Manaaki Whenua
Landcare Research

Predator and biodiversity response monitoring in Cape to City: annual report 2021

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Predator and biodiversity response monitoring in Cape to City: annual report 2021

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Summary

Project and client

- The Cape to City programme aims to control invasive predators (feral cats, stoats and ferrets) across 26,000 ha of farmland, peri-urban areas, and native bush in Hawke's Bay. Rats are also controlled in some targeted areas. The objective is to restore the landscape such that 'native species thrive where we live, work and play'.
- Monitoring is necessary to determine whether predator control is having an effect on predator populations, and on populations of native species.
- Manaaki Whenua – Landcare Research has been contracted by Hawke's Bay Regional Council (HBRC) to monitor the relative abundance and distribution of predators, as well as native lizards and invertebrates, in the Cape to City area and an adjacent non-treatment area.

Objectives

- This report summarises the predator and biodiversity monitoring conducted in Cape to City since monitoring began in 2015.

Methods

- Predator control is being carried out by HBRC and local landholders. Stoats and ferrets are being removed using a network of 1,467 kill traps, which was rolled out in 2016 and 2017.
- Feral cats were subject to a pulsed control operation in 2016 and 2017 using a rolling front of cage and leghold traps across the treatment area. Some localised pulses of control have been conducted since, but there has been no attempt at sustained, widespread control of feral cats.
- Since 2015, predators have been monitored in November each year using 37 motion-triggered cameras (camera traps) in the treatment area, and 31 cameras in the non-treatment area. Camera traps also detected other species, including rats, mice, rabbits, and hares.
- Relative abundances of native lizards and invertebrates were monitored in the treatment and non-treatment areas using tracking tunnels, wētā houses, tree wraps, frass funnels, and artificial cover objects. Tracking tunnels also detected rats and mice.

Results

- Before the main pulse of cat trapping was completed in mid-2017 the relative abundance of feral cats was similar in the treatment and non-treatment areas.
- In late 2017, and again in 2018, cats were less abundant in the treatment than in the non-treatment area. In 2019 and 2020, the relative abundance of feral cats was once again similar in both areas.
- Before predator control began, the relative abundance of stoats was higher in the treatment area than in the non-treatment area. From 2016, the relative abundance of stoats was at or close to zero in both areas.
- The relative abundance of ferrets fluctuated in both areas, but remained at or close to zero in the treatment area after completion of the trap roll-out.

- Camera trapping showed that the relative abundance of rodents fluctuated, but declined in both areas from 2018 onwards.
- The relative abundances of rabbits and hares were higher in the treatment area in most years, but in 2020 it was similar in both areas.
- Tracking tunnel monitoring suggested that skinks, geckos and wētā were generally more abundant in the treatment area than in the non-treatment area, although differences were statistically significant only in some sampling periods. No wētā were detected by tracking tunnels in 2020.
- Data from wētā houses suggested that wētā were already more abundant in the treatment area before predator control began. From summer 2017/18 onwards there was an upward trend in wētā numbers in the treatment area, but not in the non-treatment area. In 2020, wētā houses in the treatment area contained around 10 times more wētā than those in the non-treatment area.
- No lizards were recorded under the tree wraps in either the treatment or non-treatment area.
- Frass funnels indicated that arboreal stick insects and tree wētā were more abundant in the treatment area than in the non-treatment area throughout most of the study period.

Conclusions

- The results suggest that predator control has reduced the relative abundance of stoats and ferrets.
- Although the initial knock-down of feral cat numbers was apparently effective, their relative abundance has since recovered to pre-control levels.
- There was no evidence of an increase in rodents following removal of predators.
- Detections of rabbits and hares were initially localised, but became more widespread in both the treatment and non-treatment area.
- Native lizards and invertebrates appear to be more abundant in the treatment than in the non-treatment area, although similar pre-existing differences were apparent.
- Together, tracking tunnels and wētā houses suggest that relative abundances of wētā, skinks, and geckos have increased in the treatment area relative to the non-treatment since predator control began.
- Due to a lack of replication, we cannot confidently conclude that the observed differences were the result of predator control as opposed to natural variation between areas.

Recommendations

- Predator monitoring suggests that additional cat control is required if sustained reductions in feral cat populations are to be achieved.
- Although the relative abundances of stoats and ferrets have been at or close to zero in the treatment area since 2017, continued monitoring is required to determine whether their abundance is genuinely lower than in the non-treatment area.
- We suggest that monitoring of lizards and invertebrates be discontinued. The constraints of the study design (lack of replication, and the fact that there were pre-

existing differences between the treatment and non-treatment area) mean that continued monitoring is unlikely to be very informative.

1 Introduction

As part of the Predator Free Hawke's Bay initiative, the Cape to City programme aims to control invasive predators – feral cats (*Felis catus*), stoats (*Mustela erminea*), and ferrets (*M. furo*) – across 26,000 ha of farmland, peri-urban areas, and native bush in Hawke's Bay. Rats (*Rattus rattus* and *R. norvegicus*) are also being controlled in selected areas. The objective is to restore the landscape such that 'native species thrive where we live, work and play' (HBRC 2020). Achieving this objective requires monitoring to demonstrate:

- reduced abundance and distribution of predators
- increased abundance, distribution, and diversity of native species.

Manaaki Whenua – Landcare Research was contracted by Hawke's Bay Regional Council (HBRC) to monitor the relative abundance and distribution of predators, native lizards, and invertebrates in the Cape to City area and in an adjacent non-treatment area. In 2021 HBRC requested that we also investigate whether invasive prey species may have become more abundant since predator control began. These species include rodents (rats and mice *Mus musculus*), and lagomorphs (rabbits *Oryctolagus cuniculus* and hares *Lepus europaeus*).

2 Objectives

This report summarises the predator and native biodiversity monitoring conducted in Cape to City since 2015. It also considers whether invasive prey (rodents and lagomorphs) have become more abundant since predator control began. For each year we compare the relative abundance of:

- feral cats, stoats and ferrets
- rodents and lagomorphs
- native lizards and invertebrates

in the Cape to City treatment area and adjacent non-treatment area.

3 Methods

3.1 Predator control

Predator control is being carried out by HBRC and local landholders. Stoats and ferrets are being removed using a network of kill traps, which was rolled out across the treatment area in 2016 and 2017. The network comprises 1,467 kill traps (podiTRAP, Metalform, Dannevirke, NZ) spaced at one trap per 10 ha in Areas A and C, and one trap per 20 ha in Area B (Figure 1). The variation in trap density was intended to test whether predator populations could be maintained at the same level with less trapping effort. Rats are also controlled using poison bait in some selected areas (Figure 2).

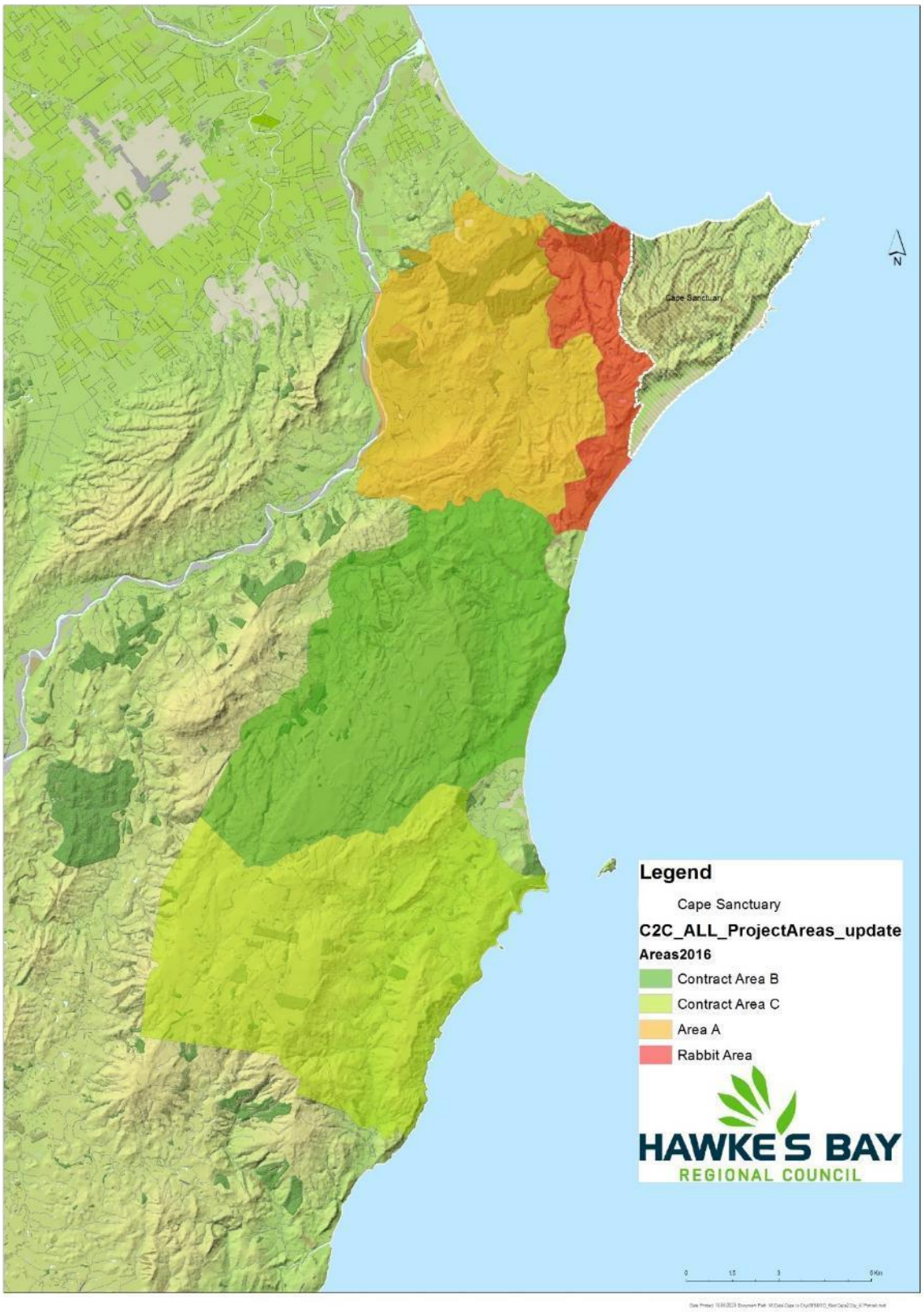


Figure 1. Map of the Cape to City treatment area showing predator control operation Areas A (pale orange), B (dark green) and C (pale green). No predator control has been conducted in the area labelled 'Rabbit Area' (dark orange). Adjacent to the west and south of Areas A, B and C is the non-treatment area (see Figure 3b). Map courtesy of HBRC.

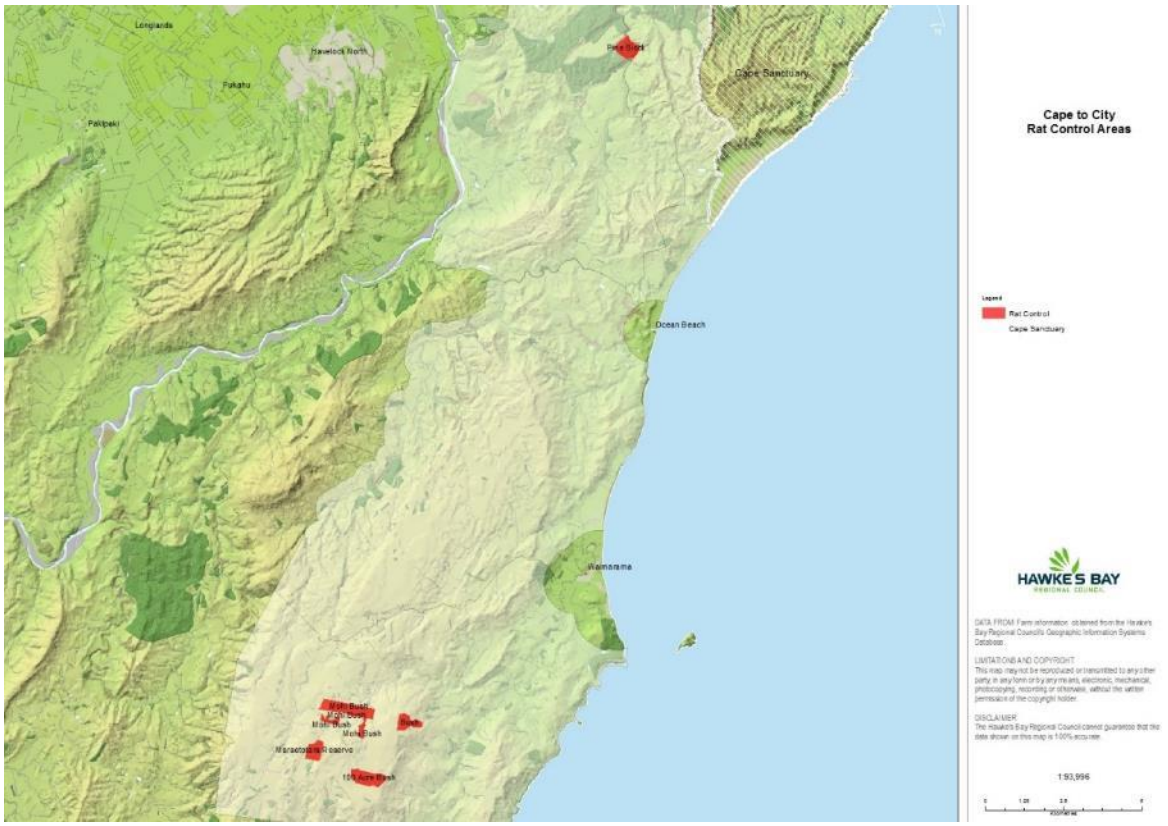


Figure 2. Map of the Cape to City area showing areas of targeted rat control (red). Map courtesy of HBRC.

Feral cats were subject to a pulsed control operation in 2016 and 2017 using a rolling front of cage and leghold traps across the treatment area. Cage traps were deployed in approximately 1,230 locations and leghold traps in 130 locations. Some localised pulses of trapping were conducted between 2018 and 2020, but there has been no attempt at sustained, widespread control of feral cats. The number of predators captured each year is summarised in Table 1.

Table 1. Number of predators removed each year by trapping in Cape to City

Year	Cats	Ferrets	Stoats	Weasels
2016	80	21	3	0
2017	170	31	22	2
2018	22	37	42	10
2019	19	6	30	10
2020	6	5	9	7
Total	**297**	**100**	**106**	**29**

Source: HBRC, unpublished data.

3.2 Camera trapping

From 2015 to 2020, predators were monitored in November/December each year using 37 motion-triggered cameras (camera traps) in the treatment area and 31 cameras in the non-treatment area (Figure 3). Camera traps (Browning Strike Force BTC-5, Prometheus Group, Birmingham, Alabama) were placed at least 2 km apart, achieving broad coverage of the study area, and were left in place for 21 days. Cameras were set to take three images in quick succession when triggered, with no delay between successive triggers. To reduce the probability of detecting owned cats, which were not being targeted for control, cameras were placed at least 100 m away from the nearest dwelling.

In this report, relative abundance estimates for rodents and lagomorphs are also included. These were calculated retrospectively for previous years by reviewing stored image data. We grouped images of rats and mice under the category 'rodents', and images of rabbits and hares under the category 'lagomorphs.'

We estimated the relative abundance of feral cats, stoats, ferrets, rodents, and lagomorphs by calculating the camera trap rate (CTR), which is the number of detections of a species per 100 camera trap days (Rovero & Marshall 2009). Detections of the same species by the same camera are considered to be separate encounters if they are separated by more than 30 minutes (Garvey et al. 2017), or if individuals can be identified based on appearance (e.g. coat colour). Any images of cats wearing a collar are discounted, as these are assumed to be owned cats.

To determine whether there was statistical evidence for differences in CTR between the treatment and non-treatment area, we used visual inspection of the 95% confidence intervals (CIs), which are an indication of precision. Where the lower 95% CI for one estimate overlaps less than halfway with the upper 95% CI of another estimate, this indicates moderate statistical evidence of a difference (<5% probability that the result was obtained by chance). Non-overlapping 95% CIs indicate strong statistical evidence of a difference (<1% probability the result was obtained by chance) (Cumming 2009).

(a)

(b)

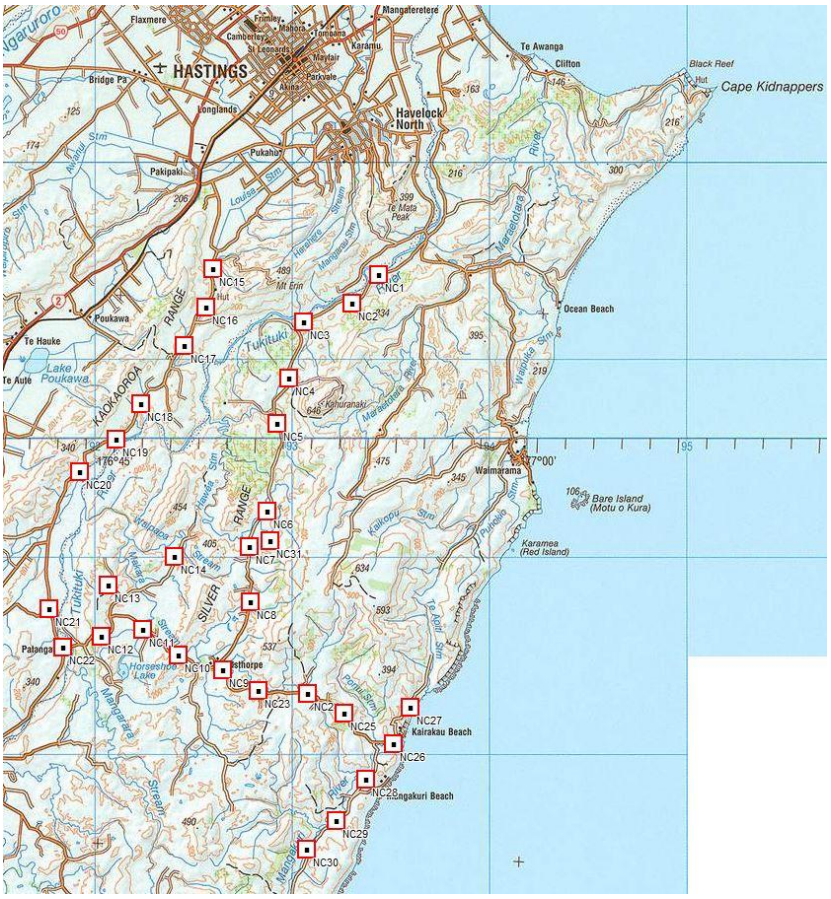


Figure 3. Locations of camera traps used to monitor predators in the Cape to City treatment area (a) and adjacent non-treatment area (b).

3.3 Tracking tunnels

To monitor relative abundances of wētā and lizards, as well as rats and mice, tracking tunnels were set 20 m apart in lines of five, with ≥100 m between adjacent lines. The tunnels were left in place year-round. There were 75 lines of tracking tunnels in the treatment area (nine of which were in Mohi Bush, where rats were also controlled), and 50 lines in the non-treatment area. Until 2020, tracking tunnel data were collected twice each year, in summer and spring. In 2020, tracking tunnel data were collected once, in spring.

Tracking ink (Black Track, Pest Management Services, Wellington) was applied to the floor in the middle of each tunnel, and sheets of tracking paper were fastened to the tunnel floor at each end with drawing pins. Each tunnel was baited with a small blob of peanut butter in the middle of the tracking ink. Tracking papers were retrieved after 3 days and labelled with line number, tunnel number and date. Footprints on the tracking papers were identified using field guides (Gillies & Williams 2002; Agnew 2009; NPCA 2014). Tracking rates (the percentage of tracking tunnels in which footprints were recorded) were calculated for rats, mice, wētā, skinks and geckos. Again, differences between treatment and non-treatment were determined by overlap in 95% CIs.

3.4 Wētā houses

To monitor invertebrates in forested areas, wētā houses were set 20 m apart in lines of five, with ≥100 m between adjacent lines. Until 2020 there were 13 lines of wētā houses in the treatment area (nine of which were in Mohi Bush), and 18 lines in the non-treatment area. In 2020 this was increased to 19 lines in the treatment area and 45 lines in the non-treatment area following a power analysis of data, which suggested that increased sampling effort was required.

Four of the five wētā houses on each line had two holes ('galleries') in which invertebrates could shelter. The third (middle) wētā house on each line was larger, had six galleries, and could accommodate a larger number of invertebrates (see Glen et al. 2019). All wētā houses were attached to tree trunks at approximately chest height, left in place year-round, and checked in spring and summer each year.

For each monitoring season we estimated the mean number of wētā, spiders and other invertebrates in each wētā house. Potential differences between treatment and non-treatment were investigated using one-tailed *t*-tests with adjustment for unequal variance.

3.5 Tree wraps

Tree wraps (sheets of foam-rubber attached to tree trunks) can be effective for monitoring arboreal lizards, which shelter between the tree wrap and the trunk (Bell 2009). In forested areas tree wraps were installed 20 m apart in lines of five, with ≥100 m between adjacent lines. There were 13 lines of tree wraps in the treatment area (nine in Mohi Bush), and 18 lines in the non-treatment area. These were left in place year-round, and checked in spring and summer.

3.6 Frass funnels

Frass funnels are an effective method to estimate the relative abundance of large arboreal invertebrates, such as tree wētā and stick insects (Sweetapple & Barron 2016). Conical nets of fine wire mesh are mounted on wooden stakes under the tree canopy. The wide end of the net faces upwards, while the narrow end is tied closed so that the droppings (frass) produced by arboreal invertebrates fall into the net and are captured (Sweetapple & Barron 2016).

Frass produced by tree wētā and stick insects are readily distinguished based on shape and size, and the weight of frass collected in the funnels provides an index of relative abundance of these taxa (Sweetapple & Barron 2016). There were 20 frass funnels in the treatment area, 16 in Mohi Bush, which has also been subject to rat control since mid-2016. There were 30 frass funnels in the non-treatment area. Twice each year (in spring and summer) the contents of the funnels were collected and the relative abundance of tree wētā and stick insects estimated based on the mean weight of frass per funnel.

4 Results

4.1 Camera trapping

Before the first pulse of cat trapping in 2017, the CTR of feral cats was similar in the treatment and non-treatment areas (Figure 4a). In 2017 and 2018 lower CTRs suggested that cats were less abundant in the treatment than in the non-treatment area. However, in 2019 and 2020, relative abundance was again similar in both areas. Only one cat detected on camera had a collar.

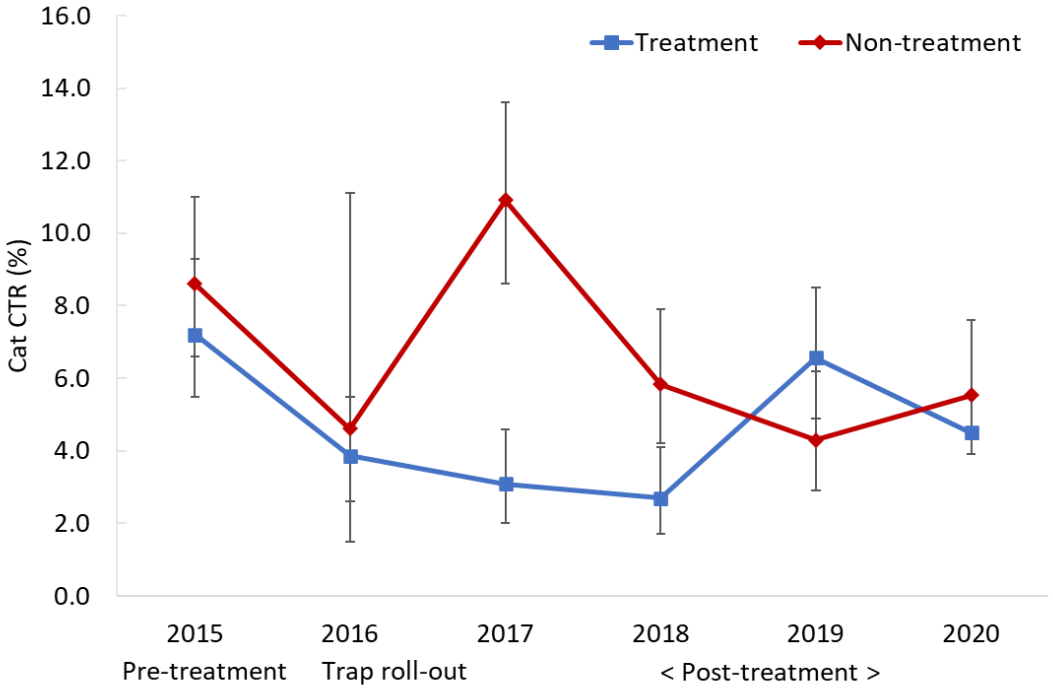
In 2015, before predator control, the relative abundance of stoats was higher in the treatment area (Figure 4b). From 2016 to 2019 the CTR of stoats was at or close to zero in both areas.

The relative abundance of ferrets fluctuated in the non-treatment area, but was at or close to zero in the treatment area after completion of the trap roll-out (Figure 4c).

The relative abundance of rodents was similar in both areas in 2015, before predator trapping began (Figure 4d). In subsequent years the CTR of rodents fluctuated widely, but declined sharply after 2018 in both areas.

In 2015 (pre-trapping), the relative abundance of lagomorphs was similar in both areas. Lagomorph CTR in the treatment area remained similar from 2015 to 2018, but declined in the non-treatment area. In 2019 there was strong statistical evidence of an increase in lagomorph CTR in both the treatment and non-treatment areas. However, in 2020 the relative abundance of lagomorphs was again similar in the two areas (Figure 4e).

(a)



(b)

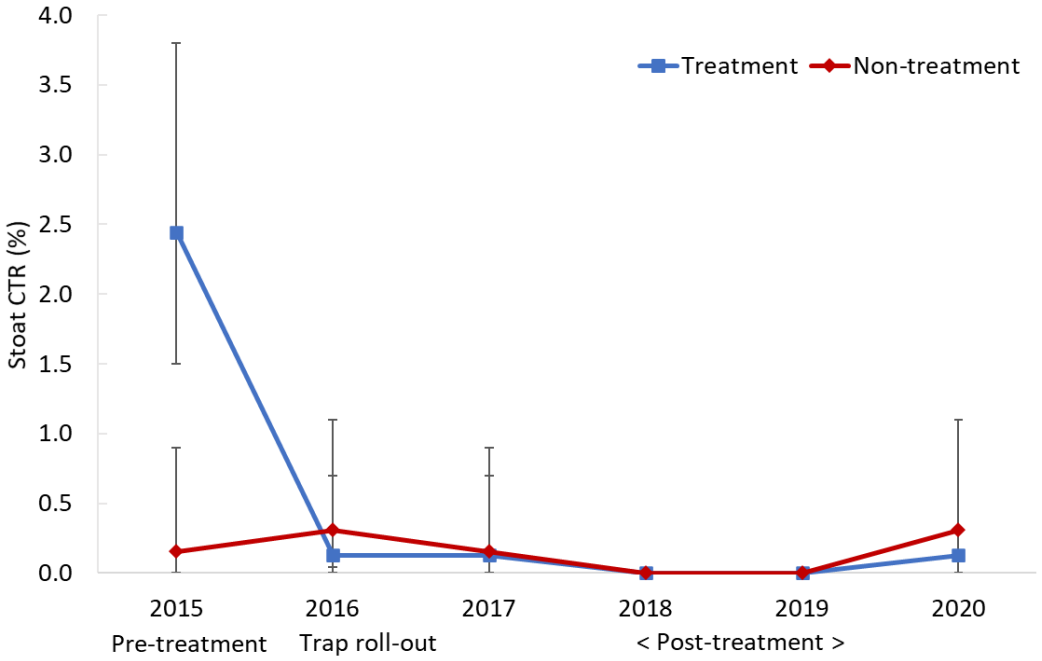
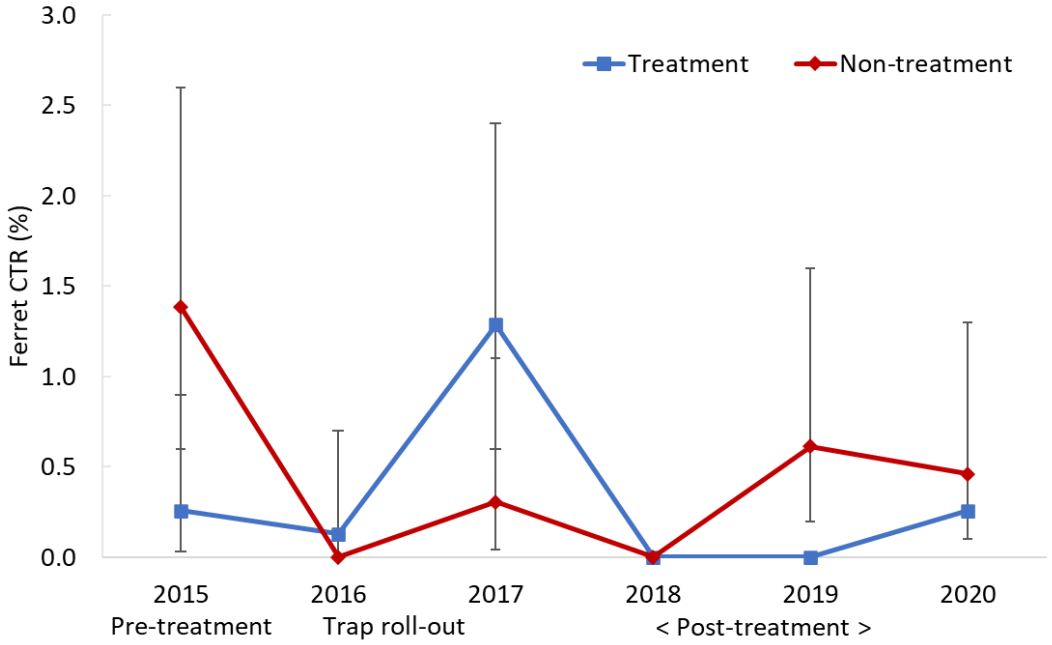


Figure 4. (continued on following pages). Camera trap rate (CTR) ±95% CI of (a) feral cats, (b) stoats, (c) ferrets, (d) rodents, and (e) lagomorphs in the Cape to City treatment area (blue) and adjacent non-treatment area (red).

(c)



(d)

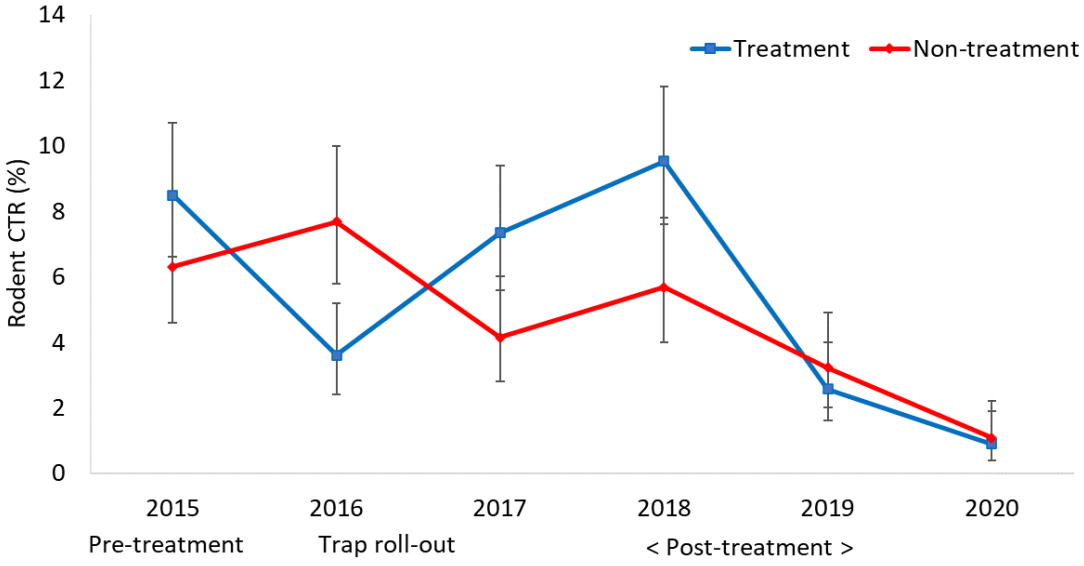


Figure 4. (continued from previous page)

(e)

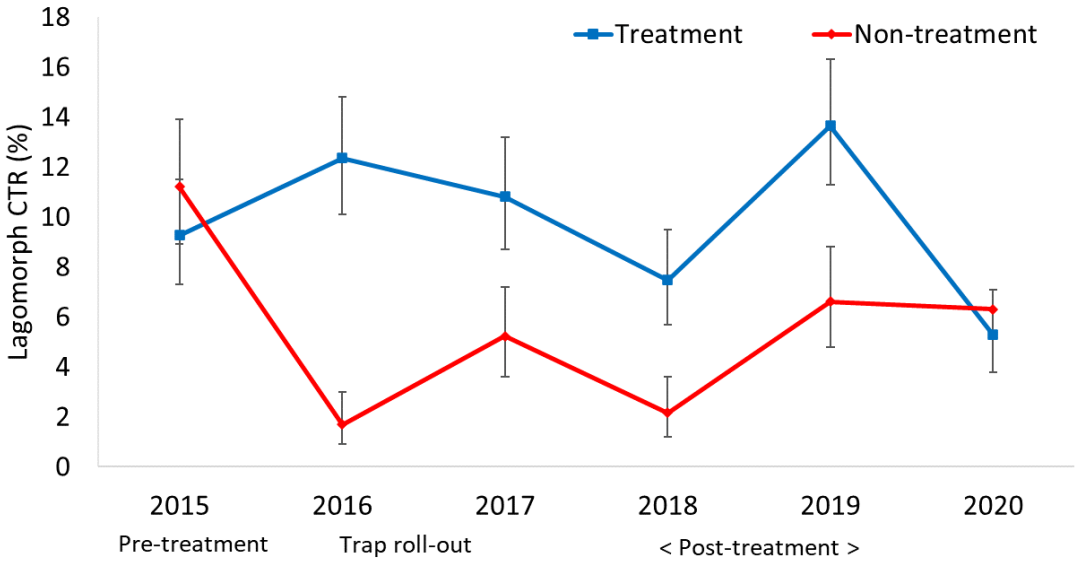
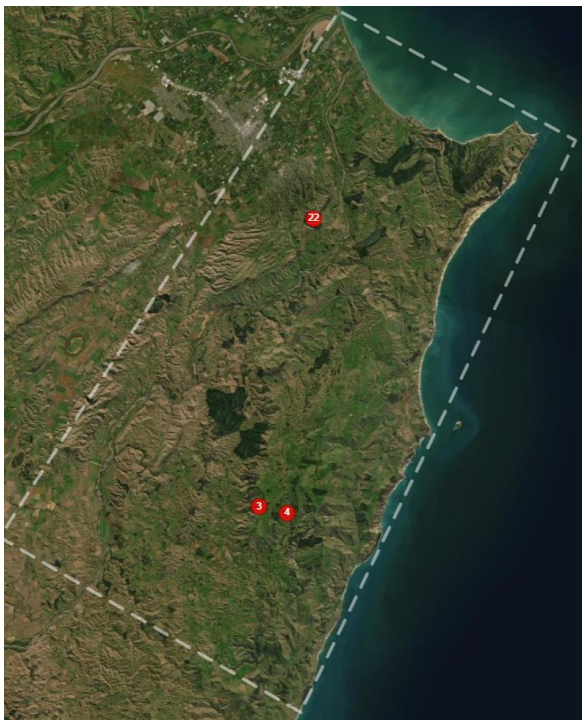


Figure 4. (continued from previous pages).

In 2015, before trapping started, lagomorphs were detected by three camera traps in the treatment area and by one in the non-treatment area (Figure 5). In subsequent years lagomorphs were detected more widely across both areas, but particularly in the treatment area.

2015:

Treatment



Non-treatment

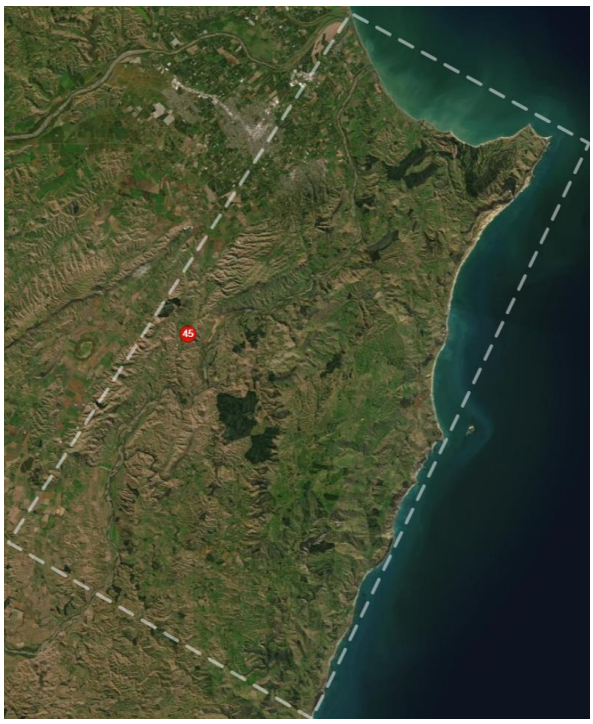


Figure 5. (continued on following pages). Lagomorph detections by year at each camera trap in the treatment area (left) and non-treatment area (right). The numbers of detections at each camera are shown inside the circle. Green circles represent cameras with a single detection; red circles represent two or more detections.

2016:

Treatment

Non-treatment

2017:

Treatment

Non-treatment

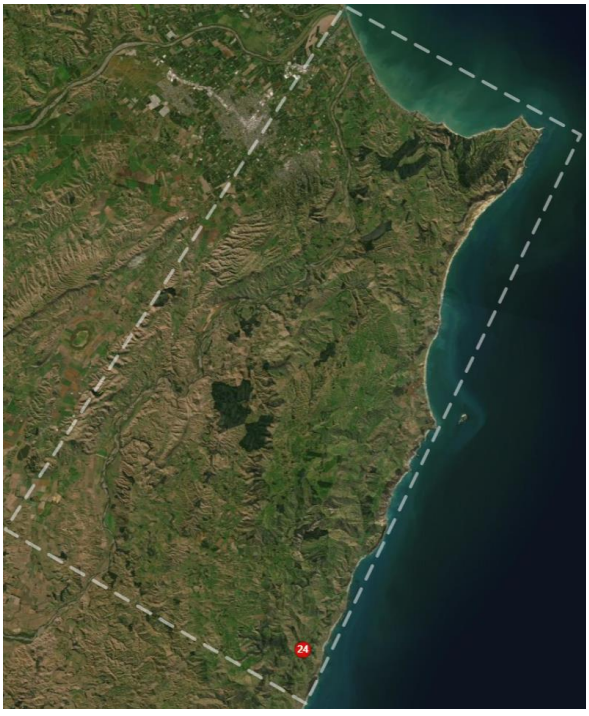
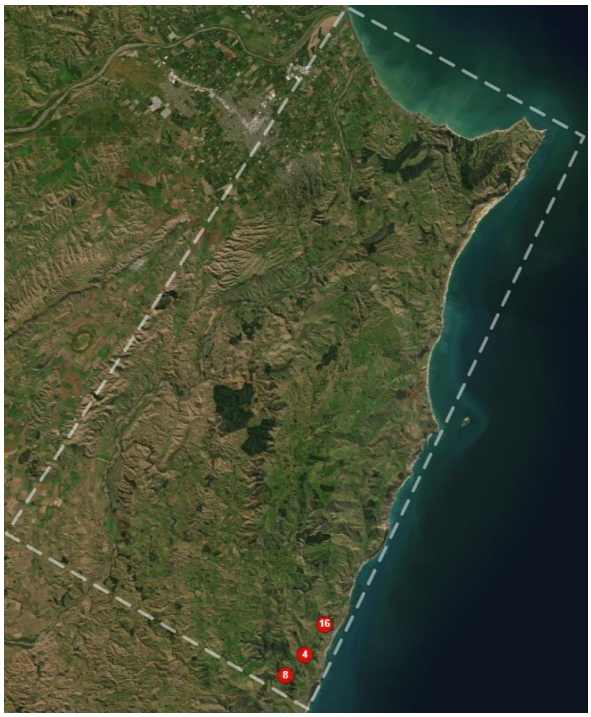


Figure 5. (continued from previous page).

2018:

Treatment

Non-treatment



2019:

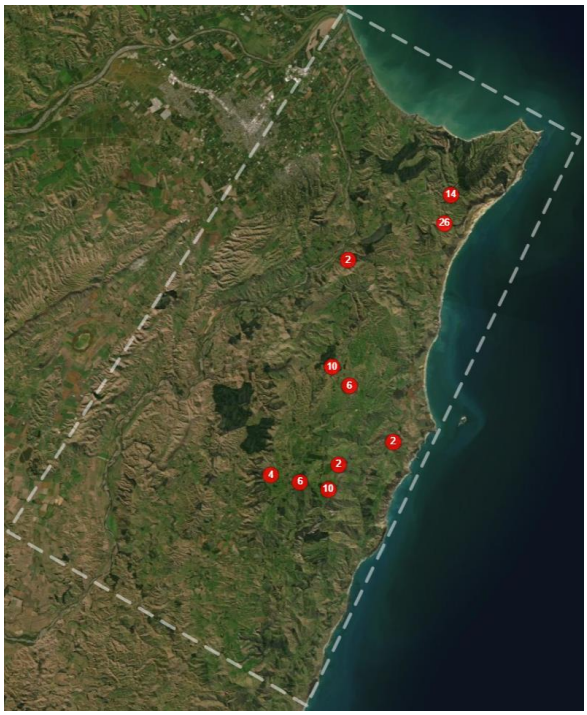
Treatment

Non-treatment

Figure 5. (continued from previous pages).

2020:

Treatment



Non-treatment

Figure 5. (continued from previous pages).

4.2 Tracking tunnels

The tracking rates of rats were initially similar in the treatment and non-treatment areas. However, tracking rates were much higher in Mohi Bush – a forest remnant within the treatment area – before rat control was applied there (Figure 6a). After rat control was applied in Mohi Bush, rat numbers were lower than pre-control levels in every sampling period. Tracking rates of rats in the wider treatment area were also consistently lower than in the non-treatment area (Figure 6a).

The tracking rates of mice were similar in the treatment and non-treatment areas in every monitoring session. However, in the rat control area, tracking rates of mice increased after rat control, before returning to pre-control levels (Figure 6b).

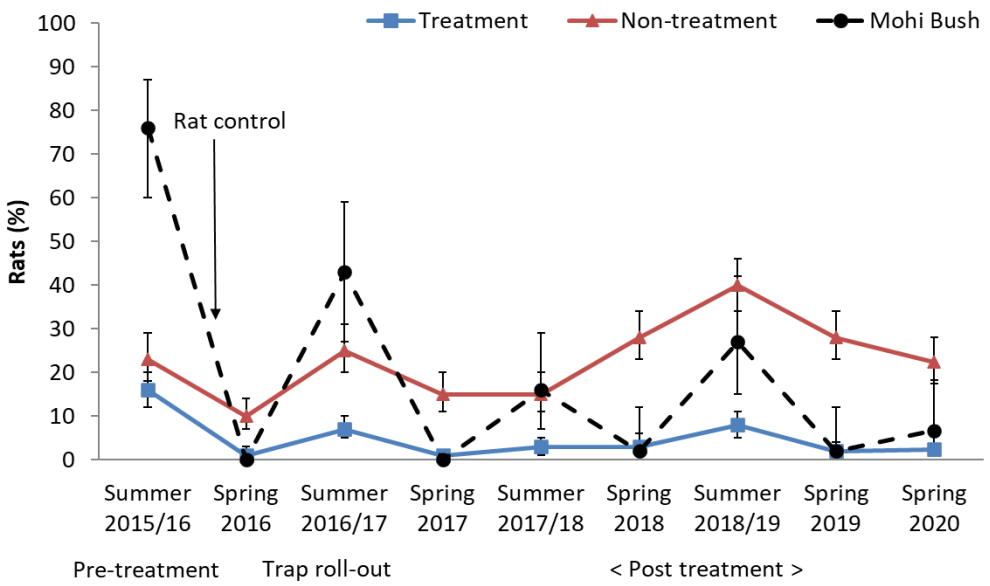
The tracking rates of wētā fluctuated between zero and 3.5% in the treatment area, but were consistently low (0–0.8%) in the non-treatment area (Figure 6c). A lack of overlap in the 95% confidence intervals provides strong statistical evidence for differences between the treatment and non-treatment areas in some monitoring sessions, but not in others. Tracking rates of wētā in Mohi Bush ranged from 0 to 9%. However, extensive overlap in 95% CIs indicates that these estimates are no different to those from the wider non-treatment area (Figure 6c).

The tracking rates of skinks ranged from 0 to 2.4% in the treatment area (Figure 6d). Skink tracks were detected in the non-treatment area on only two occasions: in summer 2018/19 and in spring 2020. There was strong statistical evidence of a difference between

treatment and non-treatment areas in some seasons, but not in others. No skink tracks were recorded in Mohi Bush.

The tracking rates of geckos in the treatment area ranged from 0.3% to 4.5%, while those in the non-treatment area ranged from 0 to 1.2% (Figure 6e). There was extensive overlap in 95% CIs in most monitoring periods, indicating no statistical evidence for differences between the treatment and non-treatment areas. However, in spring 2020 there was strong statistical evidence that the relative abundance of geckos was higher in the treatment area. No gecko tracks were recorded in Mohi Bush.

(a)



(b)

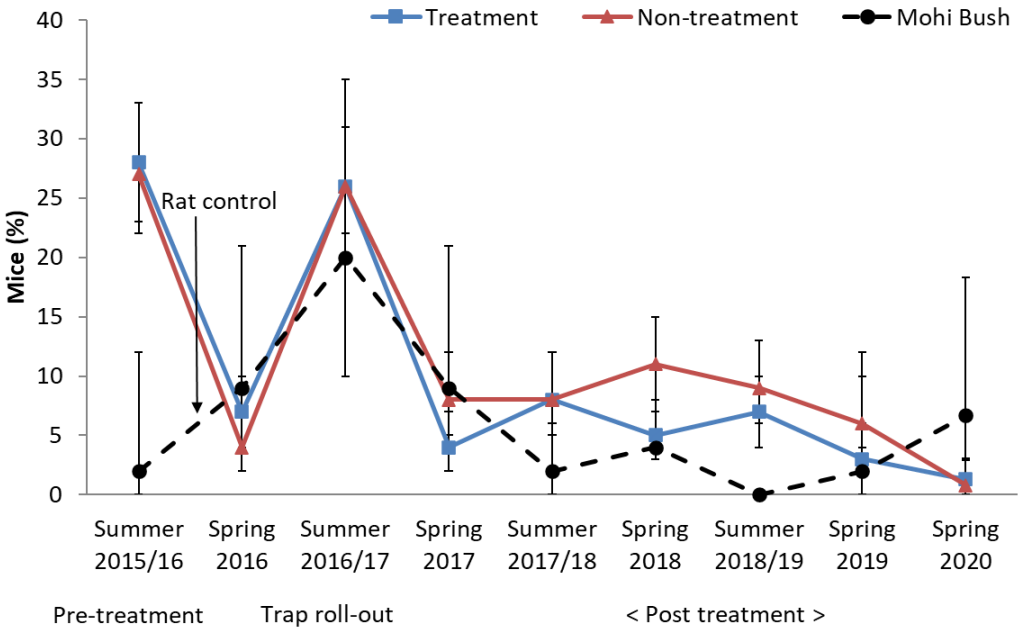
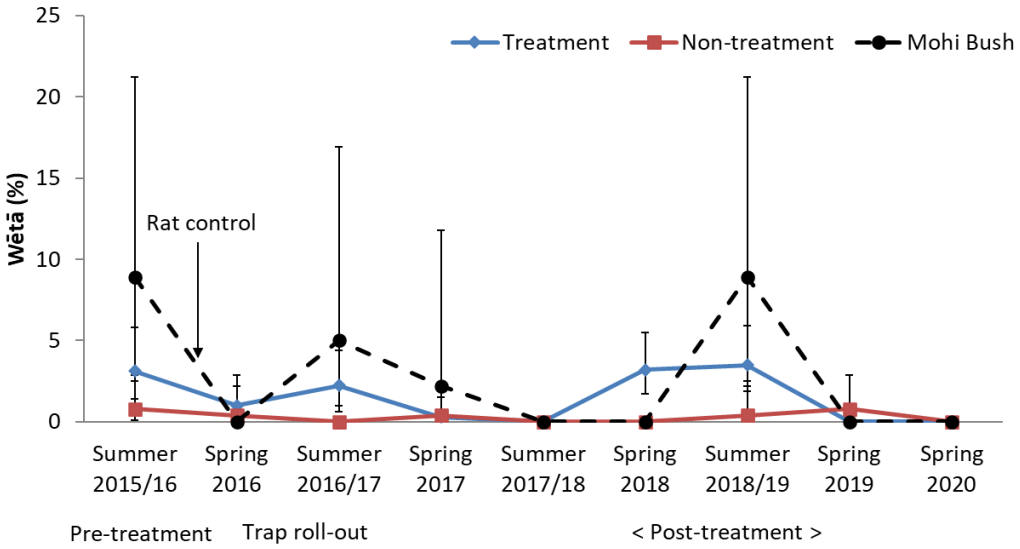
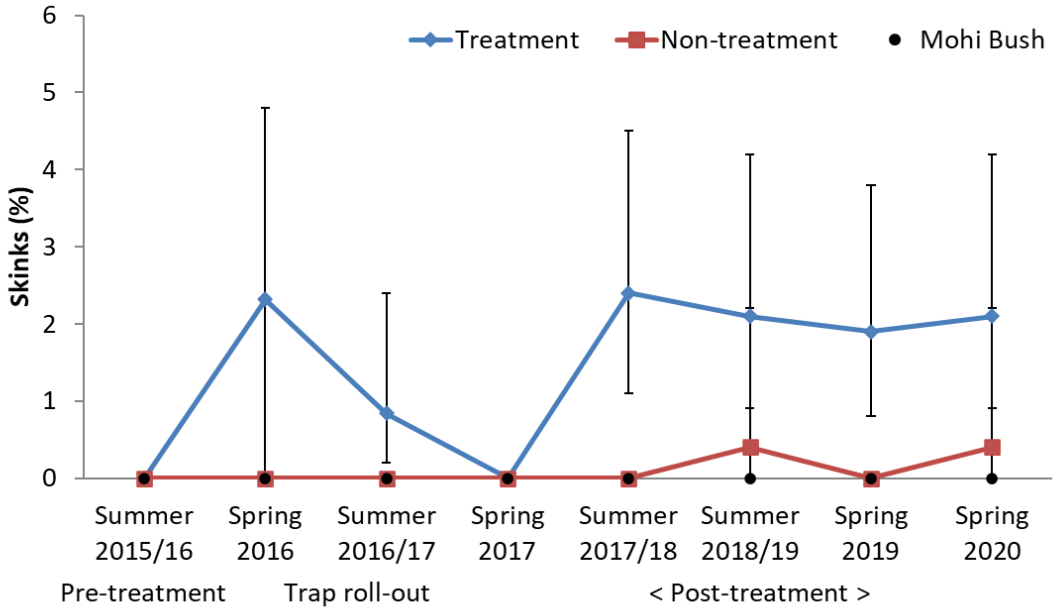


Figure 6. (continued on following pages). Percentage (±95% CI) of tracking tunnels detecting (a) rats, (b) mice, (c) wētā, (d) skinks, and (e) geckos in the treatment area (blue), non-treatment area (red), and Mohi Bush (black), which is a rat control area located within the treatment area.

(c)



(d)



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(e)

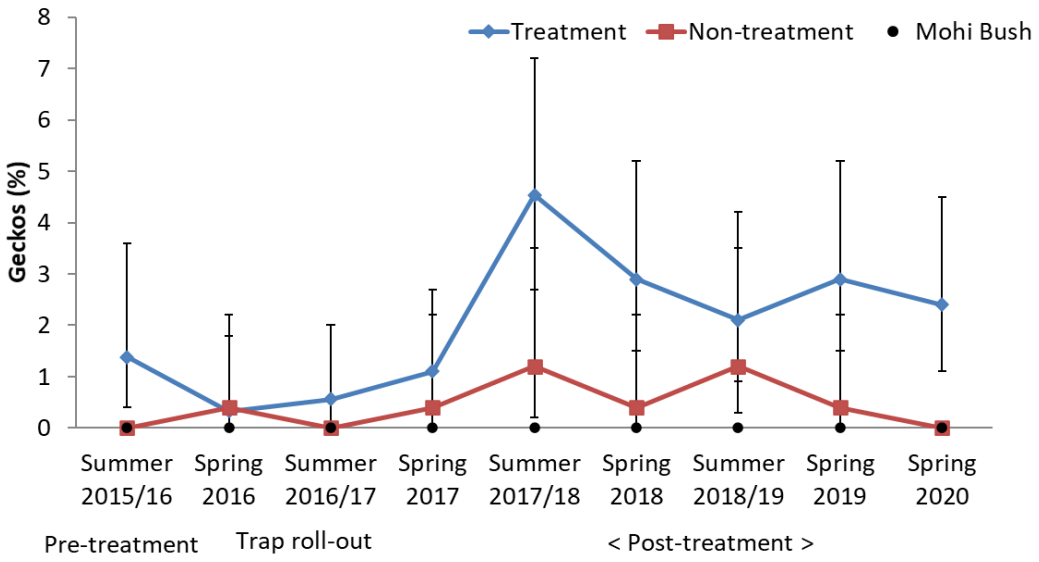
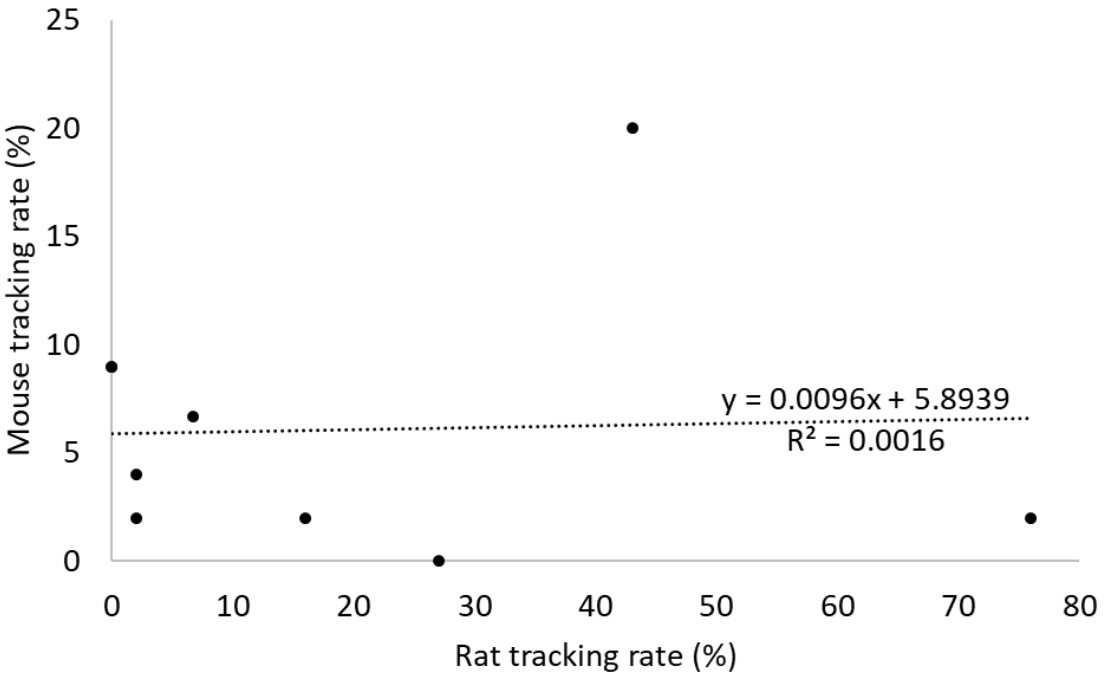


Figure 6. (continued from previous pages).

There was some evidence of an inverse relationship between tracking rates of rats and mice in Mohi Bush. There was one season (summer 2016/17) when the tracking rates of both rats and mice were relatively high (Figure 7a). However, excluding this out-lying data point, an inverse relationship was apparent (Figure 7b).

(a)



(b)

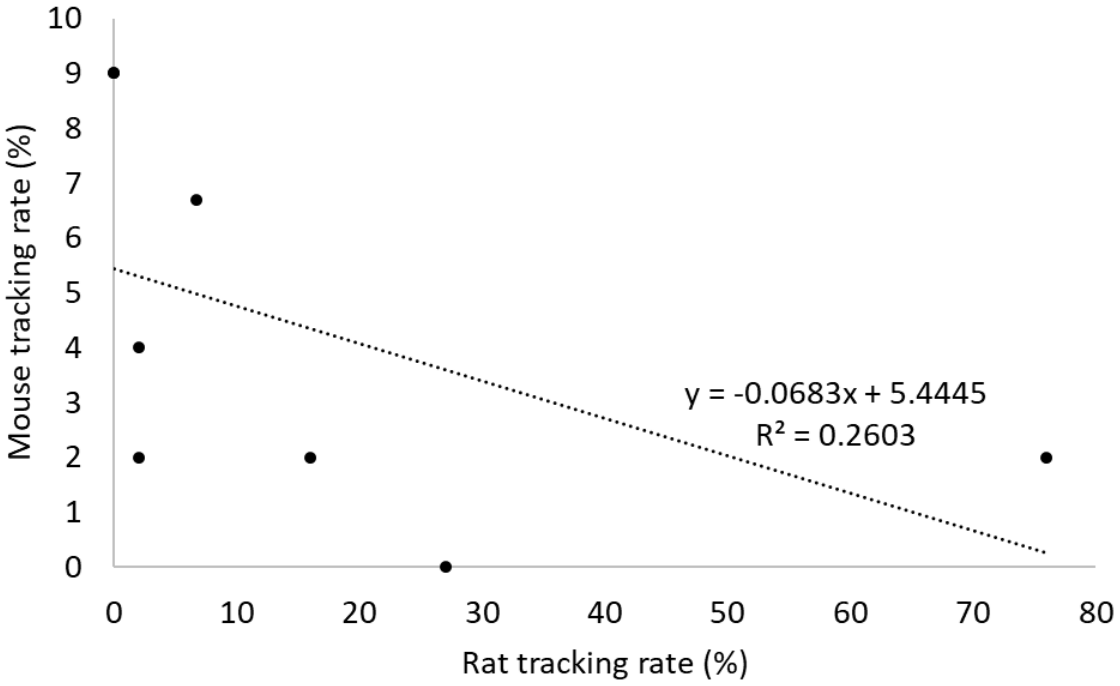


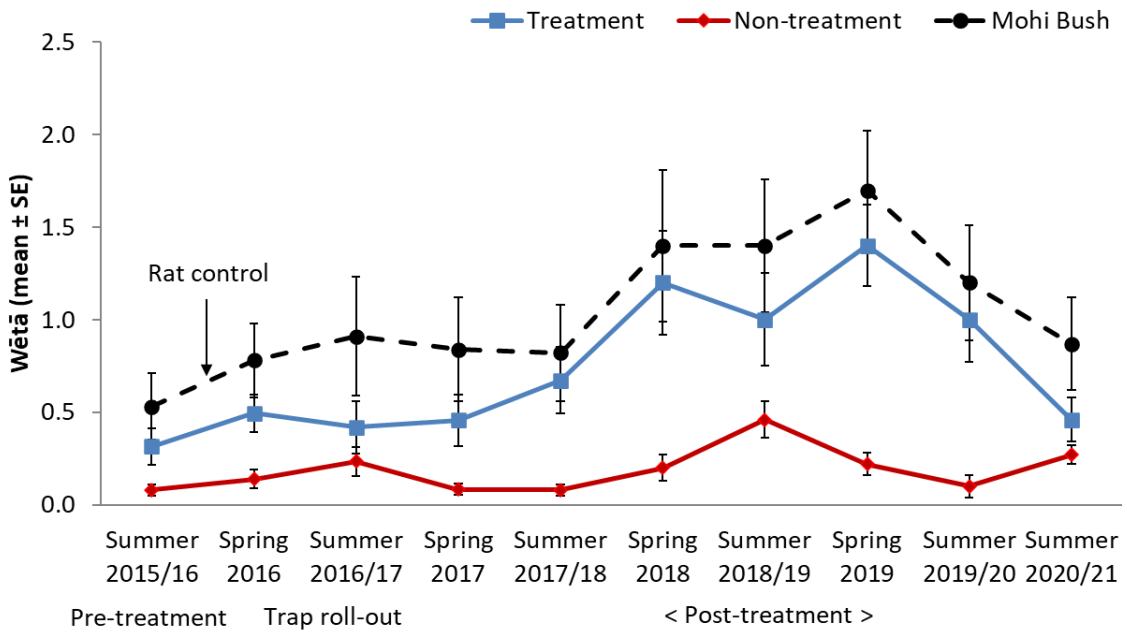
Figure 7. Rat tracking rate vs mouse tracking rate in Mohi Bush (a) including all seasons, and (b) excluding one out-lying data point from summer 2016/17.

4.3 Wētā houses

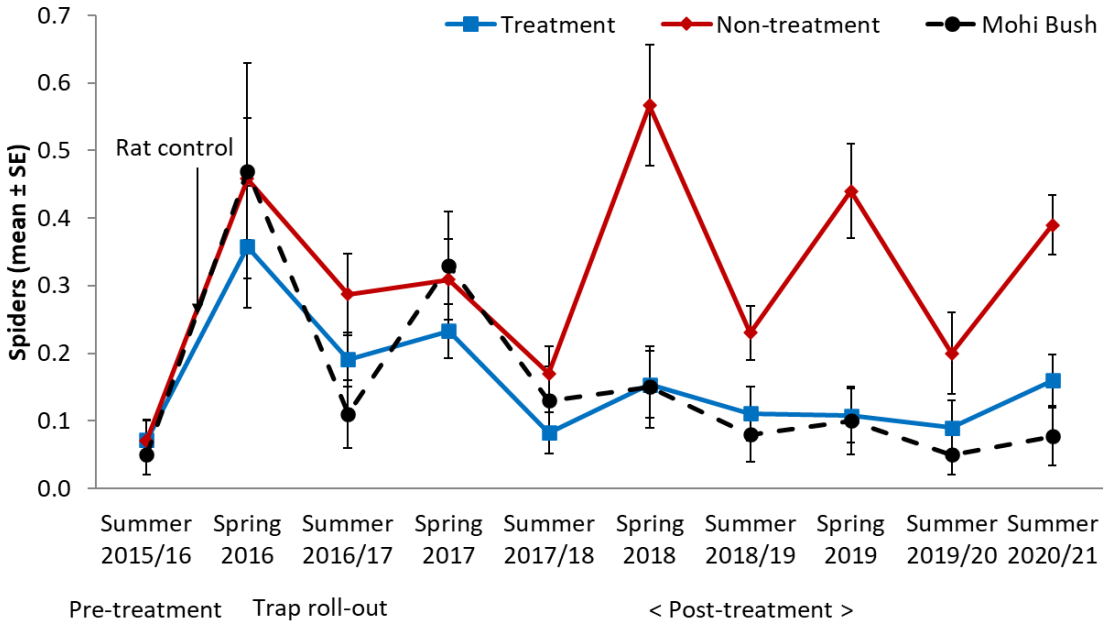
In summer 2015/16, before predator control, mean wētā numbers per wētā house were three times higher in the treatment than the non-treatment area (t = 2.12, p = 0.04) (Figure 8a). After summer 2017/18 there was an upward trend in numbers of wētā in the treatment area, but not in the non-treatment area. In summer 2019/20 there was a 10-fold difference between the two areas (t = 3.85, p = 0.0001). However, in the most recent sampling period, wētā numbers were only 50% higher in the treatment area than in the non-treatment area (t = 1.73, p = 0.04). Wētā numbers were slightly higher in the rat control area before rat control began, and remained so in every subsequent monitoring period (Figure 8a).

The number of spiders was initially similar in all areas, but has since fluctuated considerably (Figure 8b). Since spring 2018 there was an increasing trend in spider numbers in the non-treatment area. Spider numbers remained similar in the rat control area and in the wider treatment area (Figure 8b). The number of other invertebrates fluctuated in all areas with no apparent trend (Figure 8c).

(a)



(b)



(c)

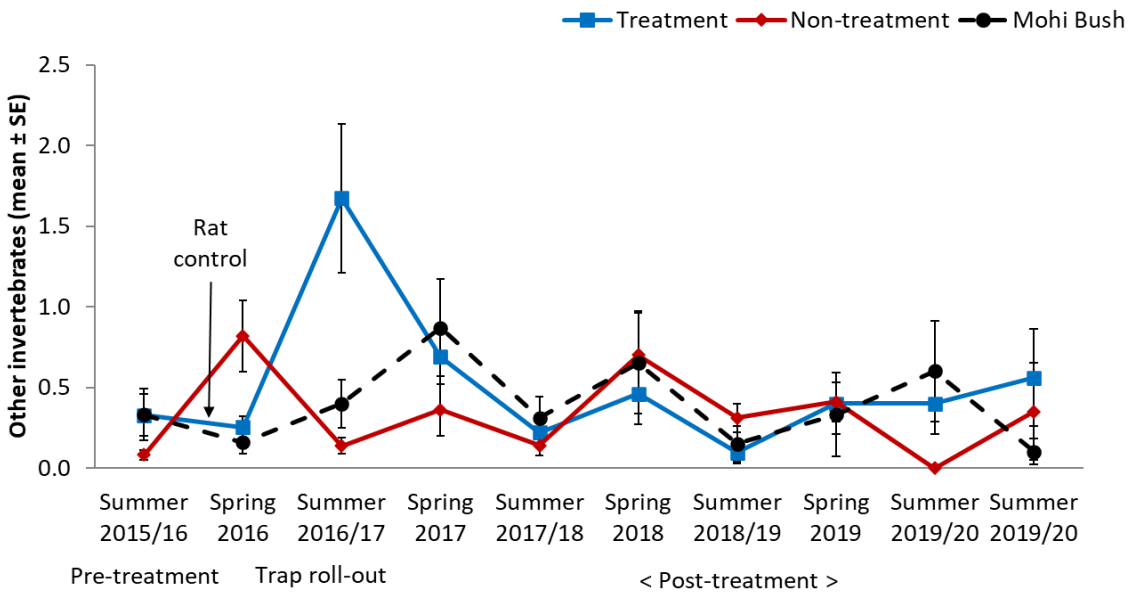


Figure 8. Mean (±SE) numbers of (a) wētā, (b) spiders and (c) other invertebrates found in wētā houses in the Cape to City treatment area (blue), non-treatment area (red) and Mohi Bush (black), which is a rat control area within the treatment area.

4.4 Tree wraps

No lizards were recorded under the tree wraps in either the treatment or non-treatment area. However, invertebrates were frequently recorded. The number of invertebrates under the tree wraps fluctuated in all areas with no apparent trend (Figure 9).

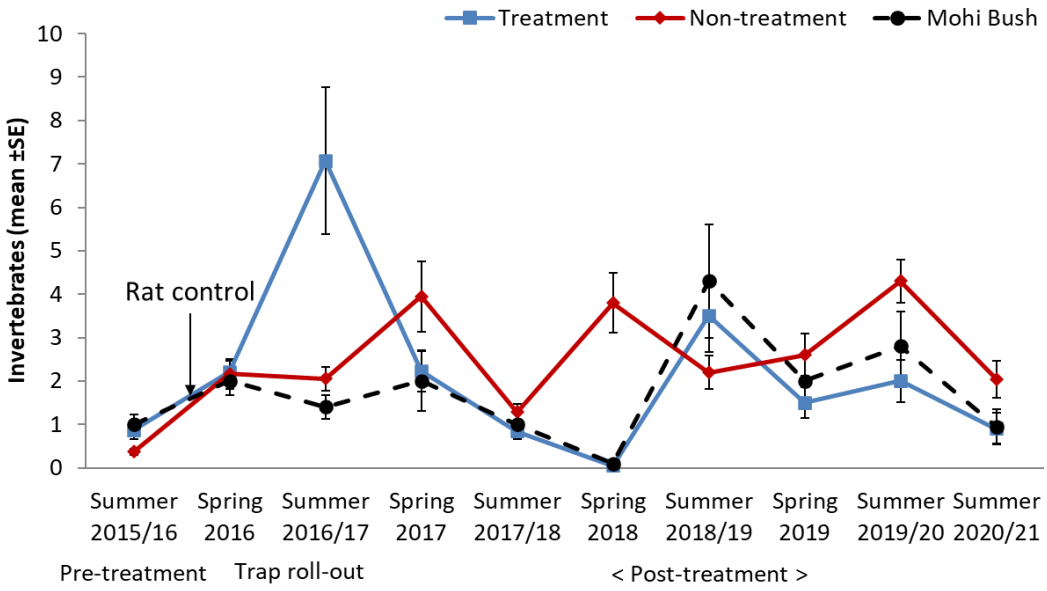


Figure 9. Mean (±SE) numbers of invertebrates recorded using tree wraps in the treatment area (blue), non-treatment area (red), and Mohi Bush (black), which is a rat control area within the treatment area.

4.5 Frass funnels

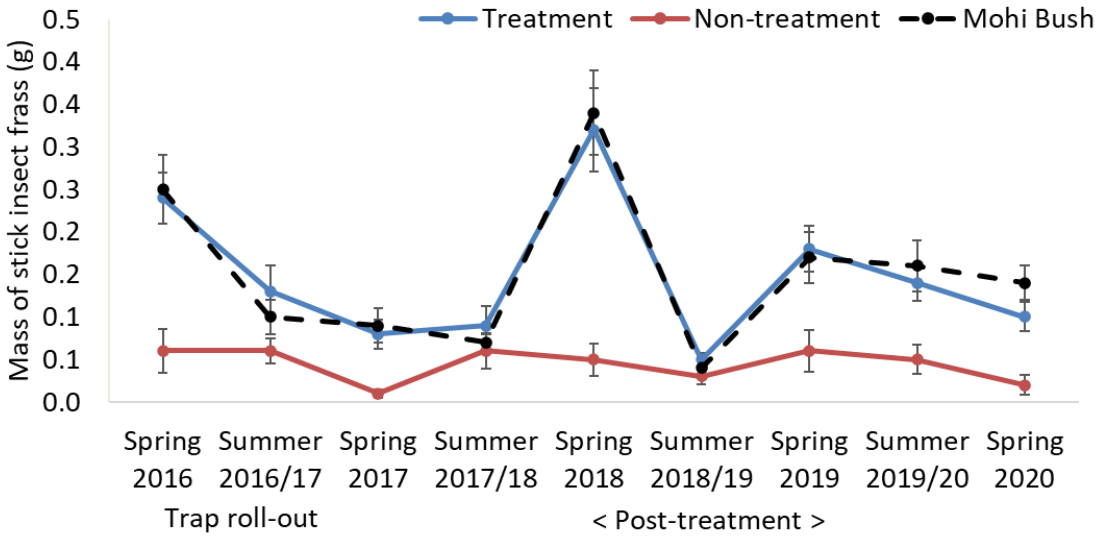
Frass funnels most often captured frass from arboreal stick insects and tree wētā. Frass from other taxa, including molluscs and cockroaches, was recorded occasionally, as well as seeds and fruit of trees such as tawa (*Beilschmiedia tawa*) and hīnau (*Elaeocarpus dentatus*).

Although the frass funnels were in place before predator control, the first frass samples were collected in spring 2016, by which time rat control had started in Mohi Bush. As 16 of the 20 frass funnels in the treatment area were in Mohi Bush, this may have influenced the results.

Both arboreal stick insects ($t = 4.43$, $p < 0.001$; Figure 10a) and tree wētā ($t = 1.7$, $p = 0.01$; Figure 10b) were more abundant in the treatment area in spring 2016. Indices then fluctuated in both areas, but were generally higher in the treatment area. The estimated relative abundance of stick insects in the rat control area was similar to that in the wider treatment area (Figure 10a).

The estimated relative abundance of tree wētā was initially similar in the rat control area and in the wider treatment area, but was slightly higher in the rat control area from spring 2018 onwards (Figure 10b).

(a)



(b)

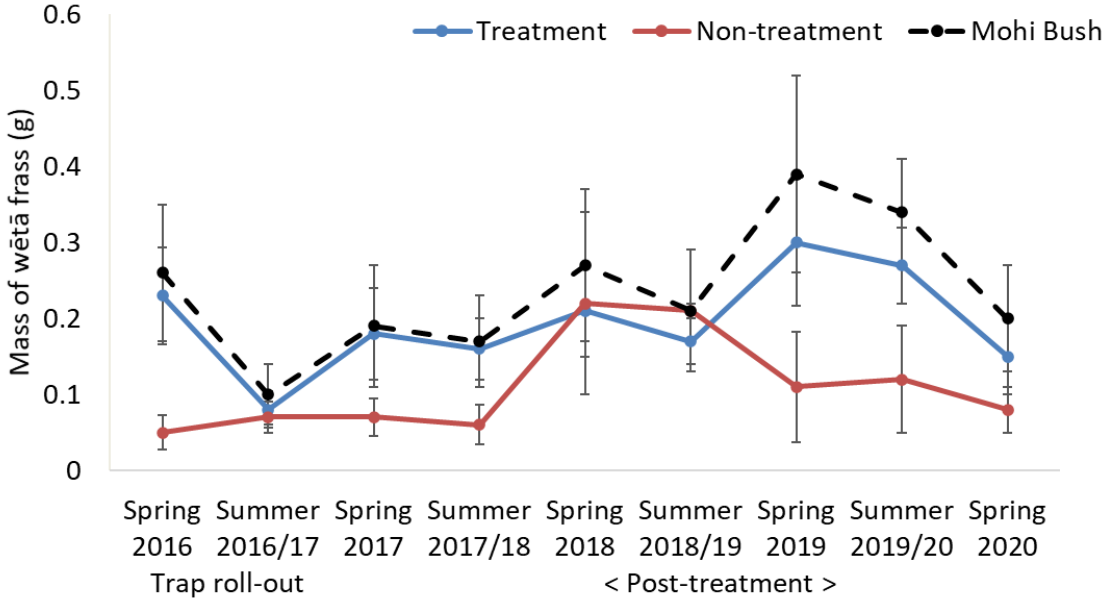


Figure 10. Mean mass (±SE) of (a) stick insect frass and (b) wētā frass recorded in frass funnels in the treatment area (blue), non-treatment area (red), and Mohi Bush (black), which is a rat control area within the treatment area.

5 Conclusions

5.1 Predator control

Our results suggest that predator control has reduced the relative abundance of feral cats, stoats and ferrets. However, because of a lack of replication (we have only one treatment and one non-treatment), we cannot confidently conclude that the observed differences result from predator control rather than natural variation in predator populations.

The relative abundance of feral cats was lower in the treatment than in the non-treatment area for the 2 years after knock-down control, but was similar between the two areas in the two most recent sampling seasons. This suggests that the knock-down control was effective, but the feral cat population has since recovered to pre-control levels.

Due to low detection rates, relative abundance estimates of stoats and ferrets are imprecise, which limits our ability to make statistical inferences. However, the relative abundance of stoats and ferrets in the treatment area was at or close to zero for the last 3 years. This could be a result of predator control and/or natural variation.

Rat control in Mohi Bush appears to have been effective, reducing the relative abundance of rats to near zero each spring, and restricting relative abundance each summer to less than half the pre-control level. There was some evidence of a short-term increase in the relative abundance of mice after each application of rat control. However, tracking rates of mice returned to low levels each summer, with the exception of summer 2016, when mouse tracking rates peaked in all areas.

5.2 Biodiversity response

Again, the ability to draw firm conclusions regarding cause and effect is limited by lack of replication. However, our results suggest that native lizards and invertebrates were more abundant in the treatment than the non-treatment area. Although pre-existing differences were apparent, trends suggest increasing abundance of these taxa in the treatment area.

Together, tracking tunnels and wētā houses suggest that relative abundances of wētā, skinks and geckos increased in the treatment area relative to the non-treatment after predator control began.

There was little evidence that removal of predators led to increased abundance of invasive prey. Rodents were less abundant in 2019 and 2020 than in previous years. The abundance and distribution of rabbits and hares appeared to fluctuate, but showed no apparent overall trend, suggesting that predator control did not lead to increased abundance of these species.

6 Recommendations

Our predator monitoring suggests that additional cat control is required if sustained reductions in feral cat populations are to be achieved. Although detections of stoats and ferrets have been at or close to zero in the treatment area since 2017, continued monitoring is required to determine whether their abundance is genuinely lower than in the non-treatment area.

We suggest monitoring of lizards and invertebrates be discontinued. The constraints of the study design (lack of replication, and the fact that there were pre-existing differences between treatment areas) mean that continued monitoring is unlikely to be highly informative.

7 Acknowledgements

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8 References

Agnew W 2009. What made these tracks? A guide to assist in interpreting the tracks of small mammals, lizards and insects. Warkworth, NZ, Chappell Printing.

Bell TP 2009. A novel technique for monitoring highly cryptic lizard species in forests. Herpetological Conservation and Biology 4: 415–425.

Cumming G 2009. Inference by eye: reading the overlap of independent confidence intervals. Statistics in Medicine 28: 205–220.

Garvey PM, Glen AS, Clout MN, Wyse SV, Nichols M, Pech RP 2017. Exploiting interspecific olfactory communication to monitor predators. Ecological Applications 27: 389–402.

Gillies C, Williams D 2002. A short guide for identifying footprints on tracking tunnel papers. Wellington, Department of Conservation.

Glen AS, Perry M, Yockney I, Cave S, Gormley AM, Leckie C, Dickson R, Rakete-Stones W, Rakete-Stones P, Norbury GL, et al. 2019. Predator control on farmland for biodiversity conservation: a case study from Hawke's Bay, New Zealand. New Zealand Journal of Ecology 43: 3358.

HBRC 2020. Cape to City. https://www.pfhb.nz/cape-to-city/ (accessed 9 June 2020).

NPCA 2014. Pest detective. http://www.pestdetective.org.nz/ (accessed 29 August 2018).

Rovero F, Marshall AR 2009. Camera trapping photographic rate as an index of density in forest ungulates. Journal of Applied Ecology 46: 1011–1017.

Sweetapple P, Barron M 2016. Frass drop for monitoring relative abundance of large arboreal invertebrates in a New Zealand mixed beech forest. New Zealand Journal of Ecology 40: 321–329.