex movement until 3 min 30 s.
12/05/2024	4.28	F	-	-	Neck in outer curve of bar.	Vocalising and breathing freely. Kill bars pushing cat against outer curve but airway unrestricted because aligned with inner keyhole.

Table 7. Outcome of Test 6 using the A24 kill trap in Professional Trap Kit for capturing Norway rats

Test date	Weight (g)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
1/03/2024	252.1	F	NA	NA	Head.	The sound of the trap firing was mistaken for the sound of another rat jumping on top of nest box seen on one of the cameras. The struck rat was found dead with rigor mortis 30 min later when testing ceased. Skull fractured and copious bleeding from left ear. Kill assumed to be rapid.
20/03/2024	239.1	F	-	-	Front left paw and left side of head.	Impact stunned rat but it remained conscious; ran 60 cm out of tunnel initially and then appeared incapacitated though conscious; revived to full mobility at 3 min 15s; crush damage to front left paw and bruising around left eye.

Table 8. Outcome of Test 7 using the Trapinator Fusion kill trap for capturing ship rats

Test date	Weight (g)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
Trial 1						
29/01/2024	148.0	M	<29 s	3 min 43 s	Longitudinal full body.	Rat struck by far edge of kill bars nearest to the wall of the tunnel. Removed from trap at 2 min to assess cessation of heartbeat.
31/01/2024	129.0	M	-	-	Nil – complete miss.	
Trial 2						
26/04/2024	133.1	F	<23 s	6 min 1 s	Full body.	Full body compression: no movement observed; removed from trap at 3 min to determine cessation of heartbeat.
28/04/2024	219.5	M	<20 s	<3 min 29 s	Head and chest.	Reflex movement by rear legs and tail until 1 min; no heartbeat detected when removed from trap after 3 min.
30/04/2024	119.5	F	-	-	Nil – complete miss.	Multiple visits to trap entrance tunnel before finally triggering trap.
30/04/2024	156.3	M	-	-	Nil – complete miss.	Multiple visits to trap entrance tunnel before finally triggering trap.

Test date	Weight (g)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
30/04/2024	216.9	M	<21 s	<3 min 22 s	Head.	Skull crushed; reflex movement by rear legs and tail until 1 min; no heartbeat detected when removed from trap at 3 min.
2/05/2024	157.4	M	<22 s	<3 min 15 s	Head and shoulders.	Skull crushed; no heartbeat detected when removed from trap at 3 min.
2/05/2024	213.8	M	NA	NA	Head.	Skull crushed. Time to death was not assessed as trap accidently left set overnight and the rat was found dead the following morning. Extent of damage indicates death would have been rapid.
6/05/2024	180.4	M	<20 s	<3 min 20 s	Head and shoulders.	Skull crushed; reflex movement until 1 min 44 s; no heartbeat detected when removed from trap at 3 min.
11/05/2024	148.1	F	-	-	Nil – complete miss.	Multiple visits to trap entrance tunnel before finally triggering trap.
11/05/2024	179.2	M	-	-	Hindquarters.	Prolonged period in trap entrance tunnel with only tail visible; probably gnawing label on plate as this was only accessible when the trap was set. When caught, the front half of the rat was positioned in the gap along the front of the trap.

Table 9. Outcome of Test 8 using the SA4 kill trap for capturing ferrets

Test date	Weight (kg)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
16/11/2023	1.17	M	2 min 37 s	5 min 10 s	Neck.	No breaths detected.
16/11/2023	0.91	F	1 min 59 s	4 min 13 s	Neck.	Faint audible intake of breath up to c. 2 min.
16/11/2023	0.69	F	1 min 15 s	3 min 45 s	Neck.	Initial vocalisation then no breaths detected.
16/11/2023	1.28	M	2 min 28 s	4 min 54 s	Neck.	No breaths detected.
16/11/2023	1.18	M	2 min 4 s	5 min 27 s	Neck.	No breaths detected.
16/11/2023	1.24	M	2 min 39 s	5 min 19 s	Neck.	No breaths detected.
16/11/2023	0.67	F	-	-	Hindquarters.	Entered trap tunnel and turned around. Sitting in front of trap for >5 min before backing into trigger and being caught. Didn't eat morsel of pre-feed at tunnel entrance.

Test date	Weight (kg)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
21/02/2024	0.88	M	1 min 58 s	4 min 53 s	Neck.	No breaths or vocalisation. Reflex movement until 3 min 10 s.
21/02/2024	0.69	F	2 min 7 s	4 min 23 s	Neck.	No breaths or vocalisation. Reflex movement until 3 min.
21/02/2023	0.65	F	-	-	Neck and front left leg.	Continued breathing. Euthanised after 5 min.

Table 10. Outcome of Test 9 using the Nooski rat trap for capturing ship rats

Test date	Weight (g)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
5/06/2024	143.5	F	<35 s	3 min 46 s	Neck.	Rapid loss of consciousness.
12/06/2024	112.7	M	<33 s	3 min 3 s	Neck & FL paw.	Reflex movement stopped at 2 min 5 s.
12/06/2024	196.5	M	43 s	2 min 41 s	Neck.	Reflex movement stopped at 2 min 6 s.
12/07/2024	102.2	F	30 s	3 min 40 s	Neck.	Rapid loss of consciousness.
15/07/2024	150.3	F	<1 min 3 s	3 min 23 s	Neck.	Terminal movement took rat 2 m from trap, which delayed consciousness assessment; reflex movement stopped at 2 min.
16/07/2024	131.6	M	-	-	Nil – complete miss.	This rat sprung off the trap by interfering with the trigger arm 3 nights previously; behaviour was tentative, with short feeding bouts with rapid backing out of the tunnel.
16/07/2024	143.2	M	<30 s	3 min 48 s	Neck & FR paw.	Reflex movement until 2 min 40 s.
17/07/2024	103.3	F	47 s	2 min 34 s	Neck.	Reflex movement until 1 min 22 s.
18/07/2024	149.9	F	42 s	4 min 41 s	Neck & FR paw.	Reflex movement until 2 min 49 s.
18/07/2024	113.1	F	25 s	3 min 47 s	Neck & FL paw.	Reflex movement until 2 min. This rat sprung off the trap by interfering with the trigger arm the previous night.
19/07/2024	162.4	M	33 s	3 min 18 s	Neck	Reflex movement until 1 min 53 s. This rat sprung off the trap by interfering with the trigger arm 2 nights previously.

Table 11. Outcome of Test 10 using the Nooski rat trap for capturing Norway rats

Test date	Weight (g)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
22/07/2024	275.5	M	-	-	Nil – complete miss.	Eating pre-feed from unset trap following 2 nights.
22/07/2024	337.6	M	-	-	Nil – complete miss.	Not eating pre-feed out of unset trap following 2 nights.
22/07/2024	232.6	F	<37 s	4 min 51 s	Neck.	Reflex movement until 2 min 8 s.
23/07/2024	213.7	F	<24 s	4 min 52 s	Neck & FR toes.	Reflex movement until 2 min 15 s.
24/07/2024	309.5	M	-	-	Nil – complete miss.	Rat paused at entrance of tunnel after trap fired, indicating little trauma.
24/07/2024	242.3	M	-	-	Nil – complete miss.	Ring in entrance tunnel.
28/07/2024	142.7	F	1 min 2 s	4 min 23 s	Neck.	Reflex movement until 2 min 18 s.
28/07/2024	266.5	M	1 min 1 s	3 min 53 s	Neck.	Reflex movement until 2 min.
28/07/2024	288.0	F	-	-	Nil – complete miss.	Eating pre-feed from unset trap following 2 nights.
28/07/2024	254.6	M	1 min 1 s	5 min 37 s	Neck.	Reflex movement until 2 min 8 s.
30/07/2024	245.5	M	52 s	<3 min	Neck.	Reflex movement until 1 min 52 s. Next rat caught at same time so time to heart stop approximate.
30/07/2024	281.0	F	55 s	2 min 39 s	Neck.	Reflex movement until 1 min 46 s.
1/08/2024	276.9	F	-	-	Nose.	Initially sprung off trap while on top of the baiting chamber but was unphased. Trap reset and rat entered trap within 15 min.

Appendix 2 – Hedgehogs successfully killed by the Rewild trap during Test 1

978 g male

994 g male

779 g male

767 g male

857 g female

933 g male

812 g male

831 g male

657 g male

732 g female

Appendix 3 – Feral cats successfully killed by the Sentinel kill trap during Test 2

3.83 kg male

3.66 kg female

2.97 kg male

3.57 kg male

Appendix 4 – Feral cats caught by the Trapinator kill trap during Test 4

3.30 kg male

2.94 kg female

3.67 kg male

3.17 kg male

Appendix 5 – Feral cats caught by the AT220 kill trap during Test 5, trials 1 & 2

4.29 kg male (trial 1)

3.22 kg male (trial 1, fail)

2.27 kg female (trial 2)

3.35 kg male (trial 2)

2.60 kg female (trial 2)

2.97 kg male (trial 2)

4.28 kg female (trial 2, fail)

Appendix 6 – Ship rats caught by the Trapinator Fusion kill trap during Test 7, trials 1 & 2

148.0 g male (trial 1)

133.1 g female (trial 2)

219.5 g male (trial 2)

216.9 g male (trial 2)

157.4 g male (trial 2)

213.8 g male (trial 2)

180.4 g male (trial 2)

179.2 g male (trial 2, fail)

Appendix 7 – Ferrets caught by the SA4 kill trap during Test 8

1.17 kg male

0.91 kg female

0.69 kg female

1.28 kg male

1.18 kg male

1.24 kg male

0.67 kg female (fail)

0.88 kg male

0.69 kg female

0.65 kg female (fail)

Appendix 8 – Ship rats caught by the Nooski rat trap during Test 9

143.5 g female

112.7 g male

196.5 g male

102.2 g female

150.3 g female

143.2 g male

103.3 g female

149.9 g female

113.1 kg female

162.4 g male

Appendix 9 – Norway rats caught by the Nooski rat trap during Test 10

232.6 g female

213.7 g female

142.7 g female

266.5 g male

254.6 g male

245.5 g male

281.0 g female

276.9 g female (fail)