TECHNICAL REPORT #6

LOW HEIGHT PREDATOR FENCING

Tom Agnew, Maggie Nichols – September 2018

This project was one of a suite of projects initiated and largely carried out during 2015-2017, with funding from six New Zealand dairy companies, i.e. Fonterra, Tatua, Synlait, Westland Milk Products, Open Country Dairy and Miraka.

INTRODUCTION

A critical component of the 'Remove and Protect' model that Zero Invasive Predators Ltd (ZIP) is pioneering involves developing barriers to limit incursions of possums, rats and stoats into predator-free areas (in order to protect at-risk flora and fauna).

Predator fencing has proven to be an effective barrier to predators. Cap and mesh fence systems designed to exclude predators are typically constructed at a minimum height of 1,800 mm, which reflects the jumping abilities of medium-large mammals such as feral cats (*Felis catus*) (Day and MacGibbon 2007). To date in New Zealand, predator fences have largely been restricted to relatively small mainland conservation sanctuaries (Innes et al 2012; Burns et al 2012) and around industrial food processing plants (e.g. milk factories).

Traditional predator fencing is considered by some to be relatively expensive (e.g. Scofield et al 2011). Large posts must be erected every 2 m to manage the wind loading of a high fence. There are also significant material costs for capping and mesh. Traditional predator fencing costs between $200-400 per metre (Campbell-Hunt 2008; Bell 2014), depending on terrain and site access. Another reason for the high cost is that fences are generally engineered to meet the specifications for each job, meaning there are no large scale productionisation processes for building critical elements such as the capping.

As well as the financial costs, traditional predator fencing can be considered aesthetically unpleasant. The 1800mm height and solid capping running along the top of that fence can be foreboding and give the impression of excluding areas from public access. While untested, we hypothesised that being able to reduce the height of the predator fence while maintaining its proven effectiveness for excluding predators would remove a significant portion of the social backlash to predator fencing as a management tool around inhabited areas.

ZIP's focus is on the three predator species understood to have the largest impact on native biodiversity across the majority of ecosystems in New Zealand, i.e. possums (*Trichosurus vulpecula*), ship rats (*Rattus rattus*) and stoats (*Mustela erminea*) (Brown et al 2015). Given that the 1800mm height is largely in response to the jumping height of feral cats (Day and MacGibbon 2007) and feral cats are not a target species for ZIP, we suspected that the height of the traditional predator fence could be lowered while still being an effective barrier to possums, rats and stoats. One such option for a reduced height is that of a standard stock fence – 1100mm – given the wide application and social acceptance of these fences throughout the rural landscape.

Building on earlier work of others examining the physical capabilities of various mammalian pest species during 'escape' attempts (e.g. Zealandia[1]; Day T. and MacGibbon R. 2007), we tested this low height predator fence idea using a specially constructed fenced pen. This technical report details the methods and results, along with suggested improvements for future predator fencing.

METHODS

The ZIP predator behaviour facility at Lincoln includes a 2 hectare predator enclosure constructed using an industry standard 1,800 mm high predator fence (Day T. and MacGibbon R. 2007). To test the 'escape' abilities of possums, rats and stoats, we constructed a 4 m x 4 m 'internal pen' within the confines of the larger enclosure. The internal pen is constructed of the same materials as the surrounding enclosure, except that it features a removable cap and mesh system that can be lowered or raised depending on the animal being tested.

Figure 1. 4 m x 4 m internal pen inside the 2 hectare predator enclosure.

[1] See https://www.visitzealandia.com/About/History/A-World-First-Sanctuary [cited 31 August 2018]

The possums, rats and stoats used in this trial were caught in the wild, then held for two weeks in individual outdoor pens to acclimatise to captivity.

Individual animals of each species were then transferred to the 'internal pen', and given a three-night period to attempt escape. Sustenance food, water and shelter was provided within the pen.

Live-capture cage traps baited with highly desirable food items were placed on the outside of the internal pen cell to encourage the animal to escape from it.

If an animal was contained within the pen for three nights, then the trial was declared a success and the animal was replaced with another until a minimum of 20 animals had been tested for all species.

If an animal successfully escaped the internal pen, then it was returned to the pen, and this time monitored by cameras to help us identify how it escaped. Interesting behaviour witnessed by researchers was also recorded (Figure 2 and Figure 3, below).

In total, we tested 22 stoats, 21 possums and 20 ship rats, at fence heights of 800 mm, 900 mm, and 1100 mm. Animals that escaped the internal pen with the fence height set at 800 mm or 900 mm were retested when the fence height was raised.

This trial was completed under approval of the Lincoln University Animal Ethics Committee.

RESULTS

A predator proof fence at the standard stock fence height of 1100 mm has so far proven capable of restricting escape for almost all individual possums, rats and stoats tested in our trial (Table 1 below).

Table 1. Fence heights and escape rates for possums, ship rats and stoats.

Target species	**Sample size (*n*)**	**@ 800mm (n)**	**Number of escapes**	**@ 900mm (n)**	**Number of escapes**	**@ 1100mm (n)**	**Number of escapes**
Possum	21	-	-	-	-	21	1
Ship rat	20	8	0	-	-	12	0
Stoat	20 [NB]	6	2*	8	1*	9	1*

[NB] 20 individual stoats were used, for 23 escape attempts – stoats that successfully escaped a lower height were retested once the fence height was increased.

* The same individual stoat successfully escaped at all three heights (the other stoat that escaped the 800mm high fenced pen could not escape when it was increased to 900mm in height).

Possums were not tested below a fence height of 1100mm because, based on the work of others (Day T. and MacGibbon R. 2007), we were confident they were likely to escape at the lower heights. Only one possum out of the 21 trialled was able to escape the internal pen– meaning that the low height fence was a barrier to 95.2% of the possums (n=21, 95% CI [76.2%, 99.9%]).

None of the eight ship rats tested escaped the 800 mm fence height, resulting in a 100% exclusion success rate (n=8, 95% CI [63.1%, 100%]). When the fence height was increased to 1100 mm for possum trials, an additional 12 ship rats were individually trialled with no escapes observed from those 12 individuals (n=12, 100% exclusion success, 95% CI [73.5%, 100%]). In total, none of the 20 ship rats were able to escape the internal pen with the fence set at 1,100 mm or lower – meaning that the low height fence was a barrier to 100% of the rats (n=20, 95% CI [83.2%, 100%]).

Two of six stoats escaped an initial fence height of 800 mm – an exclusion success rate of only 66.7% (n=6, 95% CI [22.3%, 95.7%]. The two individuals who escaped from the first height trial and six additional new stoats were trialled at 900 mm, with only one escape recorded – an exclusion success rate of 87.5% (n=8, 95% CI [47.3%, 99.7%]. Interestingly, the successful escape was attributed to one of the two individuals that previously escaped at 800 mm. That same animal and a further 8 new individual stoats were trialled with the internal pen fence set at 1100 mm. Interestingly, that same stoat escaped again, while the other stoats were kept within the internal pen – an exclusion success rate of 88.9% (n=9, 95% CI [51.8%, 99.7%]. In total, only one of the 20 stoats trialled was able to escape the internal pen with the fence set at a height of 1100 mm or lower – meaning that the low height fence was a barrier to 95% of the stoats (n=20, 95% CI [75.1%, 99.9%]).

DISCUSSION

<u>Behavioural observations</u>

Throughout the entirety of these trials, researchers witnessed very few instances of any of the individual predators jumping from the ground as an attempt to escape the pen. At all heights, the animals' first instincts were to climb, and then jump from around halfway up the mesh wall.

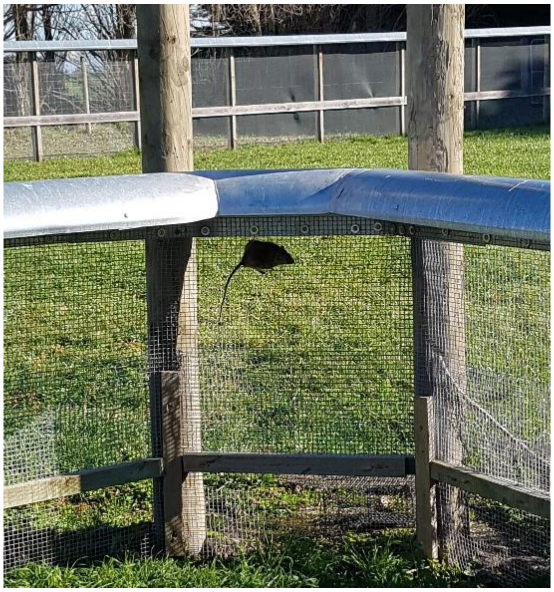

Figure 2. Rat climbing mesh of internal cell.

The two stoats that escaped (including the one that escaped at all three heights trialled) worked out that if they climbed the mesh towards a corner of the pen, they could use the 45° angle to attack the cap on the other side of the cell. This behaviour led to their successful escapes. This corner would not typically be constructed in this way in a 'real world' setting, as it is an artefact of the requirement to create a small pen (e.g. tight corners to enclose the area). Therefore, this method of escape would be much less likely to occur in reality.

Likewise, most possum escape attempts involved leaping upwards at the cap from approx. halfway up the mesh wall. However, in their case, they were unable to reach high enough to grip onto the top of the cap (or beyond) and pull themselves over it. Ultimately, each attempt ended with a fall to the ground.

The one possum that did escape during the trial was observed on a number of occasions using the 45° angle at the corner of the pen to 'attack' the cap on the other side of the cell (much like the two stoats that were able to escape). The possum escape events themselves were not observed.

Figure 3. A possum unsuccessfully attempts to breach the 1100 mm high internal pen (left); and the scratch marks left in the cap as a result of a failed attempt to escape (right).

Ship rats were the most likely species to attempt digging at the base of the mesh. However, all digging animals were deterred once they reached the mesh skirt approximately 200 mm down. No jumping behaviour was witnessed from any of the rats.

Explanation of the successful stoat escapes

Stoats were the most successful of the predator species trialled at escaping the internal cell throughout testing, with four escapes occurring from two individuals over the 23 trials at various heights. However, it is considered that all of the escapes can be at least partly attributed to design or manufacturing flaws in the internal cell. Two of the escapes are explained above – stoats leaping across tight corners to overcome the cap.

One of the successful escapes at the 800mm height was enabled by an exposed rivet hole that had gone unnoticed at the time of construction (this flaw was subsequently corrected, by welding it shut).

The successful escape at the 900mm height is considered to have been achieved when the stoat jumped on to the capping from the top of a wooden batten set against the mesh inside the pen (Figure 5 below). Due to the width of this batten, it effectively reduced the cap 'overhang' width from 250 mm to around 220 mm which proved to be within the stoat's physical capability to overcome the effect on its centre of gravity of reaching up to the top of the cap.

Figure 4. Stoat successfully escapes from 900 mm fence by jumping from the wooden batten below (which had the effect of reducing the cap overhang distance).

Both of these examples illustrate how precise fencers must be when constructing predator fencing, as any weakness can be quickly exposed by intelligent animals. In saying that, based on these identified issues, we would expect a well-constructed field-deployed 1100mm high fence to achieve even better results that were achieved in our trial.

Potential to reduce the cost of predator fencing

As stated earlier, current 'industry standard' predator fencing is considered expensive. With the successful testing of the low height fence, we consider there is significant potential to productionise predator fencing systems – i.e. to manufacture and construct them more efficiently – which will lower the associated costs. Options include:

- A lower fence results in less mesh required in the fence itself (e.g. 1800mm down to 1100mm, removes 700mm across the entire length of fence), so a reduced material cost.

- Lowering the fence height reduces the weight and relative wind load, meaning fewer large posts are required and those that are can be spaced further apart (and potentially supported with waratahs)

- Reduce the costs of driving in the posts required to support the weight of the fence (which is one of the most expensive aspects of predator fence construction)

- Develop methodologies to produce the capping, and manage the cornering of fences, which is where a large portion of the expense sits due to the customised approach taken at present.

- Retrofit a revised cap and mesh system onto existing stock fences in rural landscapes, saving costs on building new fences from scratch.

Potential application of low height predator fences

The success of these trials suggest that a predator fence of equivalent height to that of a stock fence will be successful at excluding the majority of predators. Given the vast fencing network across the rural landscape of New Zealand, there is enormous potential for the adoption of this technology to assist with creating predator-free landscapes. In saying that, we recognise that the rural environment is also an inhabited and a working environment – a place where people need to be able to move to and from easily and frequently.

As such, ZIP is currently looking into the potential of various deterrent methodologies to support the implementation of low height fences in these sorts or places. Of particular focus at present is technologies to protect 'deliberate openings' in the predator fences (e.g. gates, driveways). These deterrent technologies, such as electric cattle grids and high-powered lights, would enable human traffic to flow unimpeded, while still limiting incursions by predators.

It is important to remember, when considering barriers to predator reinvasion, that no solution is likely to be 100% effective. After all, even off shore islands and traditional predator fenced sanctuaries suffer predator incursions from time to time. A systems approach (and one dependent on the particular situation at hand) is likely to get the best result, such as low height predator fencing in combination with a good trapping network out front (to reduce invasion pressure), and a sensitive detection network and response system behind it (to rapidly find invaders that do breach the barrier).

ACKNOWLEDGEMENTS

We wish to thank Nigel Broadbridge and his team at Central Fencing Ltd for the original construction of the internal cell, and for being on hand to rapidly adjust the height of it as required – this has allowed us to test the jump abilities of our three target species at a variety of heights over a short period of time. We would also like to acknowledge the technical advice and input on predator fencing from John McClennan and others, particularly the team at Zealandia who made their jump height trial data from the early 90s available to us. A special thank you to the ZIP team at Lincoln (and beyond), who undertook or assisted with these trials.

REFERENCES

Bell, P. (2014) Predator Free Rakiura Halfmoon Bay Project—analysis of options for proposed predator fence. Discussion document prepared by the Department of Conservation for the Predator Free Rakiura (PFR) Governance Group, c/o Southland District Council, Invercargill. 17 pp.

Brown, K., Elliott, G., Innes, J. and Kemp, J. (2015). *Ship Rat, Stoat and Possum Control on Mainland New Zealand: An Overview of Techniques, Successes and Challenges.* Wellington: Department of Conservation.

Burns, B.; Innes, J.; Day, T. 2012: The use and potential of pest-proof fencing for ecosystem restoration and fauna conservation in New Zealand. Pp. 65–90 in Somers, M.J.; Hayward, M.W. (Eds): *Fencing for conservation: restriction of evolutionary potential or a riposte to threatening processes?*, DOI 10.1007/978-1-4614-0902-1_5, © Springer Science+Business Media, LLC 2012.

Campbell-Hunt, D.M. (2008) Ecotourism and sustainability in community driven ecological restoration; case studies from New Zealand. Sustainable Tourism III (eds. C.A. Brebbia & F.D. Pineda). *Ecology and the Environment* **115**, pp. 231–240. WIT Press, Southampton.

Day T. and MacGibbon R. (2007) Multiple-species exclusion fencing and technology for mainland sites. In: *Managing Vertebrate Invasive Species: Proceedings of an*

International Symposium (ed W.C.P.G.W. Witmer, K.A. Fagerstone), National Wildlife Research Center, Fort Collins, CO.

Innes J., Lee W. G., Burns B., Campbell-Hunt C., Watts C., Phipps H., and Stephens T. (2012) Role of predator-proof fences in restoring New Zealand's biodiversity: a response to Scofield et al. (2011) *New Zealand Journal of Ecology* **36(2)**: 232-238

Scofield, R.P.; Cullen, R.; Wang, M. 2011: Are predator-proof fences the answer to New Zealand's terrestrial fauna biodiversity crisis? *New Zealand Journal of Ecology* 35(3): 312–317.