Efficacy of a low height predator fence comprised of galvanized mesh and a high-density polyethylene (HDPE) cap as a barrier for ship rats (*Rattus rattus*)

Report prepared for Predator Free Wellington

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1. Introduction

In June 2019, Predator Free Wellington (PF Wellington) contracted Zero Invasive Predators Ltd (ZIP) to trial the efficacy of a low height predator fence constructed of galvanized mesh and a high-density polyethylene (HDPE) pipe "cap" as a barrier for ship rats (*Rattus rattus*).

The purpose of the trial was to inform the design of the height and cap components of fences proposed to protect the outcomes of a predator removal operation on Miramar Peninsula from reinvasion by ship rats. Structural elements of the fence design (e.g. wind loading) were excluded from the trial.

PF Wellington requested that we initiate the trial at 800 mm fence height, with a 90 mm HDPE cap. As the trial progressed, 110 mm HDPE cap was also tested and Norway rats (*Rattus norvegicus*) were included to reflect their expected presence in the Predator Free Wellington site.

2. Methodology

2.1 Trial pen

The trial was undertaken at the ZIP predator behaviour facility in Lincoln, Canterbury in a purpose-built, 2500 mm x 2000 mm pen located within a 2-hectare predator enclosure. Three walls of the pen are concrete blocks lined with metal plates to a height of 1800 mm. The front wall is a simple timber fence frame at a height of 800 mm, the inside face of which is lined with 12 mm x 12 mm galvanized metal mesh and capped with a continuous section of high-density polyethylene (HDPE) pipe. Trials were initially undertaken using a 90 mm pipe (21st June – 29th July) and later on a 110 mm diameter pipe (31st July – 8th August).

Due to the lower height of the front wall escape pressure is concentrated on this face. Previous trials have demonstrated that the small size of the pen leads to high motivation for individuals to escape (T. Agnew, pers. comm.).

The trial was initiated on the expectation that testing would be undertaken to identify a fence that prevented at least 19 of 20 rats tested from escaping.

2.2 Animals

A total of 17 wild-caught adult ship rats (*Rattus rattus*) were supplied to ZIP by independent contractors for fence testing. The animals comprised: eight male ship rats, with a body weight range of 113 - 236 g, and nine female ship rats with a body weight range of 72 - 189 g. All individuals were in good condition at the time of testing, and during trials were supplied with a diet of pellets, seeds and water.

Three wild-caught adult Norway rats (*Rattus norvegicus*) were also tested against the 90 mm cap. These animals comprised: two males with body weights of 354 g and 240 g, and a 210 g female.

Figure 1: Pen used for fence testing

2.3 Test procedure

Individual rats were released into the trial pen for a period of at least 2 nights. Interactions with the fence and cap were continuously recorded via two Techview QV-3140 cameras (full D1 resolution, 100 frames per second, IR illumination) located at the rear of the pen. This allowed the researcher to: (i) confirm that individuals had made attempts to cross the fence, and (ii) in the case of escape, determine the mode of escape.

Live capture traps were set within the 2-hectare enclosure to catch any individual rats that escaped from the trial pen. This enabled us to retest animals, including against a larger diameter cap.

All testing done in this trial was carried out with Lincoln University Animal Ethics Committee approval (AEC2016-40).

3. Results

3.1 Ship rats

3.1.1 90 mm cap

Fourteen individual ship rats were tested against the 90 mm diameter cap between the 21st of June and the 29th of July 2019. All individuals made repeated attempts to cross the low height fence section of the pen. The majority of escape attempts involved a climbing approach; however, in some instances, jumping behaviour was also observed. In no instance was a rat observed to jump to a height at which it could reach the pipe cap.

Two rats successfully escaped the pen; both were males with body weights of 166 g and 177 g respectively. In both cases, the individual positioned themselves beneath the pipe and reached their forelegs around, grasping the upper surface of the pipe. The position of the forelegs provided the rat sufficient anchorage to climb around the pipe.

Due to these two failures (which exceeded the success criteria) the 90 mm diameter cap was deemed insufficient to be an effective barrier and so, with the approval of PF Wellington, it was replaced with a 110 mm diameter pipe on the 31st of July.

3.1.2 110 mm cap

Following the installation of the 110 mm pipe, the 177 g male rat, which had previously escaped the 90 mm cap, was retested. The extra diameter of the pipe prevented the individual reaching its forelegs to the upper face of the pipe and thus prevented escape (Figure 2). The other escapee, a 166 g male, could not be retested as it died of natural causes prior to the installation of the larger pipe; it is therefore unknown whether the 110 mm diameter cap would have been sufficient to contain this individual.

An additional three ship rats (164 – 197g), which had not been tested previously, were tested against the 110 mm pipe cape. The first two individuals tested (197g male and 189g female) were not able to escape from the pen. However, the other individual, a 164 g

female, was able to escape past the larger cap. The method of escape was similar to those observed in the 90 mm trials, with the individual reaching around to the upper surface of the pipe and then pulling itself up (Figure 3). This individual made many prior escape attempts (20+) over the course of approximately 10 hours before this ultimately successful climb.

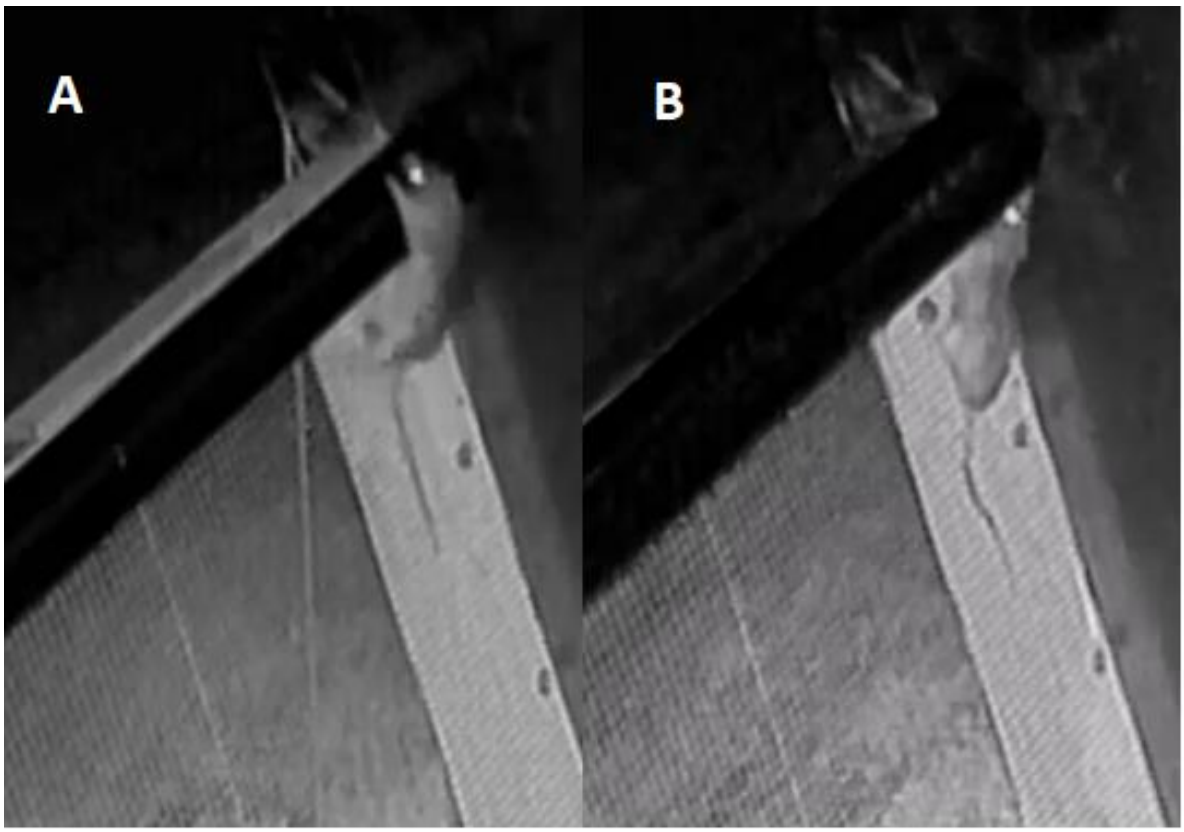

Figure 2: (A) The 177 g male climbing past the 90 mm pipe, and (B), the same rat interacting with the larger diameter, 110mm pipe.

Figure 3: The 164 g female which was able to climb past the 110 mm pipe cap.

At this point of the trial PF Wellington advised us that the results to date – i.e. 1 escape out of 16 ship rats tested up to the 110 mm diameter pipe cap (with an unknown result for the deceased rat) - had given them enough confidence to proceed with finalizing the design of predator fences for the road/coast barrier system to protect Miramar Peninsula from reinvasion by rats.

3.2 Norway rats

3.2.1 90 mm cap

Norway rats will almost certainly be present at the sites of the proposed predator fences, and so with PF Wellington's approval, we tested individuals of this species too. Norway rats are less adept at climbing than ship rats (Foster et al. 2011), but warranted testing due to their larger size and the reduced height fence being trialed. Three Norway rats were trialed against the 90 mm pipe, and all were contained.

3.3 Overall result

In total, across both species of rats tested, 1 out of 19 (with one) individuals were able to breach the predator fence when capped with HDPE pipe up to a diameter of 110 mm. The

fate of the 20th rat is unknown due to it successfully escaping from the 90mm diameter cap but then dying before it could be retested against the 110mm cap.

4. Conclusions

- An 800 mm high, 12 mm x 12 mm mesh fence, constructed with a 110 mm diameter HDPE pipe cap contained 15 of the 16 ship rats tested in this trial; i.e. 94% of the ship rats tested.
- Individuals that escaped the pen (with 90 or 110 mm caps) were all in the range of 160 – 180 g and there was no apparent sex bias.
- Individuals that escaped all appeared to exhibit a similar behaviour – climbing to beneath the pipe cap, and then reaching around to near the peak and securing enough grip to pull itself over the top. This suggests that an alternative design that limits the ability for the rat to climb to within reaching distance of the cap could remove this escape route (but would require testing).
- These trials represent a high-pressure scenario in which rats are highly motivated to escape over the cap. The individual that escaped over the 110 mm cap attempted to escape more than 20 times over an extended period of time before ultimately being successful. The likelihood of this occurring in the PF Wellington fence scenario is reasonably low due to alternative routes for the rat to travel.
- Preliminary results indicate that a fence constructed with a 110 mm diameter HDPE pipe cap would also be sufficient to contain Norway rats (but further testing would be required to confirm this).

5. Recommendations

We recommend that PF Wellington:

- Use a minimum of 110 mm diameter HDPE pipe cap on any rat fence.
- Note that rats are highly unlikely to be able to jump over an 800 mm high fence, although observations suggest that a lower height could be equally effective.
- Note that traps and other items located against a predator fence will likely reduce the effective height of the fence.

6. Acknowledgements

We acknowledge and thank the following people for their help in designing and running this trial, and for interpreting and publishing the results:

- Wayne Holcroft and James Wilcocks (Predator Free Wellington), for initiating and guiding the project
- Mike Hanson caught the ship rats and Norway rats we used to carry out these trials.
- Joseph Arand, Briar Cook, and Helen Nathan (all ZIP) provided advice and suggestions on adapting the trial as new results came to light.

7. References

Foster, S., King, C., Patty, B. & Miller, S. (2011) Tree-climbing capabilities of Norway and ship rats. *New Zealand Journal of Zoology*, 38, 285-296.