



Manaaki Whenua
Landcare Research

Pen testing the kill efficacy of six predator traps, 2022/23

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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 six predator kill traps. The work was undertaken between January and July 2023.

Objective

- To assess the killing performance of selected kill traps against stoats, Norway rats, ship rats, possums, 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 stoat, Norway rat, ship rat
 - Supervisor Max Norway rat
 - D-Rat Lumber Jack Norway rat
 - A24 Norway rat
 - Timms possum
 - SA4 ferret.
- Wild-caught and captive-bred animals were penned individually and trialled in a free-approach test. Traps were set as per manufacturers’ instructions.
- 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 minutes. For the trap to pass the NAWAC trap-testing guidelines, 10 of 10 animals need to be rendered irreversibly unconscious within 3 minutes.
- A sample size of 10 was chosen for all tests, except the Timms trap test on possums, for which a sample size of 25 was selected. With that sample size no more than four possums could remain conscious beyond 3 minutes, and of these only two could be conscious beyond 5 minutes to pass the guideline. Animals that were trapped but remained conscious for longer than 5 minutes would be euthanised.
- For all captures, the trap jaw-strike location was identified and recorded.
- This work was carried out with the approval of the Manaaki Whenua – Landcare Research Animal Ethics Committee (AEC 21/11/04).

Results

- Eleven out of eleven stoats were killed successfully with the Rewild trap. An extra stoat was tested because the seventh capture and successful kill was atypical, with the stoat forcing its way past the side flap of the integral trap tunnel.
- Ten out of ten Norway rats were killed successfully with the Rewild trap.
- The first ship rat tested with the Rewild trap was struck and held by the neck by the first kill bar. The rat remained conscious and was euthanised after 3 minutes. The trap was modified by increasing the treadle set-off weight by 15%. Testing restarted and three rats were killed successfully before a fourth was caught by the neck and remained conscious beyond 3 minutes. This rat was euthanised and testing ceased. The trap was then modified by extending the first and second kill bars, and 10 out of 10 ship rats were killed successfully.
- Two Norway rats were killed successfully with the D-Rat Lumberjack trap before the third triggered the trap and escaped uninjured. The fourth rat tested was struck on the neck and pulled itself out of the trap after 25 seconds. This rat remained conscious beyond 3 minutes so was euthanised and testing ceased.
- One Norway rat was killed successfully with the Supervisor Max trap before the second was caught by the neck and pulled itself out after 1 minute. This rat was euthanised after 3 minutes and testing ceased.
- The first Norway rat tested failed to be killed successfully with the A24 trap. This rat sustained survivable injuries, with a damaged fore paw and a minor fracture in front of one eye, and remained conscious beyond 3 minutes. Testing ceased.
- Twenty possums were tested using the Timms trap: 15 were irreversibly unconscious in under 3 minutes, two between 3 and 5 minutes, and three pulled themselves out of the trap and survived. Testing ceased when the 20th possum was caught but pulled itself out and remained conscious beyond 5 minutes.
- Six ferrets were killed successfully with the SA4 trap before the seventh was pinned at the rear of the mandible. It was still able to breathe and remained conscious beyond 3 minutes. Testing ceased.

Conclusions

- The Rewild trap passed the NAWAC trap-testing criterion when tested on stoats and Norway rats. Once the trap was modified it passed the criterion for ship rats. Due to high impact momentum and clamping, the modified trap is likely to kill stoats and Norway rats as effectively as the original version.
- Both the D-Rat Lumberjack and Supervisor Max traps had already passed the NAWAC trap-testing criterion with ship rats, but both trap types failed to kill Norway rats during the testing reported here. Strike location was consistent with neck strikes, but impact momentum was not adequate to consistently kill average-sized Norway rats, which are larger than most ship rats.
- The A24 trap had already passed the NAWAC trap-testing criterion for stoats and ship rats, but failed when tested on Norway rats. The rat tested survived the impact because it was positioned to the side of the path of the impactor when it fired. How frequently this occurs when these traps are used in the field is unknown.

- The Timms trap failed to pass the NAWAC trap-testing criterion, which is the same result as when it was tested in 2001 using a different baiting strategy. Welfare compromise of possums that escape would probably be low, with no injuries observed in the possums that escaped.
- The SA4 trap failed to pass the NAWAC trap-testing criterion. A minor increase in trigger depth may be all that is needed to pass the NAWAC trap-testing criterion.

Recommendations

- DOC should consider which of the traps tested here 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 continue to test the killing efficacy of new trap models. Traps that are used to target pest species other than those listed by Predator Free 2050 could be included to increase the tools available for multi-species pest control.

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 six predator kill traps. The work was undertaken between January and July 2023 and was the second 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 is being 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 6 March 2023).

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 inform changes that could be made to trap designs to increase the likelihood of successful kills. The test results reported here are for the second tranche of 10 trap tests (six different trap types) tested within the Tools to Market programme.

3 Objective

- To test the killing performance of selected kill traps against stoats, Norway rats, ship rats, possums, and ferrets using the NAWAC trap-testing guideline (NAWAC 2019).

4 Methods

DOC provided traps sourced from the manufacturers or suppliers (Table 1). The different trap types were tested on species nominated by DOC (Table 1), with traps set as per the manufacturers' instructions and outlined in the following test descriptions.

Table 1. Manufacturer, trap type, and species tested

Manufacturer	Trap type	Species tested
Rewild	Rewild	Stoat; Norway rat; ship rat
Envirotools	D-Rat Lumber Jack	Norway rat
Envirotools	Supervisor Max	Norway rat
Goodnature	A24	Norway rat
Stallion Plastics Ltd*	Timms	Possum
Steve Allan	SA4	Ferret

* Supplied by www/traps.co.nz.

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).

4.1 Test 1. Rewild trap on stoats

A mix of wild-caught and captive-bred stoats was used for testing. The wild-caught stoats had been housed in outdoor cages for approximately 1 year and the captive-bred stoats were about 3 months old and of adult size when used. Stoats were caged individually, and the trap was tested in a free-approach test. In each cage, one trap was placed beside the stoat's nest box and baited with chicken mince in the bait well (Figure 1). The stoat was pre-fed for at least one night with the trap left unset, with bait replenished daily if required, before lethal testing commenced.

When a stoat 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 minutes. Additional unconscious (reflex) movement was also recorded. The top cover of the Rewild trap is attached to the kill bars² (Figure 2), so opening this would raise the kill bars off a trapped animal. This could influence killing performance, particularly if compression by the trap kill bars was contributing 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 minutes 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 stoats needed to be rendered irreversibly unconscious within 3 minutes.

² <https://rewild.nz/wp-content/uploads/2022/12/Quick-Start-guide.pdf> accessed 7 March 2023;



Figure 1. Unset Rewild kill trap in a stoat cage next to a stoat nest box. The raised pink flag on top of the trap indicates that the trap is unset or has fired. The trap was baited with chicken mince placed in the bait well of the trap, located behind the trap treadle at the rear of the trap (not visible).



Figure 2. Open Rewild kill trap. The trap was baited with chicken mince placed in the bait well of the trap. The top cover is attached to the kill bars, so opening the cover raises the kill bars and disengages the treadle, putting the trap into safe mode for baiting. (See <https://rewild.nz/wp-content/uploads/2022/12/Quick-Start-guide.pdf>, accessed 7 March 2023).

4.2 Test 2. Rewild trap on Norway rats

Wild-caught 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 was placed against the side of the arena (Figure 3). The trap was baited with standard feed pellets (Teklad Global 18% protein rodent diet, Envigo, WI, USA) coated with bacon fat; these were placed in the bait well of the trap and water was available *ad libitum*. The rats were pre-fed for at least 1 night before commencing testing.

When the traps were set for lethal testing, they were baited the same way as when pre-feeding. When a rat was struck, it was assessed according to the method described in Test 1, differing only in that rats were removed from the trap ≥ 1 minute after being struck and once reflex movement had ceased to assess cessation of heartbeat.



Figure 3. Test arena with unset Rewild trap, as deployed for Tests 2 & 3. Standard feed pellets coated with bacon fat or Nutella® were placed in the trap bait well for Norway and ship rats, respectively. A Protecta EVO Ambush bait station (in background) was provided as a secondary nest box.

4.3 Test 3. Rewild trap on ship rats

Wild-caught ship rats were acclimatised, housed, and tested as described for Norway rats in Test 2 (Figure 3). The first rat tested failed to be rendered unconscious within 3 minutes, so testing ceased and the traps were examined. The set-off weight at the front of the trap treadle of all traps used was found to be approximately 85 g, which was 15% lower than the 100 g indicated by the manufacturer. Following discussion with the DOC technical review group, it was decided to recalibrate traps at 100 g set-off weight and restart testing. Before restarting animal testing the traps were dry fired (i.e. fired with nothing between the kill bars and treadle) 10 times each to ensure the calibration screws remained in the same position and set-off weights remained consistent.

The fourth rat tested in the second trial failed to be rendered unconscious within 3 minutes, so testing ceased. The DOC technical review group and the manufacturer reviewed the results, and it was decided to modify the trap by extending the first and second kill bars closest to the entrance to reduce the gap between the treadle and kill bars when the trap had fired (Figure 4). Again, traps were checked and calibrated at 100 g set-off weight, and traps were dry fired 10 times before trial 3 commenced.



Figure 4. Extension to kill bar (L) compared to original Rewild trap (R). This reduced the gap between the treadle and kill bars when the trap fired, and this configuration was used for the third trial of Test 3. The top cover and entrance chamber have been removed to provide a view of the difference. Trap kill bars are shown in fired position.

4.4 Test 4. D-Rat Lumber Jack trap on Norway rats

Wild-caught Norway rats were acclimatised and housed as described for Tests 2 & 3. As in these previous tests, rats were confined individually in each arena and a free-approach set-up was used. In each arena a trap was placed against the arena wall (Figure 5) and baited with crunchy peanut butter, which was provided with the trap by the manufacturer. As per manufacturer's instructions the bait well was two-thirds filled with peanut butter and a small dab was placed at the entrance of the tunnel.³ The rats were pre-fed for at least one night with the trap unset before lethal testing commenced.



Figure 5. Unset D-Rat Lumber Jack kill trap (top) and Supervisor Max kill trap (bottom) placed in test arenas. The traps were baited with crunchy peanut butter in the bait well of the trap, and a small dab was placed at the entrance to the tunnel. A Protecta EVO Ambush bait station (in background) was provided as a secondary nest box.

³ [Lumber Jack + D-Rat Combo – Enviro Tools](#) (accessed 9 March 2023).



Figure 5. (continued).

4.5 Test 5. Supervisor Max on Norway rats

The traps were set and baited as in Test 4 above (Figure 5). Rats were acclimatised to the test arena and the unset trap for three nights before lethal testing commenced.

4.6 Test 6. A24 on Norway rats

Wild-caught Norway rats were acclimatised and housed as described for Tests 2–5 above. Following the manufacturer’s instructions, the traps were secured to the side of the arenas, with the trap base 12 cm above the ground and baited with the chocolate-based rodent paste in an automatic lure pump provided with the trap⁴ (Figure 6). Rats were acclimatised to the unset but baited traps for two nights before CO₂ canisters were attached to the traps and lethal testing commenced.

⁴ [Goodnature Quick Start Guide | Installing Your A24 Trap](#) (accessed 8 March 2023).



Figure 6. A set Goodnature® A24 trap deployed in a test arena. The trap is screwed to a vertical board, with the base of the trap 12 cm above the ground and 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 (in background) was provided as a secondary nest box.

Any rats that survived were euthanised by cervical dislocation (if not struck on the neck) or an intracardiac injection of 0.5 mL/kg bodyweight pentobarbitone (if struck on the neck), following anaesthesia with Isoflurane. They were then necropsied to identify whether the trap had caused any obvious injury.

4.7 Test 7. Timms trap on possums

Wild-caught possums were acclimatised to captivity in outdoor pens for at least 1 week before being transferred to observation pens for the trap testing. In each observation pen a trap was placed in the centre of the pen (Figure 7). The unset trap was baited with half an apple, replaced daily, to pre-feed possums for at least two nights prior to commencing lethal testing. Once testing commenced, traps were baited with one-eighth of an apple, as described in the operating instructions for the similar Flipping Timmy trap.⁵

⁵ [ET-D0060B baiting-instructions-flipping-timmy_serial.pdf \(shopify.com\)](#) (accessed 30 May 2023).



Figure 7. Timms traps deployed in observation pens. The traps were firmly secured to the ground using the pins provided with the trap. A circular 55 mm hole, duct-taped back in place, was cut in the side of the trap so that time to loss of palpebral (blinking) reflex) by captured possums could be assessed.

For this test a sample size of 25 possums was selected by the client. For the trap to pass the NAWAC (2019) trap-testing guideline, 21 of 25 possums need to be rendered irreversibly unconscious within the 3-minute interval; two can exceed the 3-minute interval but be rendered irreversibly unconscious in under 5 minutes; and two can exceed 5 minutes. If these criteria are met, then the trap qualifies as a Class B trap for welfare performance. Once irreversible unconsciousness is identified, a stethoscope is used to determine cessation of heartbeat.

All testing was carried out during the first 3 hours of darkness, when possums are most active.

4.8 Test 8. SA4 trap on ferrets

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 pinned on the bait spike at the rear of the trap (Figure 8). A small amount of rabbit meat was placed inside one of the side entrances of the tunnel to encourage entry by ferrets.



Figure 8. 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).

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

5 Results

5.1 Test 1. Rewild trap on stoats

Eleven out of eleven stoats were killed successfully with the Rewild trap, with animals struck by three to five kill bars and all incurring skull fractures (Table 2 in Appendix 1; Appendix 2). No heartbeat or other signs of life were detected in any of the 11 stoats when they were released from the trap after 3 minutes. An extra stoat was tested because the seventh capture and successful kill was atypical, with the stoat forcing its way past the side flap of the integral trap tunnel. Cutting and duct-taping the side of the trap may have made it easier for this small stoat (<200 g) to push in from the side, but there is some flexibility in the sides of unmodified traps so it is possible that small animals could enter the trap this way.

5.2 Test 2. Rewild trap on Norway rats

The Rewild trap successfully killed 10 of 10 Norway rats, with all sustaining skull fractures (Table 3 in Appendix 1; Appendix 3). All were irreversibly unconscious when first assessed. The seventh rat tested was not struck when the trap fired, so because no welfare compromise had occurred with this individual, testing continued and a further four rats were successfully killed. The Rewild trap can be fired by dropping a weight on the trap cover, so it is possible the captive rat jumped or fell on the trap cover, with the resulting vibration triggering the trap.

5.3 Test 3. Rewild trap on ship rats

The first ship rat tested with the Rewild trap was struck and securely held by the neck by the first kill bar closest to the trap entrance (Table 4 in Appendix 1; Appendix 4). Because there was a 15 mm gap between the kill bar and the trap treadle, the rat was restrained but not injured. The rat remained conscious throughout and was euthanised after 3 minutes. The trap treadle set-off weight was increased to 100 g (see Methods, section 4.3), and testing restarted.

Three rats were killed successfully before a fourth was caught by the neck by the first kill bar and remained conscious beyond 3 minutes (Table 4 in Appendix 1; Appendix 4). This rat was euthanised and necropsy revealed laceration and bruising in the neck. The trap was modified for a second time by extending the first and second kill bars (see Methods, section 4.3) and testing restarted. Nine ship rats were successfully killed before the 10th was not struck when the trap fired. Because no welfare compromise had occurred with this individual, testing continued, and the 11th rat was successfully killed (Table 4 in Appendix 1; Appendix 4).

5.4 Test 4. D-Rat Lumber Jack trap on Norway rats

Two Norway rats were successfully killed when struck on the neck. The first was irreversibly unconscious when first assessed, whereas the second was struck side on, pinned but initially able to breathe. The conscious rat struggled, repositioned, and occluded its airway, leading to irreversible unconsciousness at 3 minutes (Table 5 in Appendix 1; Appendix 5). The third rat tested was not struck when the trap fired, so because no welfare compromise had occurred with this individual, testing continued. The fourth rat was struck on the neck, initially stunned, but pulled itself out after 25 seconds. The impact of the kill bar forced the mouth of the rat onto the bait cup, which damaged its teeth. This rat was euthanised after remaining conscious beyond 3 minutes and testing ceased.

5.5 Test 5. Supervisor Max on Norway rats

One Norway rat was killed successfully with the Supervisor Max trap when struck on the neck at the rear of its skull. The second rat tested was struck in a similar position and stunned by the impact of the kill bar. This rat revived after 1 minute and pulled itself out of the trap. After 3 minutes it was euthanised, and necropsy revealed bruising at the rear of its skull. Testing ceased (Table 6 in Appendix 1; Appendix 5).

5.6 Test 6. A24 on Norway rats

The first Norway rat tested failed to be killed successfully with the A24 trap. This rat sustained survivable injuries with a damaged fore paw and a minor fracture in front of one eye and remained conscious beyond 3 minutes. Testing ceased (Table 7 in Appendix 1).

5.7 Test 7. Timms trap on possums

Three possums were rendered irreversibly unconscious before the fourth remained conscious for 3 min 26 seconds. Testing continued and the next seven possums were rendered irreversibly unconscious under in 3 minutes. Possums 12 and 13 were struck on the neck but pulled themselves out after 2 and 27 seconds, respectively. Another two possums were rendered irreversibly unconscious in under 3 minutes before the next, possum number 16, remained conscious until 4 minutes 50 seconds. Three more possums were killed successfully before number 20 pulled itself out after 1 minute 32 seconds. Because the 20th possum tested was conscious beyond 5 minutes, the criterion for a NAWAC pass was exceeded and testing ceased (Table 8 in Appendix 1; Appendix 6).

5.8 Test 8. SA4 trap on ferrets

Six ferrets were rendered irreversibly unconscious in under 3 minutes with fully occluded airways before the seventh was struck at the back of the mandible and pinned in the trap. This ferret maintained limited breathing and remained conscious beyond 3 minutes. Testing ceased (Table 9 in Appendix 1; Appendix 7).

6 Conclusions

6.1 Rewild trap

The Rewild trap passed the NAWAC trap-testing criterion when tested on stoats and Norway rats. Once the trap was modified it also passed the criterion for ship rats. The original trap had a 15 mm gap between the first kill bar and the treadle. Of the 16 ship rats tested in all three trials, five were caught by the first kill bar only. This might be an indication that these rats were more cautious and were backing out when the trap fired. Reduction in the gap between the first kill bar and the treadle meant that these more tentative individuals experienced lethal strikes, with two of the final ten successful kills only struck by the first kill bar. Due to high impact momentum and clamping force, the modified trap is likely to kill stoats and Norway rats as effectively as the original version.

Once trap testing progressed to the two rodent species, gnawing damage on the plastic components was observed when rats had access to unset traps. The plastic bait wells were the most frequently damaged component, but some gnawing also occurred on the rear grills and entrance chambers. This suggests the field life of this trap model could be limited when used in areas with high rat numbers. The manufacturer should investigate using more durable products for making the trap, and/or make replacement parts available so that damaged components can be replaced.

The Rewild traps required adjustment of the treadle spring-off weight for testing. The process for this was similar to that used to calibrate DOC series traps, differing in that a calibration screw was tightened or loosened rather than adjusting a sear. The manufacturer should be encouraged to calibrate the traps in controlled factory conditions before sale.

6.2 D-Rat Lumber Jack and Supervisor Max traps

Both the D-Rat Lumberjack and Supervisor Max traps have already passed the NAWAC trap-testing criterion with ship rats,⁶ but both trap types failed to kill Norway rats during the testing reported here. Strike location was consistent with neck strikes, but impact momentum was not adequate to consistently kill average-sized Norway rats, which are larger than most ship rats (Morriss 2019). Norway rats that survived were initially stunned, but revived and had the strength to pull themselves out of traps and escape.

⁶ Bionet trap testing summary table. <https://www.bionet.nz/assets/Uploads/Trap-summary-table-18-July-2022-v2.pdf> (accessed 15 June 2023).

6.3 A24 trap

The A24 trap has already passed the NAWAC trap-testing criterion for stoats and ship rats but failed when tested on Norway rats. The rat tested survived the impact because it was positioned to the side of the path of the impactor when it fired. The rat tested weighed 230 g, which is average for Norway rats and larger than most ship rats (Morriss 2019). How frequently this type of escape occurs when these traps are used in the field is unknown.

6.4 Timms trap

The Timms trap failed to pass the NAWAC trap-testing criterion for possums, which repeats the results of an equivalent test in 2001 using a different baiting strategy (carrot disc aligned horizontally; Warburton & Poutu 2002). The welfare compromise of possums that escape would probably be low, with no injuries observed in the four possums that escaped during this test. The 13th possum that was tested and pulled itself out after 27 seconds appeared unphased by the experience: although not bold enough to stick his head back in the entrance of the fired trap, he returned within half an hour of being struck and was observed sniffing around the trap and scent marking the adjacent post. The one possum that pulled out of the trap in the 2001 testing was likewise not overly perturbed by the experience and was successfully killed by a Timms trap later in the trial (Warburton & Poutu 2002), giving further evidence of the low welfare compromise on possums that escape from this trap type.

6.5 SA4 trap

The SA4 trap failed to pass the NAWAC trap-testing criterion for ferrets. The seventh ferret was not as far into the trap when struck as the previous six; consequently, the kill bar was aligned with the back of its mandible, which prevented full occlusion of its airway. Adjusting the trap trigger so that ferrets are slightly further into the trap when it activates could mean the trap would meet the NAWAC trap-testing criterion if the modified trap were resubmitted for testing.

7 Recommendations

- DOC should consider which of the traps tested here 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 continue to test the killing efficacy of new trap models. Traps that are used to target pest species other than those listed by Predator Free 2050 could be included in the testing programme to increase the tools available for multi-species pest control.

8 Acknowledgements

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9 References

- DOC 2021. Trap types and animal welfare considerations: best practice for humane pest animal control [updated 2021]. Department of Conservation internal guidance. DOC -5405339, revision 13.
- Morriss G 2019. Pen testing of the kill efficacy of the Victor® Professional rat trap and the Modified Victor stoat and rat trap for capturing ship and Norway rats. Manaaki Whenua – Landcare Research contract report LC3441 for Predator Free 2050.
- Morriss G 2022. Pen testing the kill efficacy of four predator traps, 2021/22. Manaaki Whenua – Landcare Research contract report LC4182 for the Department of Conservation.
- National Animal Welfare Advisory Committee 2019. Guideline 09: Assessing the welfare performance of restraining and kill traps 2019.
<https://www.mpi.govt.nz/dmsdocument/8521-nawac-guideline-09-assessing-the-welfare-performance-of-restraining-and-kill-traps> (accessed 6 March 2023).
- Warburton B, Poutu N 2002. Effectiveness of Timms traps for killing possums. Landcare Research Contract Report LC102/133 for the Ministry of Agriculture & Forestry.

Appendix 1 – Results tables

Table 2. Outcome of test using the Rewild kill trap for capturing stoats

Test date	Weight (g)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
25/01/2023	200.5	F	<38 s	<3 min 27 s	1st bar shoulders; 2nd bar neck; 3rd bar back of skull.	No reflex movement observed; upper body and head flattened; fractured skull.
25/01/2023	277.5	M	<25 s	<3 min 47 s	1st bar chest; 2nd bar shoulders; 3rd bar neck; 4th bar skull.	Reflex movement of back legs/tail until 44 s; upper body and head flattened; fractured skull.
25/01/2023	308.0	M	<29 s	<3 min 54 s	1st bar back of chest; 2nd bar shoulders; 3rd bar neck; 4th bar skull	Reflex movement of back legs/tail until 35 s; upper body and head flattened; fractured skull.
25/01/2023	272.0	M	<25 s	<3 min 40s	1st bar shoulders; 2nd bar neck; 3rd bar skull.	Reflex movement of back legs/tail until 1 min; upper body and head flattened; fractured skull.
26/01/2023	278.0	M	<25 s	<4 min 2 s	1st bar chest; 2nd bar shoulders; 3rd bar back of skull; 4th bar between ears and eyes.	Reflex movement of back legs/tail until 35 s; upper body and head flattened; fractured skull.
26/01/2023	280.0	M	<21 s	<3 min 54 s	1st bar chest; 2nd bar shoulders; 3rd bar neck; 4th bar skull.	Reflex movement of back legs/tail until 35 s; upper body and head flattened; fractured skull.
26/01/2023	194.5	F	<30 s	<4 min 14 s	5th bar chest; 4th bar shoulders; 3rd bar neck/head.	Forced through plastic flap on side of trap; caught facing towards trap entrance; reflex movement of back legs/tail until 1 min; fractured skull.
26/01/2023	342.5	M	<25 s	<3 min 45 s	1st bar chest; 2nd bar shoulders; 3rd bar back of skull; 4th bar between ears and eyes.	Reflex movement of back legs/tail until 45 s; upper body and head flattened; fractured skull.
26/01/2023	199.5	F	<27 s	<3 min 40 s	1st bar chest; 2nd bar shoulders; 3rd bar back of skull; 4th bar between ears and eyes.	Reflex movement of back legs/tail until 40 s; upper body and head flattened; fractured skull.
26/01/2023	202.5	F	<30 s	<4 min 15 s	1st bar abdomen; 2nd bar rear of shoulders; 3rd bar front of shoulders; 4th bar neck; 5th bar across ears.	No reflex movement observed; upper body and head flattened; fractured skull.
31/01/2023	305.5	F	<24 s	<3 min 52 s	1st bar front of shoulders; 2nd bar back of skull; 3rd bar between ears and eyes.	Reflex movement of back legs/tail until 44 s; fractured skull.

Table 3. Outcome of test using the Rewild kill trap for capturing Norway rats

Test date	Weight (g)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
31/01/2023	237.0	M	<20 s	3 min 29 s	1st bar skull.	Reflex movement of back legs/tail until 40 s; fractured skull.
31/01/2023	255.0	F	<20 s	4 min 23 s	1st bar shoulders; 2nd bar back of skull; 3rd bar across eyes.	Reflex movement of back legs/tail until 55 s; upper body and head flattened; fractured skull.
1/02/2023	245.8	F	<20 s	3 min 3 s	1st bar across neck; 2nd bar between ears and eyes.	Reflex movement of back legs/tail until 1 min; upper body and head flattened; fractured skull.
3/02/2023	141.5	F	<15 s	5 min 11 s	1st bar across chest; 2nd bar skull.	Reflex movement of back legs/tail until 1 min 35 s; upper body and head flattened; fractured skull.
3/02/2023	321.0	M	<22 s	4 min 24 s	1st bar across chest; 2nd bar skull.	Reflex movement of back legs/tail until 1 min 8 s; upper body and head flattened; fractured skull.
3/02/2023	301.8	M	<17 s	4 min 50 s	1st bar chest; 2nd bar back of skull; 3rd bar across eyes.	Reflex movement of back legs/tail until 1 min 20 s; upper body and head flattened; fractured skull.
6/02/2023	343.5	M	-	-	Nil – complete miss.	
6/02/2023	197.0	F	<34 s	4 min 53 s	1st bar tail; 2nd bar hips; 3rd bar abdomen; 4th bar longitudinal chest and head; 5th bar longitudinal across top of head.	No reflex movement detected; full body compression; fractured skull.
6/02/2023	278.4	M	<16 s	3 min 30 s	1st bar across neck; 2nd bar between ears and eyes.	Reflex movement of back legs/tail until 1 min 4 s; upper body and head flattened; fractured skull.
6/02/2023	202.3	F	<14 s	4 min 56 s	1st bar chest; 2nd bar neck; 3rd bar between ears and eyes.	Reflex movement of back legs/tail until 45 s; fractured skull.
8/02/2023	176.3	F	<11 s	5 min 10 s	1st bar back of skull.	Reflex movement of back legs/tail until 1 min; fractured skull.

Table 4. Outcome of test using the Rewild kill trap for capturing ship rats

Test date	Weight (g)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
<i>Trial 1</i>						
10/02/2023	131.2	M	-	-	1st bar neck.	Pinned by 1st bar across neck; 15 mm gap between treadle and kill bar resulting in insufficient impact or compression on the rat's neck to kill rat; no injury observed.
<i>Trial 2</i>						
22/02/2023	139.9	M	<29 s	<2 min 54 s	1st bar tail; 2nd bar hips; 3rd bar abdomen; 4th bar longitudinal chest; 5th bar longitudinal head.	No reflex movement detected; full body compression; fractured skull.
22/02/2023	139.5	F	<25 s	<3 min 40 s	1st bar abdomen; 2nd bar chest; 3rd bar longitudinal head.	Reflex movement of back legs/tail until 39 s; upper body and head flattened; fractured skull.
23/02/2023	155.2	F	<30 s	<3 min 11 s	1st bar tail; 2nd bar hips; 3rd bar abdomen; 4th bar longitudinal chest and head; 5th bar longitudinal across top of head.	Reflex movement of tail until 1 min 4 s; full body compression; fractured skull.
23/02/2023	217.6	M	-	-	1st bar neck.	Pinned by 1st bar across neck; initially unconscious but revived by 4 min; necropsy revealed soft tissue damage & extensive bruising.
<i>Trial 3</i>						
10/05/2023	93.2	F	<15 s	<3 min 48 s	1st bar hips; 2nd bar abdomen; 3rd bar longitudinal across head.	Had grabbed bait so assume trap fired as the rat turned to leave; reflex movement until 1 min 40 s; upper body compression; skull fracture.
10/05/2023	155.9	M	<30 s	<3 min 28 s	1st bar abdomen 2nd bar shoulders; 3rd bar neck; 4th bar head.	Reflex movement until 54 s; full body compression.
10/05/2023	156.6	F	<30 s	<3 min 55 s	1st bar neck; 2nd bar head.	Reflex movement until 1 min 50 s; skull fracture.
10/05/2023	163.5	M	<20 s	<3 min 24 s	1st bar abdomen 2nd bar shoulders; 3rd bar neck; 4th bar head.	Reflex movement until 53 s; full body compression.

Test date	Weight (g)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
10/05/2023	158.3	M	<23 s	<3 min 38 s	1st bar abdomen 2nd bar shoulders; 3rd bar neck; 4th bar head.	Reflex movement until 41 s; full body compression; skull fracture.
12/05/2023	172.2	M	<27 s	<3 min 52 s	1st bar hips 2nd bar abdomen; 3rd bar shoulders; 4th bar head.	Reflex movement until 41 s; full body compression; skull fracture.
12/05/2023	138.4	M	<30 s	<3 min 46 s	1st bar longitudinal full body.	No reflex movement detected; rat struck longitudinal by first kill bar.
15/05/2023	220.1	M	<25 s	4 min 50 s	1st bar shoulders; 2nd bar head.	Reflex movement until 1 min 59 s; skull fracture.
15/05/2023	167.4	F	<25 s	<4 min 2 s	1st bar hips 2nd bar abdomen; 3rd bar shoulders; 4th bar head.	Reflex movement until 2 min 3 s; full body compression; skull fracture.
15/05/2023	163.3	M	-	-	Nil – complete miss.	
15/05/2023	173.5	M	<29 s	<3 min 52 s	1st bar head.	Breaths until 1 min 51 s; skull fracture.

Table 5. Outcome of test using the D-Rat Lumber Jack kill trap for capturing Norway rats

Test date	Weight (g)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
15/02/2023	252.3	F	<15 s	4 min 36 s	Neck.	Shallow breaths until c. 2 min; rapid unconsciousness probably due to spinal damage.
15/02/2023	152.0	F	3 min	7 min 54 s	Neck side on.	Initially vocalising; struggling repositioned rat to occlude airway, leading to unconsciousness; breaths until 4 min 30 s.
15/02/2023	252.0	M	-	-	Nil – complete miss.	
17/02/2023	255.9	F	-	-	Neck.	Initially stunned but revived and pulled out after 25 s; impact forced mouth into bait well, which damaged teeth.

Table 6. Outcome of test using the Supervisor Max kill trap for capturing Norway rats

Test date	Weight (g)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
20/02/2023	198.8	F	<15 s	3 min 19 s	Neck/rear of skull.	Reflex movement until 47 s; no fracture detected; rapid unconsciousness, probably due to spinal damage.
20/02/2023	252.6	F	-	-	Neck/rear of skull.	Initially stunned but revived and pulled out at 1 min 1 s; necropsy showed bruising at rear of skull.

Table 7. Outcome of test using the A24 kill trap for capturing Norway rats

Test date	Weight (g)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
26/02/2023	231.7	F	-	-	Front left paw and right side of head.	Initially stunned and uncoordinated but revived to full mobility at 4 min; crush damage to front left paw and fracture of cheek bone by right eye.

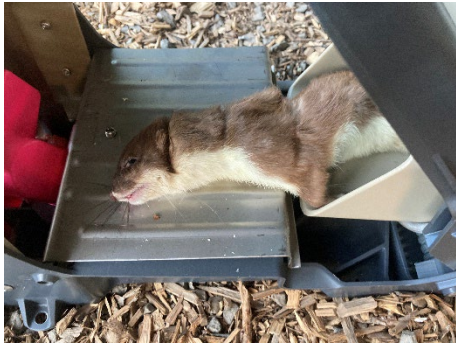
Table 8. Outcome of a test using the Timms kill trap for capturing possums

Test date	Weight (kg)	Sex	Time to loss of palpebral reflex	Time to heart stop	Strike location	Notes
15/05/2023	2.15	M	1 min 50 s	3 min 40 s	Neck	No breaths detected.
15/05/2023	2.77	F	2 min 36 s	4 min 24 s	Neck	Restricted breathing until 1 min 17 s but struggled & repositioned to fully occlude airway.
15/05/2023	3.00	M	1 min 43 s	5 min 12 s	Neck	Restricted breathing until 55 s, but struggled & repositioned to fully occlude airway.
15/05/2023	2.20	M	3 min 26 s	7 min	Neck	Restricted breathing until 1 min 17 s, but struggled & repositioned to fully occlude airway.
17/05/2023	2.30	M	1 min 55 s	3 min 40 s	Neck	No breaths detected.
17/05/2023	3.19	F	2 min 28 s	6 min 33 s	Neck	Restricted breathing until 1 min 25 s, but struggled & repositioned to fully occlude airway.
19/05/2023	2.45	M	2 min 7 s	4 min 40 s	Neck	No breaths detected.
19/05/2023	3.05	M	2 min 33 s	6 min 47 s	Neck	Restricted breathing until 1 min 56 s, but struggled & repositioned to fully occlude airway.
19/05/2023	2.80	F	1 min 52 s	9 min 20 s	Neck	Audible breaths until 1 min 2 s; some minor restricted additional breaths detected by stethoscope up to 4 min, with resulting prolonged time to heart stop.
22/05/2023	2.21	F	2 min 4 s	6 min 42 s	Neck	No breaths detected.
22/05/2023	2.72	F	1 min 29 s	4 min 35 s	Neck	Vocalising & breathing until c. 40 s, then struggled and repositioned to fully occlude airway.
22/05/2023	3.20	M	-	-	Neck	Side approach to trap; pulled out after 2 s.
24/05/2023	4.00	M	-	-	Neck	Partial side approach to trap; pulled out after 27 s.
24/05/2023	3.16	F	2 min 5 s	4 min 18 s	Neck	No breaths detected.
24/05/2023	2.17	F	1 min 12 s	6 min 37 s	Neck	No breaths detected.
24/05/2023	2.54	F	4 min 50 s	8 min 11 s	Neck	Breathing freely until c. 3 min; struggled and repositioned to fully occlude airway by c. 4 min.
26/05/2023	2.41	M	1 min 18 s	4 min 35 s	Neck	No breaths detected.
26/05/2023	3.02	F	2 min 54 s	6 min 51 s	Neck	Restricted breathing until 2 min 30 s, but struggled & repositioned to fully occlude airway.
26/05/2023	2.47	F	1 min 37 s	5 min 34 s	Neck	Restricted breathing until 1 min, but struggled & repositioned to fully occlude airway.
28/05/2023	3.19	M	-	-	Neck	Breathing freely; pulled out after 1 min 32 s.

Table 9. Outcome of a test 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
2/06/2023	1.13	M	1 min 11 s	4 min 4 s	Neck	No breaths detected.
2/06/2023	1.22	M	1 min 36 s	4 min 49 s	Neck	Vocalisation for c. 2 s, then repositioned to fully occlude airway.
2/06/2023	1.24	M	2 min 30 s	4 min 28 s	Neck	Vocalisation for c. 20 s; restricted breathing until 1 min 15 s, then repositioned to occlude airway.
5/07/2023	0.68	F	1 min 28 s	4 min 17 s	Neck	No breaths detected.
5/07/2023	0.86	F	1 min 14 s	3 min 18 s	Neck near shoulders	No breaths detected.
5/07/2023	0.84	F	1 min 39 s	4 min 8 s	Neck	No breaths detected.
5/07/2023	0.90	F	-	-	Back of mandible	Restricted breathing; not as far into trap as previous ferrets; mandible probably prevented full occlusion of airway.

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



200.5 g female



277.5 g male



308.0 g male



272.0 g male



278.0 g male



280.0 g male



194.5 g female



342.5 g male



199.5 g female



202.5 g female



305.5 g female

Appendix 3 – Norway rats successfully killed by the Rewild kill trap during Test 2



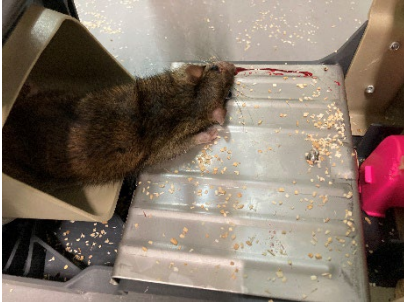
237.0 g male



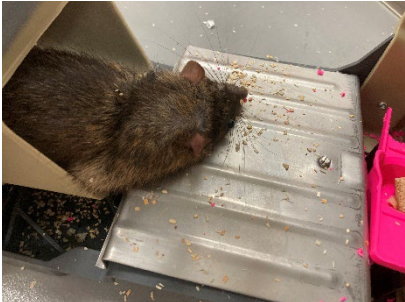
255.0 g female



245.8 g female



141.5 g female



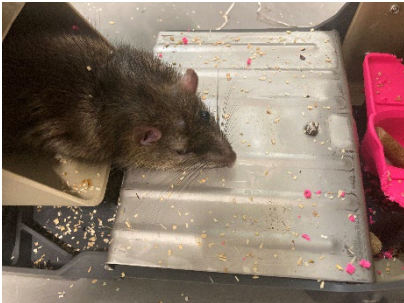
321.0 g male



301.8 g male



197.0 g female



278.4 g male



202.3 g female



176.3 g female

Appendix 4a – Ship rats caught by the Rewild kill trap during Test 3 trials 1 & 2. The first rat caught by the trap was unharmed and is not shown.



139.9 g male



139.5 g female



155.2 g female



217.6 g male (fail)

Appendix 4b – Ship rats successfully killed by the modified Rewild kill trap during Test 3, trial 3



93.2 g female



155.9 g male



156.6 g female



163.5 g male



158.3 g male



172.2 g male



138.4 g male



220.1 g male



167.4 g female



173.5 g male

Appendix 5 – Norway rats caught by the D-Rat Lumber Jack and Supervisor Max kill traps during Tests 4 & 5. The D-Rat trap type is used for both trap sets with a different tunnel configuration. Rats that survived are not shown.



252.3 g female (D-Rat Lumber Jack)



152.0 g female (D-Rat Lumber Jack)



198.8 g female (Supervisor Max)

Appendix 6 – Possums successfully killed by the Timms kill trap during Test 7. Possums that pulled out and escaped are not shown.



2.15 kg male



2.77 kg female



3.00 kg male



2.20 kg male



2.30 kg male



3.19 kg female



2.45 kg male



3.05 kg male



2.80 kg female



2.21 kg female



2.72 kg female



3.16 kg female



2.17 kg female



2.54 kg female



2.41 kg male



3.02 kg female



2.47 kg female

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



1.13 kg male



1.22 kg male



1.24 kg male



0.68 kg female



0.86 kg female



0.84 kg female



0.90 kg female (fail)