Enhancing Possum Capture Rates with Chain-Springs on Leghold Traps

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Leghold traps are an essential tool for managing brushtail possums (*Trichosurus vulpecula*) in New Zealand. However, the currently used trap design (Victor No 1) has escape rates of up to 26%. This study focussed on addressing the high escape rate to improve the usefulness and acceptability of these traps. Specifically, modifications were made to the anchoring chain of standard Victor No 1 traps by adding one or two springs. These springs were designed to reduce the forces exerted by an animal during escape attempts. Over approximately 300 trap nights per trap configuration (unmodified No-Spring, 1-Spring, 2-Springs), the capture rates (proportion of animals caught and held until inspection) were measured. The results showed that traps with one or two springs achieved a significantly higher capture rate of 92%, compared to only 74% for the standard devices. The chain springs increased the capture rate by 24% due to a 69% reduction in escape rate. This study demonstrates that a minor modification (addition of one or two springs) to the restraining chain of Victor No 1 leghold traps greatly enhances their efficacy for capturing and managing possums.

Keywords: possums; leghold traps; capture rate; animal welfare; biodiversity; animal health; public acceptance

Introduction

The introduction of the brushtail possum (*Trichosurus vulpecula*) to New Zealand has severely degraded the country's biodiversity (e.g. Murphy et al. 2019). Further, the possum acts as a carrier for bovine tuberculosis, posing a health threat to dairy and beef cattle as well as deer herds (Warburton & Livingstone 2015). To manage possum populations, various approaches are deployed in New Zealand. Among these, the leghold trap is a valuable tool, especially in situations where alternative commonly used methods (e.g. toxins) could harm non-target species or the environment (OSPRI, 2017; Warburton et al. 2022), and where possums have developed aversions to toxic baits due to prior exposure. Furthermore, these traps are the standard tool used for assessing the effectiveness of possum control operations (Forsyth et al. 2018; NPCA 2015) and for fur harvesting. Another advantage of leghold traps is that they are more acceptable to the public than other methods (Dickie & Medvecky 2023; Warburton et al. 2022).

Nevertheless, the use of leghold traps is not without limitations: there is a risk of poor welfare from distress or harm during capture and restraint (Allen et al. 2022) or escape, and non-target animals may be caught (Morriss et al. 2000). Animal welfare concerns can be addressed by assessing trap performance against mandatory minimum welfare standards (e.g. Proulx et al. 2020). In New Zealand, one type of leghold trap (Victor-type No 1, hereafter called Victor No 1) for use with possums has passed the national humane trap testing guidelines (NAWAC 2019). The welfare performance of the Victor No 1 and other types of restraining traps can be improved by incorporating shock-absorbing springs and swivels into the anchoring chain (Fleming et al. 1998; Hanson et al. 2010; Niebuhr & Warburton 2019; Warburton & Poutu 2008). The springs reduce injuries by lowering the amount of force applied to the limbs during escape attempts (Proulx 2022).

Fitting chain springs and swivels to Victor No 1 devices may offer additional advantages, as anecdotal observations by commercial operators suggest that the capture rate of possums (ability of a trap to catch and hold a target animal that has triggered the trap) is higher for traps fitted with springs and swivels compared to those without. Improved capture rates would provide numerous benefits including:

(1) more cost-effective operations: fewer trap sets would be required to achieve equivalent population reductions
(2) improved population control and environmental management: more effective trapping leads to better management of possum populations and their impact on the environment
(3) reduced risk of capturing non-target species: fewer trap sets decrease the likelihood of non-target species capture
(4) improved animal welfare: fewer potentially injured escapees
(5) reduction in trap avoidance: fewer escapees would lower the likelihood of possums becoming trap averse, thereby improving future control efforts
(6) increased public support: enhanced trapping effectiveness and humaneness would boost public acceptance of possum control through trapping.

The study aimed to determine the effect of incorporating either one or two springs, along with dual swivels, to the restraining chain of Victor No 1 traps on capture rate (measured as the number of animals caught as a percentage of the potential captures (animals caught plus escapees)) (Fleming et al. 1998). For possums, the presence of fur in empty, sprung traps indicates that an animal triggered the device but was only temporarily held (Warburton 1998).

Methods

Study population

All animal handling procedures were approved by the University of Waikato Ethics Committee (Protocol number 1068).

The field work for the study was conducted in the Hakarimata Scenic Reserve (Waikato region) and adjacent bush on farmland. The Reserve's vegetation comprised mainly broadleaf/podocarp or kanuka species. The experimental animals were handled in accordance with the mandated and industry animal welfare protocols i.e. the traps were checked daily as soon as possible after sunrise (and within the mandated 12 hours of sunrise) and captured pest animals were euthanised without undue delay and in such a manner as to minimise pain and distress (Animal Welfare Act 1999; Animal Welfare (leg-hold traps) Order 2007; National Pest Control Agencies, 2015). In the area where the trapping was undertaken, there were no at-risk native birds (kiwi or weka) and there was no history of catching any other native animals at this location.

Experimental design

The trap modifications and trapping were carried out by experienced trappers in the late autumn. Twenty-five, new, double coil spring Victor No 1 traps (Possum Traps No 1 Leghold, Twigley Enterprises NZ, Waerenga O Kuri, Gisborne 4060, NZ) were used in each of three treatment groups. The treatment groups differed in the configuration of the anchoring chain. The configurations were:

(1) standard chain with swivels at both ends (310 mm long) and no spring

(2) a 300 mm chain with swivels at both ends and incorporating a spring (36 mm long, 10 mm diameter and 1.25-gauge steel (Spring Specialists, Mt Wellington, Auckland)) positioned 50 mm from the trap, and

(3) a 360 mm chain configured as in (2) above, with the inclusion of a second spring (55 mm long, 12 mm diameter and 1.6-gauge steel (Springtown Hamilton, Colombo St, Hamilton, NZ)) which was positioned 90 mm from the anchoring end of the chain. The smaller spring aimed to dampen the force that could be applied by small animals (such as trapped possums), while the bigger spring was designed to dampen forces that could be applied by larger animals such as pigs or goats.

The experimental design was a completely randomised block design, with equal numbers of each of the three trap types used on the trap lines. Each successive block of three traps included one of each type, and the order of the three within each block was randomised.

The traps were set along ridge lines in the bush (or under large trees on the farmland) at intervals consistent with the amount of possum sign in the area. Each trap was identified with a unique number on a 100 x 100 mm corflute tag attached to the closest tree. In addition, the traps were geo-tagged with GPS coordinates to provide additional assurance that each could be easily located each day. Traps were set against the base of trees devoid of other surrounding vegetation (within a 1 m circle) so that the anchor chain could not become entangled, helping to prevent escapes and injuries to the possums.

Data collection

Using fit-for-purpose paper recording sheets, the experienced trappers manually recorded, for each trap type: possum captures; possum escapes (sprung trap plus possum sign such as fur in the trap), sprung trap without possum sign; and non-target species captures. The body weight of each animal was also recorded immediately after euthanasia using portable scales.

Statistical analyses

The primary response (dependent) variable was capture rate (numbers of possums retained in the traps as a percentage of total numbers of possums caught, including escapees). For these and other catch-related measures, statistical significance of treatment differences was assessed using the Fishers Exact Test with the significance level (P) set at 0.05 (Microsoft Corporation, Fisher's Exact Test in Excel, retrieved from https://www.microsoft.com/en-us/microsoft-365/excel). Statistical analysis of bodyweight differences across treatments was assessed by ANOVA also with P set at 0.05 (Social science statistics, one-way ANOVA, retrieved from https://www.socscistatistics.com/tests/anova/default2.aspx).

Results

For each trap type, the numbers of trap-nights, possums captured and retained in the trap, possums escaping after capture, trap activations without sign of animal presence, traps not activated, and numbers of non-targets caught are shown in Table 1. The numbers of trap nights for each trap type were similar. The confirmed possum encounter rate with traps (possums caught or escaped as a proportion of trap nights) were not significantly different between trap types (38, 45 and 40%, for No-Spring, 1-

Spring and 2-Springs, respectively, $P > 0.05$).

Table 1. The numbers of trap-nights, possums captured and retained in the trap, possums escaping after capture, trap activations without sign of animal presence, traps not activated, and numbers of non-targets caught are shown for each type of trap.

Trap type	**No. of Trap-nights**	**No. of possums caught**	**No. of possums escaped**	**No. of trap activations & no sign**	**No. of traps not activated**	**No. of non-targets caught#**
No-Spring	280	78	27	18	145	12
1-Spring	288	120	10	12	140	6
2-Springs	288	106	9	17	150	6

All were rats except for 1 hedgehog in the 1-Spring trap

The capture rate (proportion of possums caught and held until inspection) was significantly different between trap types (see Figure 1; 74, 92 and 92% of possums retained for No-Spring, 1-Spring and 2-Spring traps, respectively). In other words, the percentage of confirmed escapes was 26% for No-Spring traps, and 8% each for 1-Spring and 2-Spring traps. The differences in capture rates between each of the spring configurations and the standard No-Spring trap were significant (1-Spring P = 0.000; 2-Springs P < 0.001), whilst there was no significant difference between the 1- and 2-Spring devices (P = 1.000).

(insert Figure 1 hereabouts)

The maximum potential escape rate (sum of confirmed escapes and unidentified trap activations as a proportion of possums held until inspection, escaped or unidentified trap activations) was 37%, 16% and 20% for No-Spring, 1-Spring and 2-Spring traps, respectively. The maximum potential escape rate was higher for the No-Spring version than either one ($P = 0.000$) or two spring ($P < 0.004$) traps, and there was no significant difference between the two different spring configurations ($P > 0.05$).

The proportion of trap nights in which traps were activated by unidentified animals (no sign) was not significantly different between trap types ($P > 0.05$; 6, 4 and 6%, for No-Spring, 1-Spring and 2-Springs, respectively). The numbers of trap activations by unidentified animals as a proportion of total activations was not significantly different between trap types ($P > 0.05$; 7, 4 and 6%, for No-Spring, 1-Spring and 2-Springs, respectively).

The proportion of trap nights in which nontargets were captured was not significantly different between trap types ($P > 0.000$) (4, 2 and 2%, for No-Spring, 1-Spring and 2-Springs, respectively).

There were no significant differences in body weights of the possums caught in the various trap configurations ($P > 0.05$). The mean weights (se) were 2.3 (0.1), 2.3 (0.1) and 2.4 (0.1) kg, for No-Spring, 1-Spring and 2-Spring traps, respectively.

Discussion

This study is the first to formally report improved capture rate when springs are incorporated into the anchoring chain of restraining traps. Specifically, the capture rate of possums in Victor No 1 traps fitted with one or two springs in the chain was 92%, compared to only 74% in standard unmodified devices. Thus, the modifications using one or two chain springs increased the capture rate by 24% due to the 69% reduction in escape rate. The escape rate observed with the standard, unmodified Victor No 1 trap is consistent with previous findings - Morriss et al. (2000) reported escape rates of up to 26% with these traps. Therefore, the 69% reduction in escapes observed, compared to the standard trap, cannot be attributed to atypically high escape rates from the standard configuration.

Additionally, the lower escape rates observed with chain spring configurations cannot be explained by differences in unidentified trap activations. There were no differences between trap types on this measure, nor were there no differences in the maximum potential escape rates, which accounted for unidentified trap activations.

Furthermore, the higher capture rates of traps with chain springs cannot be attributed to potential confounding factors such as:

(1) Differences in trap attractiveness, as confirmed encounter rates by possums were consistent across configurations

(2) Differences in weights of animals caught, and consequently the forces that could be exerted, as these were not different between trap configurations

(3) Inaccurate identification of possum escapes, as the combined measure of unidentified activations and confirmed escapes (maximum potential escape rate) yielded results similar to confirmed escapes alone

(4) The presence of swivels on trap chains, as all configurations were equipped with chain swivels.

A reduction in leverage and forces applied to limbs during escape attempts from traps fitted with anchor chain springs (Proulx 2022) is the most likely explanation for the lower escape rates and higher capture rates with these configurations. This explanation is consistent with the reduced injury rate of possums and other animals trapped using similarly modified devices (Niebuhr and Warburton 2019; Proulx 2022; Warburton & Poutu 2008). The use of chain springs could also be anticipated to reduce injuries to nontarget animals caught in the traps.

Notably, the single and double spring configurations were similarly effective in reducing escapes by captured possums. While it was anticipated that the double spring configuration might perform better due to further reductions in forces during escape attempts, a maximum cushioning effect seems to be achieved with a single spring for possums weighing around 2.5 kg. In areas with low possum densities, the average weight may be more than double that observed in the current study (up to 6.4 kg, Fraser 1979). Heavier animals can exert higher forces during escape attempts. In such cases, or where other large animals such as pigs or goats are present, traps equipped with dual springs (or other designs that achieve higher tensions) may perform better and be more durable. Additional research will be required to test this notion.

Adding springs to the anchor chains of Victor No 1 traps presents numerous benefits. Increased capture rates provide more cost-effective management of possums and their impacts on the environment and animal health. Further, standard traps leave a residual population with a proportion of previously trapped animals that have learned to avoid traps. Trap shyness has been estimated at 10% (Parliamentary Commissioner for the Environment 1994), whilst the present study showed that 26% of possums escaped from standard traps. The process of trapping, escaping, and associated trauma is likely highly aversive, and possums readily learn from negative experiences (e.g., O'Connor & Matthews 1999). Therefore, chain spring traps should be used to reduce the prevalence of trap-shyness in residual possum populations.

As mentioned previously, significant proportions of possums captured in standard Victor No 1 traps sustain trauma to some degree (Niebuhr & Warburton 2019;

Warburton & Poutu 2008).The incidence and severity of trauma sustained by animals that escape have not been researched, but signs such as fur or skin left in the traps suggest that escapees sustain injuries, with no possibility for any distress to be alleviated by euthanasia. Therefore, reducing the number of escapes by using traps fitted with chain springs would likely result in fewer injured escapees and an overall improvement in animal welfare.

Collectively, these benefits provide strong support for using Victor No 1 traps with at least one spring attached to the anchoring chain when targeting possums. Further, implementing this approach is likely to bolster public acceptance of trapping as an effective method of possum control.

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Additional information

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Data availability statement

Data can be made available upon request to the corresponding author.

Conflicts of Interest

The author declares no conflict of interest.

References

Allen BL, Ballard G, Fleming PJ, Meek PD, Smith D 2022. Improving animal welfare outcomes for live-trapped terrestrial mammals in Australia. In G Proulx (Ed) Mammal trapping– Wildlife management, animal welfare & international standards. Sherwood Park, Alberta, Canada: Alpha Wildlife Publications Pp 97-119

Animal Welfare Act 1999 No 142, Public Act. New Zealand Legislation, 1999

Animal Welfare (Leg-hold Traps) Order 2007 (SR 2007/353). New Zealand Legislation, 2007

Dickie L, Medvecky F (2023). The attitudes of young adults towards mammalian predator control and Predator Free 2050 in Aotearoa New Zealand. Australasian Journal of Environmental Management. 30(2):170-87

Fleming PJ, Allen LR, Berghout MJ, Meek PD, Pavlov PM, Stevens P, Strong K, Thompson JA, Thomson PC 1998. The performance of wild-canid traps in Australia: efficiency, selectivity and trap-related injuries. Wildlife Research 25(3):327-38.

Forsyth DM, Perry M, Moloney P, McKay M, Gormley AM, Warburton B, Sweetapple P, Dewhurst R 2018. Calibrating brushtail possum (*Trichosurus vulpecula*) occupancy and abundance index estimates from leg-hold traps, wax tags and chew cards in the Department of Conservation's Biodiversity and Monitoring Reporting System. New Zealand Journal of Ecology 42(2):179-191

Fraser KW 1979. Dynamics and condition of opossum (*Trichosurus vulpecula kerr*) populations in the Copland valley, Westland, New Zealand. Mauri Ora 7:117-137

Hanson CC, Bonham JE, Campbell KJ, Keitt BS, Little AE, Smith G. 2010. The removal of feral cats from San Nicolas Island: methodology. In Proceedings of the Vertebrate Pest Conference 24(24):72-78

Morriss GA, Warburton B, Ruscoe WA 2000. Comparison of the capture efficiency of a kill-trap set for brushtail possums that excludes ground-birds, and ground set leg-hold traps. New Zealand Journal of Zoology 27(3):201-6

Murphy EC, Russell JC, Broome KG, Ryan GJ, Dowding JE (2019). Conserving New

Zealand's native fauna: a review of tools being developed for the Predator Free 2050 programme. Journal of Ornithology 160(3):883-892

National Pest Control Agencies (NPCA) 2015. A1: Possum population monitoring using the trap-catch, waxtag and chewcard methods. Wellington, National Pest Control Agencies Pp 44

NAWAC (National Animal Welfare Advisory Committee) 2019. NAWAC Guideline 09: Assessing the welfare performance of restraining and kill traps. Wellington, Ministry for Primary Industries, Wellington, New Zealand Pp 25

Niebuhr CN, Warburton B 2019. An evaluation of welfare performance of chain-spring modifications of No. 1 leg-hold traps for capturing possums. Contract Report: LC3511 Manaaki Whenua – Landcare Research Pp 8 (available https://nzfurcouncil.org.nz/wp-content/uploads/2020/05/Final-Report-Possum-leg-hold-trap-modifications.pdf)

O'Connor CE & Matthews LR 1999. 1080-induced bait aversions in wild possums: influence of bait characteristics and prevalence. Wildlife Research 26:375-381.

OSPRI 2017. Traps used for Possum Control. Factsheet OSPRI-2017-11-21. Pp.??

Parliamentary Commissioner for the Environment 1994. Possum management in New Zealand. Wellington. Pp 196

Proulx G, Cattet M, Serfass TL, Baker SE 2020. Updating the AIHTS trapping standards to improve animal welfare and capture efficiency and selectivity. Animals 10(8):1262-1288

Proulx G 2022. Modifications to improve the performance of mammal trapping systems. In G Proulx (Ed) Mammal trapping– Wildlife management, animal welfare & international standards. Sherwood Park, Alberta, Canada: Alpha Wildlife Publications Pp 173–188

Warburton B 1998 Evaluation of escape rates by possums captured in Victor No. 1 soft catch traps. New Zealand Journal of Zoology 25(2):99-103

Warburton B, Eason C, Fisher P, Hancox N, Hopkins B, Nugent G, Ogilvie S, Prowse TAA, Ross J, Cowan PE 2022. Alternatives for mammal pest control in New Zealand in the context of concerns about 1080 toxicant (sodium fluoroacetate). New Zealand Journal of Zoology 49:79-121

Warburton B, Livingstone P 2015. Managing and eradicating wildlife tuberculosis in New Zealand. New Zealand Veterinary Journal 63(Sup1):77-88

Warburton B, Poutu N 2008. Effectiveness of chain-springs on leghold traps for reducing injuries to captured brushtail possums (*Trichosurus vulpecula*). New Zealand Journal of Zoology 35(2):147-150.

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Figure 1. The percentage of possums retained in traps at inspection for each of the three different trap types (No-Spring, 1-Spring, 2-Springs).