Boffa Miskell

PoaUku long-life lures

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Cover photograph: Stoat investigating PoaUku lures during field trials © Boffa Miskell, 2021

Executive Summary

Effective trapping, monitoring and detection of pest species requires effective lures. However, nearly all currently lures are food-based and often quickly perish or are consumed by non-targets, decreasing efficacy of control operations. Lures that have higher levels of attraction and require lower levels of servicing/replacing will increase captures while decreasing labour costs.

Predator Free 2050 (PF2050) is a New Zealand government initiative that aims to rid introduced mammalian predators, namely rats, possums, and stoats, by the year 2050. The development of effective, long-life lures to increase predator interaction with control and surveillance devices is a key component of the PF2050 research strategy.

This long-life lure project for Predator Free 2050 (PF2050) aimed to develop, trial, and commercialise effective, long-life, solid-state lures for rats, possums, and mustelids. The project comprised two key stages of field trials; 1) confirmation of final lure treatments after trialling a range of potential scent options, and 2) determining how long the most successful lure type from Stage 1 remained effective at attracting the target species in larger scale field trials (after an extended weathering period of the lures for at least 3 months).

Summary of findings for PoaUku rat/possum lure:

- In the short-term (a 2-week field timeframe of video interactions), the PoaUku rat/possum lure block showed significantly more attraction versus fresh peanut butter - 642 interactions with PoaUku versus 271 interactions with peanut butter.
- The PoaUku rat/possum lure block was also proven to be both attractive and effective over *long timeframes* for rats (tested following internals of 4, 8 and 12 weeks of pre-weathering in DOC boxes), and was significantly more attractive than fresh peanut butter after weathering in the field for *more than* 12 weeks.
- The PoaUku rat/possum lure was therefore proven to be highly attractive to rats both in the short and long-term.
- Similarly, in the short-term, the PoaUku rat/possum lure block had significantly higher interactions for possums when freshly deployed than fresh peanut butter. In the longer term, possums also continued to interact with the lure blocks even after 3 months of weathering in the field, showing a substantial longevity improvement over many current lures.

Further, the high attraction rates for the PoaUku rat/possum lures at week 12 matches well with the Gas chromatography–mass spectrometry (GCMS) results undertaken at Murdoch University (Australia), which showed that some key molecules were released in their highest concentrations from the ceramic lures at week 12. It appears that the ceramic PoaUku lure continues

to become *more* attractive to rodents over a three-month timeframe. It is unknown how long this increased level of attraction continues.

Summary of findings for PoaUku mustelid lure:

For mustelids, our long-life lure has proven to be a highly attractive lure for both stoats and ferrets, as well as to multiple other pest species (including possums, hedgehogs, and feral cats), for over three months of field deployment.

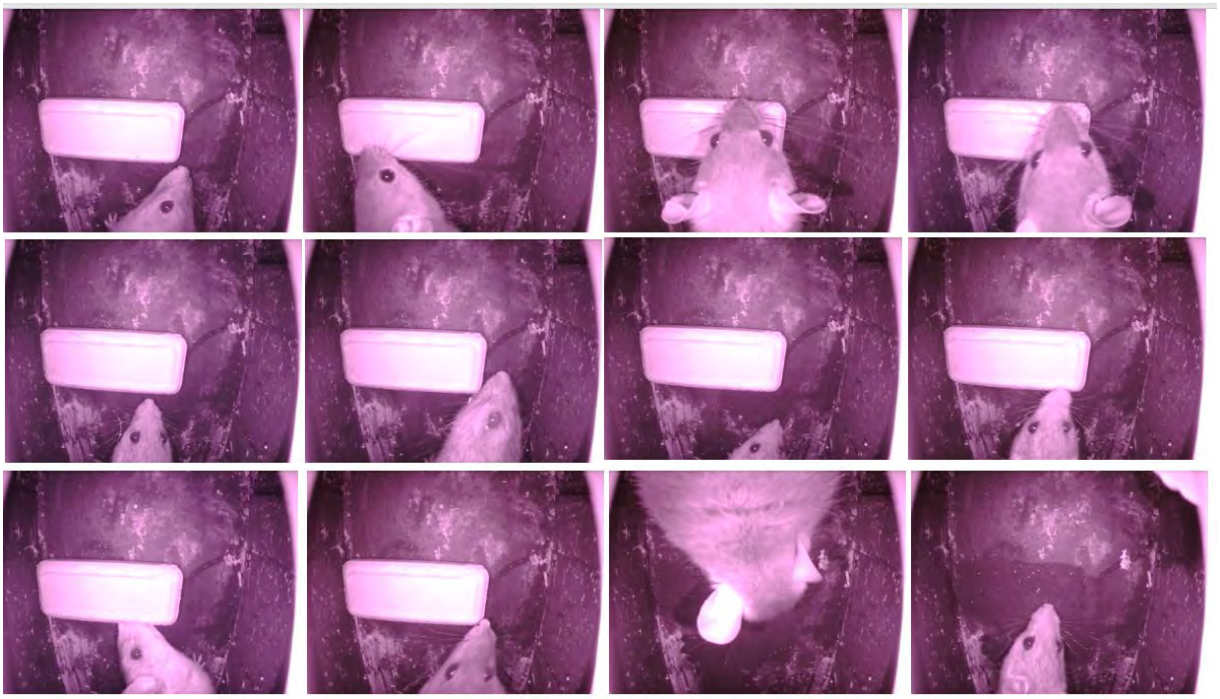
- In the short-term (a 2-week field timeframe of video interactions), Lure D (later commercialised as the PoaUku mustelid lure), was the most common lure that mustelids first interacted with (50% of "First" interactions) and also the lure that mustelid spent the most time investigating (71% of "Most" interactions)
- For stoats, fresh PoaUku mustelid lures were substantially more attractive than fresh Erayz, and were still equally attractive versus fresh Erayz after (more than) one month of field weathering.
- All four weathered durations of PoaUku mustelid lures (0, 4, 8 and 12 weeks of pre-weathering) were highly successful at attracting both stoats and ferrets, demonstrating these lures are still attractive after more than 3 months in the field.
- For ferrets, the PoaUku lure was substantially more attractive than fresh Erayz, even after weathering for over 3 months. Across all sites and weathered durations combined, PoaUku had more first approaches compared to Erayz, which was significant at the alpha = 0.1 level (p-value = 0.07).

Conclusions

The long-life, robust, inedible, and environmentally friendly nature of the long-life lures developed in this project, means they offer a substantial improvement over many lures (which rapidly deteriorate in the field, can be consumed by non-targets and don't have the proven attractiveness demonstrated here). There were no issues with mould or degradation of the PoaUku lures even after use in extended weathering trials. The lures were tested throughout New Zealand, ranging from Northland to Fiordland, to ensure attractiveness in different habitats and geographic locations. The cost-effectiveness of the PoaUku blocks makes them an extremely affordable solution for pest control operations.

Future PoaUku lure releases

Based on additional comparative lure trials, another extremely promising scent compound was discovered which appeared to be highly attractive to multiple species. However, this compound proved more difficult in terms of ensuring robustness over longer timeframes (>6 weeks). Given the exceptional attraction demonstrated by this scent we continue to undertake research to address these issues and plan to bring this multi-species option to the market in the future.



Rats interacting with a PoaUku lure over a single night during deployment in a CritterPic unit. By the end of the night a rat has removed the lure block (as evidenced in the last photo).

CONTENTS

Figures

1.0 Introduction

1.1 Predator Free 2050

The decline and extinction of many New Zealand species have been attributed to the impacts of introduced mammalian predators, in particular from rats (*Rattus* sp.), possums (*Trichosurus vulpecula*), and mustelids (*Mustela* sp.). These species pose significant threats to indigenous biota through both predation and competition, habitat destruction and altered ecosystem structure and function.

Predator Free 2050 (PF2050) is an ambitious New Zealand government initiative announced in 2016, which aims to eradicate rats, stoats, and possums from the country by 2050. Extensive collaboration is ongoing, bringing together government agencies, iwi, communities, and researchers across a wide variety of disciplines to combat these wide-ranging negative impacts of invasive mammals (Blackie et al., 2014).

To achieve a PF2050, the development and commercialisation of highly effective predator control and monitoring tools and technologies is essential (Linklater et al., 2013; Russell et al., 2015).

1.2 The need for long-life predator lures

Trapping is one of the most common methods for controlling these predators in New Zealand (Brown et al., 2015). However, the success of trapping and other control and monitoring operations, including control via kill or live-capture traps, and detection via camera traps and tracking tunnels, is strongly related to the attractiveness of the lure(s) used.

Nearly all effective lures currently used in New Zealand and internationally for attracting these species to attract target individuals into the control or monitoring device are food-based, such as peanut butter for rats and possums, fresh or dried rabbit for mustelids, and commercially available pastes and gels (Clapperton, 2006; Eason et al., 2016). However, food-based lures often perish quickly, becoming mouldy and/or releasing an inconsistent or potentially repellent odour, rendering the lure ineffective (Parkes & Murphy, 2004). Consumption of food lures by non-target animals such as ants, beetles and mice also means that food-based lures are often rapidly depleted (Jackson et al., 2016; Linklater et al., 2013).

The monetary costs of predator control and monitoring operations are therefore substantial, both in terms of ongoing labour costs to frequently replace lures and the ongoing material costs of lure replacement. The development of long-life control and monitoring technology, including resetting kill traps and smart AI monitoring systems also require effective long-life lures to allow their cost-efficiency benefits to be realised. An effective, long-lasting lure is therefore one of the largest single constraints for achieving a high capture or tracking rate in most predator control and monitoring operations (Parkes & Murphy, 2004).

1.3 Project objectives

This project was funded through PF2050's Products to Projects fund with co-funding from Murdoch University (Australia). The ultimate goal was to develop and commercialise long-life lures that are at least as attractive as current standard lures, with proven longevity (for at least three months in the field). Lures were developed to target each of the three key groups of introduced predators (rats, possums, and mustelids). The final product is shown in Fig. 1.

Ideally, any long-life lures must work in a range of environmental conditions, be either unattractive or unable to be consumed by non-target species (such as ants and or invertebrates), be cost-effective, easy to handle and store, able to be manufactured on a large scale, and are compatible with multiple trap and monitoring systems.

This study comprised multiple iterations of field trials and testing over several years, each with a different objective;

1. **Multi-choice field trials** to determine which long-life scent was most attractive to each target species group (rats, possums, and mustelids) from a range of candidate options;
2. **Comparative field trials** to determine the most attractive scent for possums/rodents out of the possum/rat scents and the mustelid scents that performed well during the multi-choice trials;
3. **Long-term weathering trials** to determine how long the most attractive long-life scent (selected based on results of trials (1) and (2)) remained attractive after weathering in outdoor conditions for at least three months; and
4. **Gas chromatography mass spectrometry (GCMS) analysis** to determine the release profiles and how long volatile components of different base blocks and long-life lure scents last under clinical conditions, controlling for potentially confounding variables such as animal behaviour, individuality, seasonality, and weather.

Fig. 1. The final product (a sustainable ceramic base block treated with an attractive long-life lure scent), in the lure holder of a DOC trap.

2.0 Methods

2.1 Long-life lure types

Base blocks – The first base block used was a plastic polymer block, currently available on the commercial market as a lure with advertised long-life properties. The plastic base block was used for the multi-choice field trials for rodents and possums and the long-term weathering trials for rodents (pre-scented with artificial vanilla) and the multi-choice mustelid trials (pre-scented with an artificial fish). Based on findings from the initial trials and the GCMS analysis, the base block was switched to a ceramic solid-state block pre-engineered for scent release for the remaining trials. This ceramic formulation constitutes the block used in the final, commercially available product.

Long-life scents –In the multi-choice field trials, three different candidate long-life scents were compared alongside a standard food-based lure for comparison (lures A, B and C for rodents and possums, and lures D, E and F for mustelids).

Candidate lure scents (A, B and C) were the same for both rodents and possums given the similarity of current lures between these species, and the potential to develop a cost-effective multi-species lure to further increase cost-efficacy for end-users.

2.2 Multi-choice field trials

Rodents – Field trials occurred at two different sites without any known predator control in the past three years (Map 1); near Masterton in the Wairarapa (16 – 18 July 2019 and 28 – 31 July 2019) and Orton Bradley Park, near Christchurch in Canterbury (14 – 17 July 2019 and 15 – 18 July 2019). Each site contained 10 lines of 9 tracking tunnels spaced 50 m apart, to a total of 90 blocks per site with 30 replicates of each lure type at each site. Each long-life lure was placed inside a tea strainer and wired inside the tracking tunnels. Lures were deployed for an initial 3-night deployment period, and then were collected and stored in an exposed, field-based location inaccessible to animals to weather for two weeks before being re-deployed along with fresh tracking cards for another 3-night period to obtain an initial idea of longevity.

Possums – Camera traps (Browning Dark Ops Dual Lens) were used to monitor interactions of target and non-target species with each lure type as a multiple-choice study design. Field trials occurred at two field sites, lasting for two weeks each (Map 1); in Auckland (13 November – 27 November 2019) and Wellington (2 December – 16 December 2019). Forty replicate multiple-choice lure stations were set up at each field site, where one of the four lure types (long-life lure candidate scents A, B and C, and control long-life block), were positioned at each corner of a 1 x 1 m square. The order of lures (i.e. closest to the camera) were randomised at each station.

Mustelids – Trial design and set-up was as per that for possums (Fig. 2), with 40 replicate multi-choice lure stations monitored by a motion-activated trail camera at two field sites (Map 1); in Taranaki (29 January – 13 February 2020) and in Canterbury (19 February – 6 March 2019).

Fig. 2. Multiple-choice lure station (for mustelids).

2.3 Comparative lure trials

Lure C was found to be the most effective rodent and possum lure during the multi-choice trials, however, scent options E and F also attracted high numbers of rats and possums during the mustelid multi-choice trials. These comparative trials were undertaken to determine to most attractive lure of these options for rodents and possums. Trial methodology followed that of the multi-choice possum and mustelid trials, where 40 replicate multiple-choice lure stations, monitored by a trail camera, were set up at two field privately-owned sites (Map 1); Mangatawhiri (20 May – 3 June 2020) and in the northern Hunua Ranges (9 June – 23 June 2020). At each multi-choice station, one candidate long-life lure (scents C, E or F) was deployed alongside fresh peanut butter (placed inside a tea strainer to prevent animals consuming it).

2.4 Long-term weathering trials

Rodents – The best candidate long-life lure for rodents (scent C) was weathered for three different durations (4 weeks = “C4”; 8 weeks = “C8”; and 12 weeks = “C12”), and compared against an un-weathered commercial “long-life” block (control) and fresh peanut butter (standard), to a total of 180 lures of each type. Long-life lures were weathered in Western Australia, subject to hot conditions and extreme temperature changes outdoors in a wire cage inaccessible to animals. Field trials occurred at three different sites across New Zealand (Map 1); in Auckland (11 – 14 November 2019), the Wairarapa (12 – 15 November 2019), and in

Canterbury (12 – 15 November 2019). Field methods were similar to the multi-choice rodent trials, where one of the five lure options were secured in rodent tracking tunnel with pre-linked tracking cards. For peanut butter lures, one teaspoon of peanut butter was placed a cardboard square and housed inside tea strainers, removing the food reward bias to ensure a fairer trial and mimic lures inside a kill trap. Nine to eleven lines of nine to ten tracking tunnels were deployed at each site, depending on terrain and weather conditions.

Possums – The (ceramic) base blocks were treated with the most attractive scent (Scent C) kept in vacuum-packed bags, which were opened and weathered in staggered treatments 4, 8 and 12 weeks prior to each trial (Fig. 3). Possum trials were conducted at four replicate field sites around New Zealand (Map 1), for two weeks per site; Waitomo (Waikato, 27 July – 10 August 2020), Huntly (Waikato, 13 August – 27 August), Whakamarama (Bay of Plenty, 31 August – 14 September 2020) and Flagpole Station (Canterbury, 17 September – 1 October 2020). Thirty multi-choice lure stations were deployed at each site, with either fresh peanut butter (on a piece of cardboard housed in a tea strainer) or a weathered long-life lure (C4, C8 or C12) at each station monitored by a camera trap.

Mustelids – Field methodology was similar to that for the long-term trials for possums, with 40 multi-choice lure stations per site, monitored by a camera trap for 14 days. Each station offered a weathered long-life lure (F0, F4, F8 or F12) and fresh Erayz (a standard food-based lure as the control, housed inside a tea strainer), totalling 10 replicates per weathered long-life treatment. Trials occurred at four replicate field sites (Map 1); in the Coromandel (30 November to 2 December – 14 to 16 December 2020), Northland (13 to 15 January – 26 to 27 January 2021), a station in Otago with known high ferret numbers (3 to 5 February – 18 February 2021), and Fiordland (23 to 24 February – 15 to 16 March 2021).

Fig. 3. Left: PoaUku Rat & Possum lure (Lure C) weathering outdoors in a simulated DOC trap box closed off to animal interactions, in preparation for the long-term weathering trials. Right: Comparison between a fresh PoaUku Rat & Possum lure (top) and a 12-week weathered lure (bottom), demonstrating the lack of mould issues.

2.5 Data analysis

Tracking cards – Where tracking cards were used, each card was analysed for prints of target species (rats and mice), as well as non-target species including possums, hedgehogs, lizards, and invertebrates.

Video analysis – Where trail cameras were used, each video recorded was scanned for appearances of possums, rats, mice, mustelids, and non-target animal interactions. For videos containing a target species, two behaviour variables were assessed:

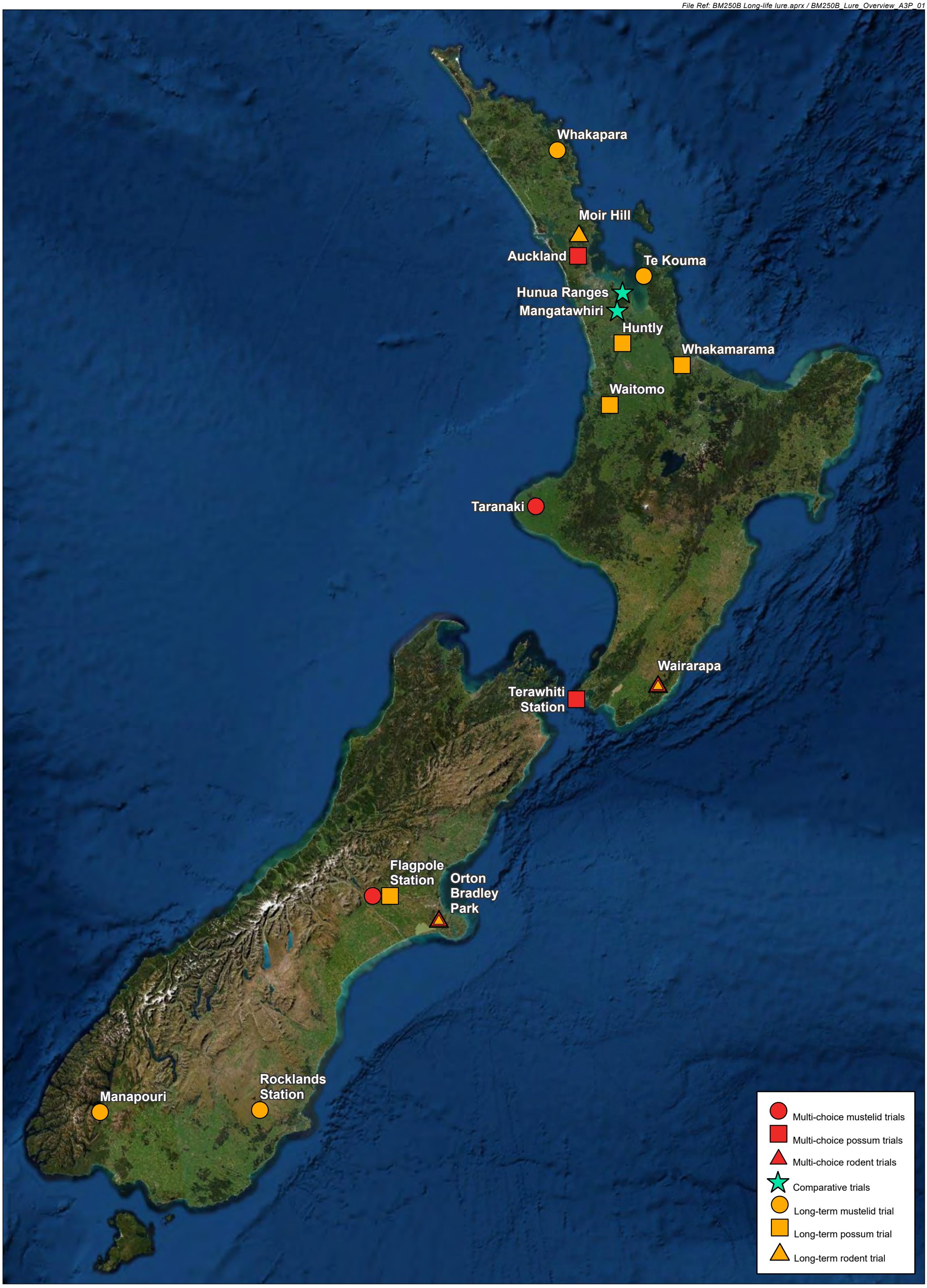
- 'First approach' (categorical variable that recorded which lure elicited the first approach of the target animal in the video, interpreted as 'preference'); and
- 'Longest duration' (categorical variable that records which lure is associated with the most time spent by the target animal approaching or investigating the lure in the video, interpreted as 'interest').

'No approach' was recorded when a target individual is visible in the camera frame but does not make any movement towards any of the lures or if the approach is not clearly able to be attributed to a single lure type. An 'interaction' was considered to be one individual for a maximum of five minutes. A new interaction was recorded for new individuals (or if the same individual returning cannot be confirmed).

Statistical analysis - Statistical analysis was conducted in R at the end of each set of field trials. Tests included chi-squared tests or Fisher's Exact tests (depending on the sample size) on data from each field site separately, as well as the combined data from field sites within each trial, for both behavioural variables of target species.

2.6 GCMS analysis

Experimental set up - Ten replicates of each of five long-life lure treatments (ceramic blocks treated with either long-life scent C, D, E, or F, or left untreated as a control) were analysed using solid-phase microextraction (SPME) followed by GCMS in order to assess the volatile chemicals emitted by the lures. SPME samples were taken at four different time intervals (weeks 0, 4, 8 and 12), to determine how the lures persist over time. A total of 200 SPME samples were analysed (10 replicates x 5 lures x 4 time intervals). Between samples, lures were weathered in five cage traps for the 12-week period (13 July 2020 – 2 October 2020) at Murdoch University in Western Australia.



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Data Sources: Earthstar Geographics

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

PREDATOR FREE SOLID STATE LURES

Overview of PoaUku Field Trial Locations

Date: 17 September 2021 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Helen.Blackie@boffamiskell.co.nz | Drawn: HCo | Checked: KHe

Map 1

3.0 Results

3.1 Multi-choice field trials

Rodents – Of the three long-life lure treatments, Lure C was found to be more attractive to rodents than Lure A or B. Five of ten (50%) of rat interactions were associated with Lure C, as were 33 of 79 (42%) of mouse interactions. The second deployment two weeks later yielded slightly more mouse interactions associated with Lure C (significant at the alpha = 0.1 level) and significantly more rodent interactions (rats and mice) with Lure C (significant at the alpha = 0.05 level). *Note these results were obtained using the previous plastic base block, which has been shown to impact scent release characteristics.*

Possums – High numbers of possum interactions were obtained, with a total of 528 possum interactions obtained during the two trials (Fig. 4). 304 of these interactions were at the Auckland field site and 224 were at the Wellington site. Lure C was the lure that possums first interacted with most frequently using data from both sites combined (91 instances; 33% of "First" interactions), while the untreated 'control' plastic blocks (currently commercially available with vanilla scent) were least attractive (44 instances; 16%).

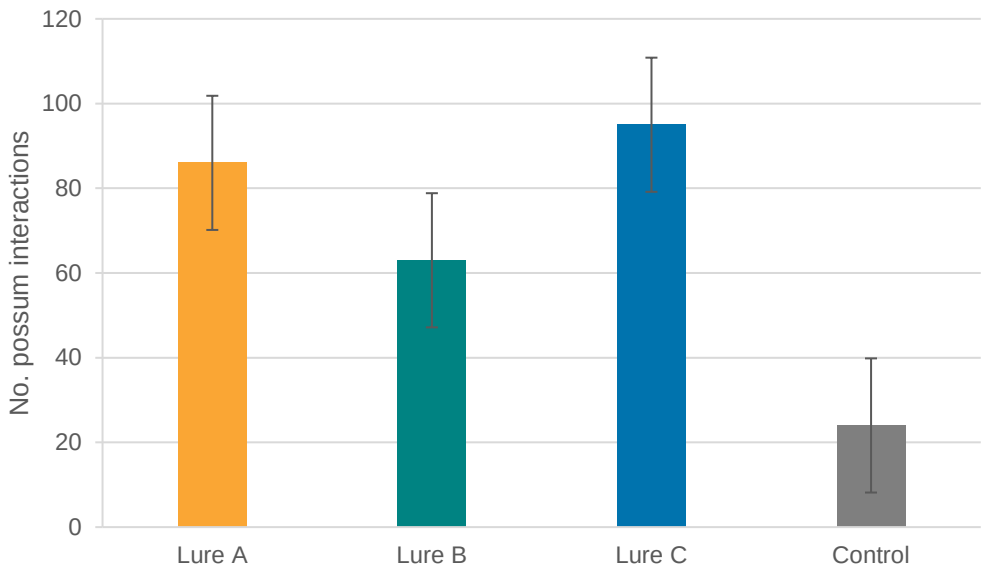

Fig. 4. The long-life scent options that possums spent the most time of each interaction investigating during the multi-choice possum trials. **Lure C** was taken forward to the long-term weathering trials and is commercialised as PoaUku Rat and Possum lure.

Mustelids – All long-life treatments both attracted and held substantially more interest from mustelids than the control plastic blocks (commercially purchased pre-scented with fish). Stoats and ferrets also attempted to eat the plastic block on several occasions. Lure D was the most common lure that mustelids first interacted with (7 instances; 50% of "First" interactions) and also the lure that mustelid spent the most time investigating (10 instances; 71% of "Most" interactions; Fig. 5). The control plastic blocks received substantially less interest from mustelids than any other lure (0 interactions where it received the most attention and only 7% of first approaches). The observed number of interactions where mustelids spent the most time

investigating each lure type (“Most”) was significantly different compared to an equal number of interactions expected if there was no preference, using data from both sites combined (Chi-squared test with Monte Carlo simulation to account for the small expected number of videos; p-value < 0.01). However, the observed number of first approaches of mustelids to each lure type (“First”) was not significant compared to an equal number of approaches expected if there was no preference between lure types (p-value = 0.125).

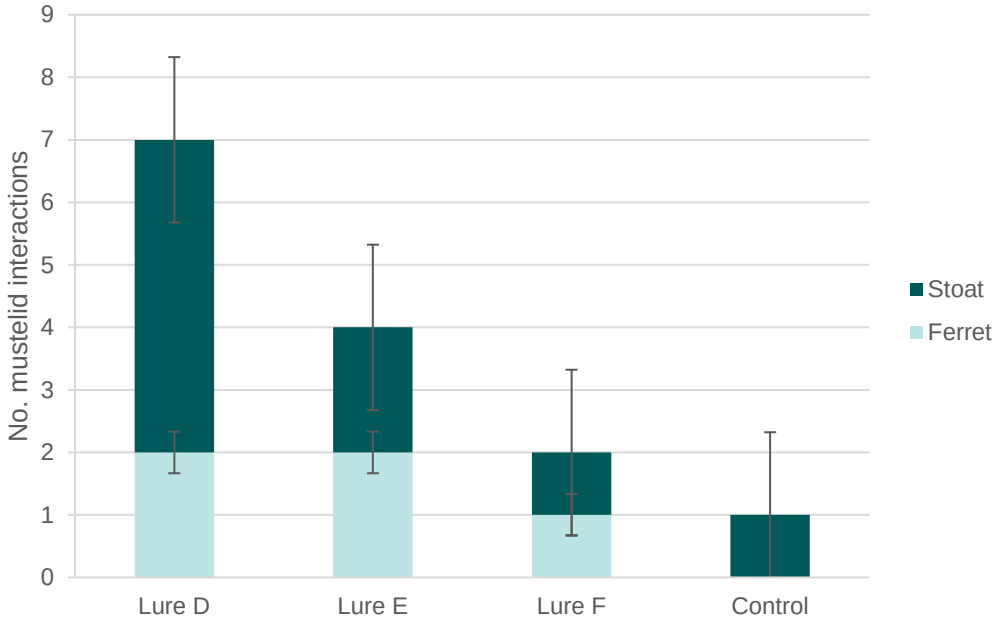

Fig. 5. The long-life scent options that mustelids (stoats and ferrets) spent the most time of each interaction investigating during the multi-choice mustelid trials. **Lure D** was selected for the long-term weathering trials, and later commercialised at the PoaUku Mustelid lure.

Other target species during the mustelid trials – Lure F was shown to be effective at attracting rodents, possums, cats, and hedgehogs, and Lure E was also attractive to both rodents and possums (Fig. 6). Lure F was associated with 40% of the interactions (193 instances) that rodents spent the longest duration spent investigating. Of the 134 possum interactions recorded during the mustelid trials, possums first approached and spent the longest time investigating the Lure E treated lures. Of the 20 feral cat interactions recorded during the mustelid trials, Lure F was the lure first approached (60% of interactions). Of the 121 hedgehog interactions recorded during the mustelid trials, hedgehogs spent the most time investigating Lure F (45% of interactions).

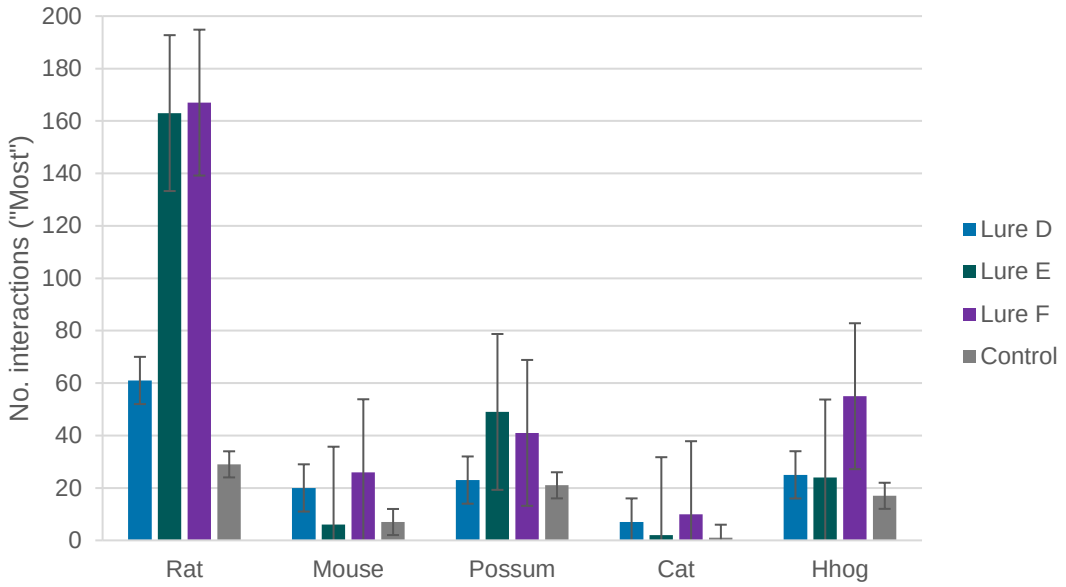

Fig. 6. The long-life scent options that other target species spent the most time of each interaction investigating during the multi-choice mustelid trials.

3.2 Comparative trials

A high number of rat (n = 2556) and possum (n = 1360) interactions were recorded during the comparative trials (Fig. 7), along with modest numbers of mouse, cat, hedgehog, and stoat interactions. As these trials occurred mid-winter when populations of these species are typically much reduced, these interactions show these lures are highly attractive and draw in target animals even at low population densities.

Rodents - Lure F was associated with the most first approaches and the longest interaction duration for both rats and mice (1149 of 1360 “Most” rodent interactions = 84%), a preference was observed at both field sites. The difference in the number of interactions among lures for rats were significantly different for both first and most variables, using data from both field sites combined and from each site considered separately (chi-squared tests). For mice, the number of first and most interactions was significantly different when considering both sites together and from the Mangatawhiri site, while no significant difference among lures was detected at the Hunua Ranges site alone. When comparing each lure separately against the standard lure (peanut butter), all three long-life lure treatments were associated with significantly more “First” and “Most” interactions compared to standard peanut butter for both rats and mice.

Possums - Lure F was the lure most commonly first approached by possums (493 of 1360 possum interactions = 36%), closely followed by Lure C (435 of 1360 “Most” possum interactions = 32%). A similar pattern of preference for Lure F closely followed by Lure C was observed at both field sites. The difference in the number of interactions among lures for possums were significantly different for both first and most variables, using data from both field sites combined and from each site considered separately. When comparing each lure separately against the standard lure (peanut butter), all three long-life lure treatments were associated with significantly more “First” and “Most” possum interactions compared to standard peanut butter. The number of first approaches by possums associated with Lure F compared to Lure C was not significantly different (p-value = 0.209), nor was the number of interactions of

which possums spent the most time interactions with Lure F compared to Lure C (p-value 0.057), using data from both sites combined.

Other target species - Lure F also appeared to be attractive to cats, hedgehogs, and stoats. Lure F was the lure at which cats spent the most time investigating during each interaction (61 of 114 cat "Most" interactions = 54%). A similar result was also observed in hedgehog interactions (12 of 23 hedgehog interactions spent the most time investigating Lure F = 52%). Four stoat interactions were recorded during the trials, of which two were associated with first approaches to Lure F.

Non-target species - A total of 125 instances of songbirds were recorded during the trial, none of which approached or investigated any of the lures. Magpies were the only bird species that interacted with the lures; 5 instances with peanut butter, 2 with Lure C, 1 with Lure F and 1 with Lure E. When present, farm dogs showed some interest in the lure stations, in particular Lure F.

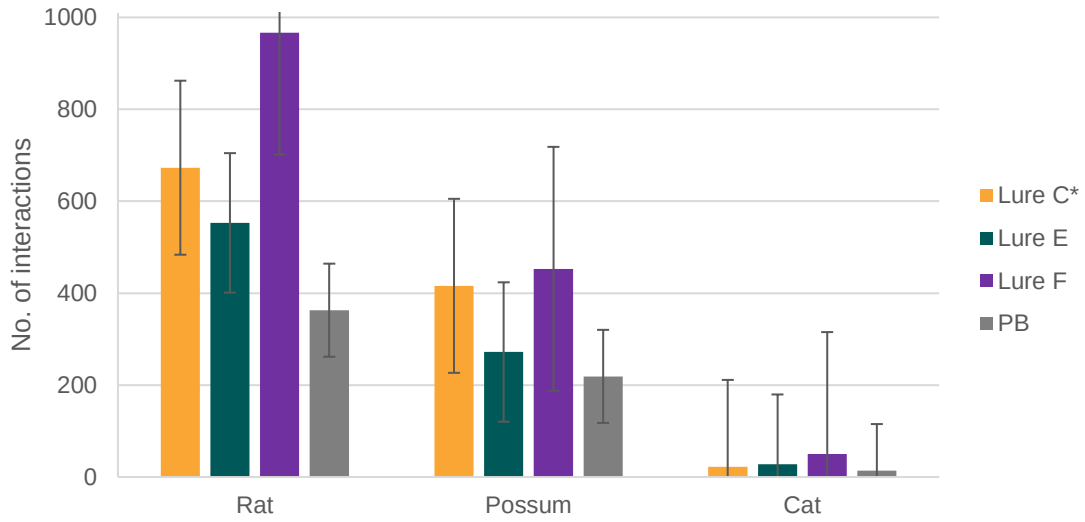

Fig. 7. The long-life scent options that rats, possums and cats first approached in each interactions during the comparative trials. Lure C* was taken forward to the long-term weathering trials for both rats and possums, and is commercialised as the PoaUku Rat and Possum lure. Lure F developed mould during weathering and this option is currently being refined with plans to commercialise in the future.

3.3 Long-term weathering trials

Rodents – Of the 250 tracking tunnels deployed across all three sites, 62 (25%) of the tracking cards recorded the presence of a rodent. The 12-week weathered long-life lure (Lure C) performed equally as well as the 4-week lure across all three sites for rats, mice and rodents combined (all three proportion Z tests; X-squared = 0, df = 1, p-value = 1). *Note these results were obtained using the previous plastic base block, which has been shown to impact scent release characteristics.*

During the long-term weathering trials for possums (with ceramic base-blocks), all three weathered durations of scent C (weathered for 4, 8 and 12 weeks) elicited more interactions than standard fresh peanut butter (Fig. 8). The Week 0 ceramic Lure C lure was significantly more attractive than peanut butter. A total of 642 interactions were recorded where rats spent the most time investigating Lure C cf. 271 interactions with peanut butter, across the two field

sites of the comparative trials (chi-squared test p-value < 0.0001), equalling a 137% percent increase in interactions with Lure C compared to PB.

Further, Lure C lures that had been weathered for over 3 months yielded a significantly higher number of rat interactions than fresh peanut butter overall, thus the use of the porous ceramic base-block lures seemed to substantially increase interaction rates for rats compared to the results from the pre-scented plastic base blocks originally used.

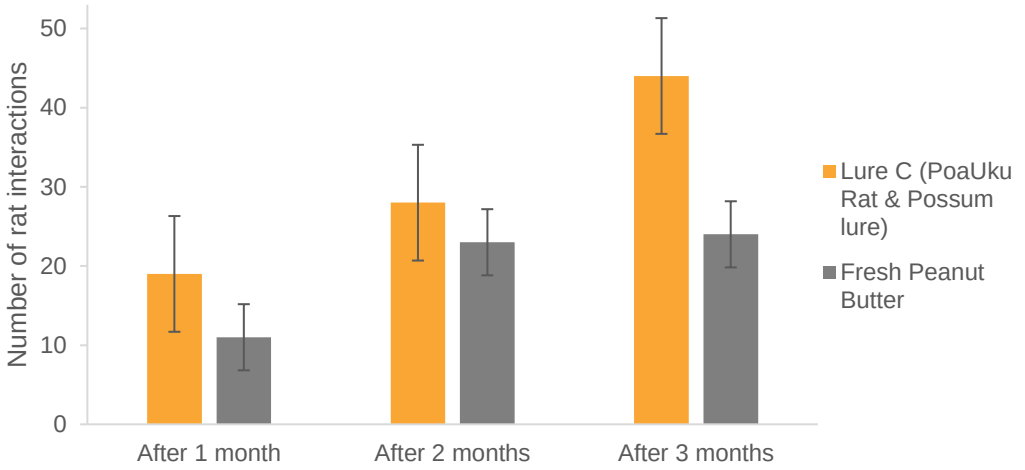

Fig. 8. Number of rat interactions during the long-term possum trials that first approached either the PoaUku Rat and Possum lure (Lure option C, pre-weathered for 4, 8 and 12 weeks) or fresh peanut butter.

Possums – Possums interacted with Lure C on multiple occasions, including those that had been pre-weathered for 12 weeks (Fig. 9). There was a total of 435 interactions where possums spent the most time investigating Lure C versus 182 interactions with fresh peanut butter, across the two field sites of the comparative trials (chi-squared test p-value < 0.0001), a 139% percent increase in interactions.

Fig. 9. Possum interactions with the PoaUku Rat & Possum Lure at four different multi-choice stations at the Whakamarama (Bay of Plenty) long-term weathering possum field trial site.

Mustelids – For stoats, fresh Lure D (D0) was substantially more attractive than Erayz, and was still equally attractive after (more than) one month of weathering (D4; Fig. 10). Across all sites and weathered durations combined, no significant difference was detected between Lure D and fresh Erayz for the number of both first approach (p-value = 0.13) and longest duration (p-value = 0.23) of stoat interactions.

For ferrets, Lure D was substantially more attractive than Erayz, even after weathering Lure D for over 3 months (Figs. 10 & 11). Across all sites and weathered durations combined, Lure D had more first approaches compared to Erayz, which was significant at the alpha = 0.1 level (p-value = 0.07). Given the small sample sizes, it was not appropriate to analyse the different sites or weathered durations separately for either ferrets or stoats*. Lure D was also first approached by hedgehogs, feral cats, rats, and mice more often than Erayz.*

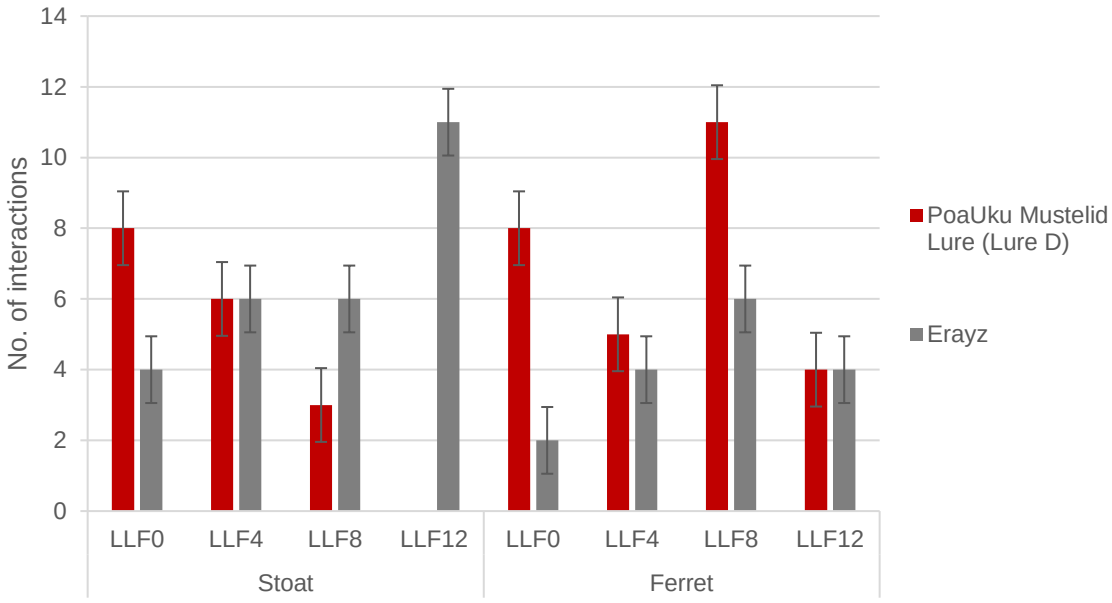

Fig. 10. Number of interactions where stoats and ferrets first approached either the PoaUku Mustelid lure weathered for 0, 4, 8 or 12 weeks compared to fresh Erayz.

Fig. 11. Ferrets captured on trail camera investigating PoaUku Mustelid lures during the long-term weathering mustelid trials.

3.4 GCMS analysis

The most notable GCMS results occurred in Lure C and F (two of the most attractive lure options based on field results), and Lure C being the commercialised rat/possum lure. The volatile organic compounds in these lures had their longer chained compounds reduced in concentration at a slow rate. The resulting smaller chained molecules thus increased over time with the higher concentrations being reached at the end of the experiment in week 12. This result is consistent with an increase in animal interactions in the field in the same timeframe (i.e. 12-week lures are highly attractive).

The ceramic blocks were proven to better preserve the lure release profile over time than the pre-scented plastic base blocks.

4.0 Discussion

4.1 Attractiveness

The PoaUku Rat and Possum lure (Lure C) was found to be *significantly more attractive* to rats fresh peanut butter, even after over 3 months of field deployment, demonstrating the long-life potential of this lure.

Possums were still interacting with the PoaUku Rat and Possum lure even after 12 weeks of weathering in the field. When deployed fresh (without pre-weathering), the PoaUku Rat and Possum lure was shown to be significantly more attractive than fresh peanut butter for both possums and rats, demonstrating applications as an effective multi-species lure. The most attractive option to possums, Lure F, developed mould after several weeks of weathering (the only scent option to do so), and work is underway to refine the treatment process to remove the mould issues.

Further, it appeared that some rats and possums would repeatedly return to the same lure, indicating that repeat visits to traps/monitoring devices are likely and that pest interest is long-lasting.

The PoaUku Mustelid Lure (Lure D) has proven to be a highly attractive lure for both stoats and ferrets (Fig. 12), as well as to multiple pest species including possums, for up to three months (in comparison to fresh Erayz). Lure F was also attractive to stoats, and may offer an effective alternative once the mould issues are addressed.

The high number of rat and mice interactions in the multi-choice trials indicate that all three candidate long-life lure treatments remained attractive to rodents after weathering for at least two months, even after a period of weathering in cold, wet, and windy winter conditions. The attractive of these lures observed at sites across a wide range of latitude and habitat types also shows these lures are effective at attracting rodents in different ecosystems, with different food sources and rodent abundancies.

The lack of interaction from non-target species is also positive; we take these results to indicate these lures are not attractive to non-target species and thus will not increase (and may even decrease) non-target catch compared to peanut butter which may be considered a food source.

4.2 Robustness

The PoaUku Rat and Possum lure, and the PoaUku Mustelid lure, was incredibly resilient to rain, heat, and mould. No mould occurred on any lure blocks during any trials or weathering conditions. The lures were not able to be consumed or damaged by targets or non-targets and remained intact throughout trials (especially in comparison to the plastic lure blocks used in the initial trials, which were regularly chewed and damaged and chewed plastic was regularly found scattered around the lure stations).

4.3 Link between field trials and GCMS results

The GCMS analysis showed that the ceramic blocks were found to better preserve the lure release profile over time than the pre-scented plastic blocks initially used (an existing lure on the market with advertised long-life properties), providing strong evidence that ceramic provides longevity benefits as well as environmentally friendly over the plastic blocks. Further, the GCMS analysis may help to explain the peaks and increases in interactions over time observed during the long-term weathering trials, notable for lure C weathered for 8 and 12-weeks.

4.4 Field sites

The use of multiple sites also helps to account for several variables that may affect the results, including different population densities of rodents, differences in local food availability, habitat, environmental parameters, seasonal influences, and local weather patterns that may have caused different behavioural responses towards lures.

High interactions rates at sites across New Zealand from Northland to Fiordland, in habitats ranging from contiguous forest to predominantly farmland, has demonstrated that these lures are effective even in different habitats with different target populations.

4.5 Benefits

Key benefits of these lures include:

- 100% natural ingredients
- Treated with a proven long-life scent
- Proven higher interaction and capture rates
- Reduces time and labour costs associated with refreshing traditional, food-based lures
- Environmentally robust, even in extreme weather conditions
- Can be used to attract the target predator(s) to standard traps, bait stations and monitoring devices
- Solid-state (inedible) by non-targets
- Sustainable and environmentally friendly
- Simple to deploy, lightweight, and mess-free
- Multiple scent options available to provide for diversity

4.6 Ongoing work

As shown in the comparative trials, Lure F was also a highly preferred option for rats and possums. Unforeseen mould issues with this particular long-life scent treatment prevented us for realising its longevity. Modifications to the treatment process and the treatment are being trialled to also bring this option to the market.

4.7 Conclusion

The key difference between these lures and current standard lures will be the lack of perishability or depletion issues, which are a huge ongoing cost for most current pest control projects (in terms of both consumables and the extensive time required to frequently re-bait traps). As well as being long-life, these lures are also designed to be extremely cost-effective.

Based on these results, our ceramic solid-state blocks offer an effective and cost-effective alternative to currently available lures and have significant potential to increase the cost-efficiency of the ongoing pest control programmes in New Zealand. These lures have been proven to last for at least three months without refreshing, allowing the benefits of long-life and automated technology to be realised. This fulfils the project's ultimate aim to develop an effective, long-life rodent lure.

As well as reducing the ongoing labour and consumable lure costs associated with current control methods, the development of effective long-life lures will also facilitate the use of the multiple long-life trap and surveillance systems currently in development (Murphy et al., 2014).

Fig. 12. Stoat successfully caught using a ceramic long-life lure in January 2021.

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About Boffa Miskell

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