PredatorFree Hawke's Bay
Whakaorangia Te Matau-a-Māui

Wireless Optimisation in Predator Free Hawke's Bay

Executive Summary

Wirelessly monitored trap networks have the potential to dramatically alter the context and costs associated with trapping networks. Using wireless efficiently is key, and this can be achieved with different approaches. Optimisation is dependent upon the percentage of the network that has been triggered, savings are larger when a smaller proportion of traps are sprung, and this is true whether talking of live capture or kill traps. Wireless monitored trap networks may also make it easier for the community to participate in trapping by allowing better use of their time and effort. For a busy farmer, knowing which traps have been triggered and need clearing as opposed to checking the whole trap network could be useful. To some extent this benefit will depend on the ease of access of the trap lines and in most cases wireless is of highest value where access to the traps is poor i.e. parts of the farm not often visited.

Two trial sites for wireless trap networks have been conducted in Cape to City, and the size and shape of a property can significantly influence trap spacing and travel time to network. Time spent checking networks could be significantly reduced with use of wireless. However this depends on the proportion of the network sprung and on individual property size, shape and trap spacings (and access through neighbouring properties).

Current data costs for nodes is a limiting factor for justifying increased maintenance costs for wirelessly monitored networks, and in total there is very little cost savings in labour for wireless compare to high installment and data costs. Installment and data costs could be optimized by only monitoring "hot" traps within networks, and those traps in remote areas of properties. Only 6.5% of traps in Poutiri Ao ō Tāne's network have caught more than two animals in the three years from 2011-14, and an even smaller proportion are target species.

Understanding network fill rates using wireless monitoring could be utilised to determine trigger levels for checking whole networks and further optimise costs. Wireless monitoring could also be used for compliance.

Introduction

As the scale of predator control programmes continue to increase, the potential of wireless systems to remotely monitor trap networks to reduce labour costs could dramatically change the context for landscape scale predator control programmes.

With the evolution of control networks, a common outcome is that pest numbers are held at low density and, especially when having to check live-capture traps daily, the majority of traps checked have no captures.

Understanding the trapping network is crucial in order to optimise use of wireless monitoring. Based on data collected in Cape to City and Poutiri Ao ō Tāne this report explores the questions:

- What is our best estimate for a percentage network check trigger?
- What is the per ha cost of predator kill trap maintenance i.e. with wireless?
- What is the time cost difference between a full check and checking only triggered traps?
- Farm management practice – how does this relate to network servicing?
    - How long can we leave triggered traps before they need to be re-checked?
    - Wireless optimisation – where do we put wireless?
        - Where we catch 80% of pests – hot traps.
        - Which areas of the farm – remote or off the beaten track areas?

Wireless Research

Warburton, 2017: Economic assessment of using wireless monitoring for managing large-scale trap-networks.

Bruce Warburton of Manaaki Whenua - Landcare Research examined the economics of using wireless networks for monitoring trap networks. A pilot trial was conducted using 99 live capture cages over 700ha of farmland within Cape to City. Two trappers were used: one inspecting all traps, and one checking only those traps signaled as being sprung.

Even though the trial was conducted using live capture cages, because all traps were checked in one go, results can inform kill trap networks.

Because the wireless technology is still in its infancy, there was an unknown level of faults (i.e. number of incorrect notifications of trap status) which Warburton notes impacted the results in a way that do not reflect the likely final performance of the technology. Additional time was also spent installing and resetting nodes which may have impacted final conclusions.

Warburton was able to model the relationship between the number of traps sprung and the time spent to check each trap. While he found an increase in mean time taken to check each trap once the proportion of sprung traps is less than 0.20, the total time taken to check the entire network is more important than time spent on individual traps.

Warburton concludes that for live capture, using wireless monitoring can provide significant savings and that savings are greater when smaller proportions of traps are sprung. Non-target captures and sprung and empty traps should be minimised to make wireless monitoring more cost effective.

Because maintenance kill traps do not need to be checked daily, cost savings can only be reached if still-set traps do not need to be checked at a predetermined interval (i.e. the still-set traps do not need their baits replenished).

Based on results from this early initial trial, the analysis showed that only if the proportion of kill-traps sprung was 0.1 or less and these traps were checked monthly was there likely to be a cost saving. If the proportion of traps sprung was higher than 0.1, or the time between checking was longer than 1 month, there were no economic benefits from using wireless monitoring (i.e. using the costs of the current technology). We now understand there is still more to learn and explore of the potential of wireless trap monitoring systems. It is also likely this trial was influenced by incorrect notifications and time spent trouble shooting nodes.

Warburton does note that non-monetised benefits can be used to justify the use of wireless systems such as increased community support and participation, use of capture data for compliance and effectiveness, and trap network optimisation – and in the case of live capture possible improved animal welfare. Additionally wireless systems could provide the information necessary to redeploy traps with three years of wireless data (i.e. identification of hot traps). Due to the significant investment in trap infrastructure, having the ability to redeploy would change the economic context.

Trial Site: Okahu

Two properties in the northern part of the Cape to City footprint were involved in trialing wireless trap network; Te Awanga Downs (400ha) and Okahu (600ha). Only Okahu will be considered in this report due to the nature of the property (i.e. is large with multiple entrances/exits). As noted in Warburton's report, the relationship between the proportion of the network checked and time required to carry out the checking is not linear. As the number of traps checked declines, the mean spacing and therefore travel time between traps increases. However, this relationship is unique and dependent on the property. For smaller properties such as Te Awanga Downs there is often less scope to decrease distance travelled to only check those triggered.

The maintenance network of 66 podiTRAPS was laid in February/March 2017 (see Figure 1).

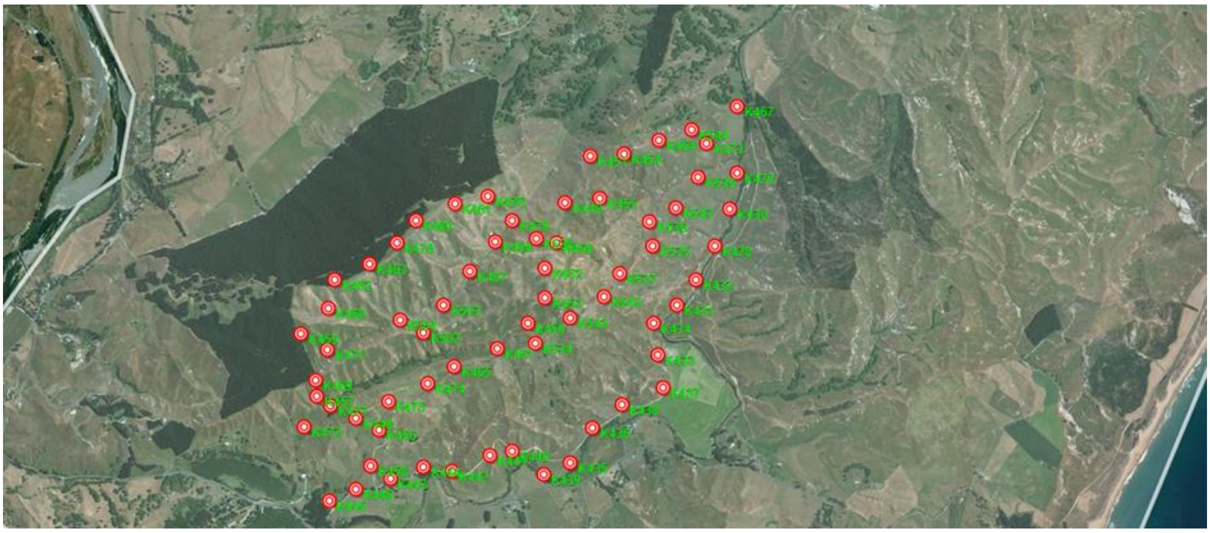

Figure 1: podiTRAP network across the property of 66 traps installed in March 2017

Estimating Costs

What is the time cost difference between a full check and checking only triggered traps?

Table 1: Raw data from wireless trapping trial

	Km travelled (mean)	Time (min) (mean)	% network triggered (mean)
Whole network check	30.64	235	NA
Triggered traps only	16.75	87	9.36%
Difference	13.89	148	

While Bruce Warburton's work concentrated on the live capture context, conclusions could potentially be applied to the maintenance kill-trap context as well (i.e. time spent checking traps).

Table 2: Expenditure in maintenance kill-trap network

Item	Value	Number	Total
Initial Outlay			
Node	$100	66	6 600
podiTRAP	$180	66	11 800
Hub	$2 000	1	2 000
Labour – deploy network	$95/hr	16 hrs	1 520
		Total	21 920
Ongoing costs (per annum)			
Labour – 3 monthly check	$95/hr	1.5hrs per check*	570
Travel time	$95/hr	1.2hrs per check	456
Data cost	$2/month/node		1 584
		Total	2 610
Labour – 3 monthly check without wireless	$95/hr	4hrs per check	1 520

*based on time spent checking network from wireless live-trapping trial (see Table 2 above).

Collecting the data for Bruce Warburton's report involved two staff members, one checking the entire network while the other only checked those traps indicated as triggered. Table 2 (below) provides a summary of this data showing that only checking those traps triggered reduced the time spent on the property by almost 60%.

As previously noted due to the unreliable nature of the technology still in development stage, there were several issues in reporting which may have impacted these results. It should again be noted that this data collected was in a live capture context.
*NOTE: prices in table 2 are dependent on final provider and may change

These figures conclude that at current estimated data costs for nodes, that there are no savings to be had from wirelessly monitored networks. Either costs need to be changed, or the importance of non-monetized benefits would need to be factored into justification for wireless monitoring on maintenance networks.

What is the cost per ha of predator kill trap maintenance with or without wireless?

Table 3: Installment and annual maintenance costs compared with wireless system and without

		Total cost	Cost per ha
Installment	With wireless	21 920	36.5
	Without wireless	13 320	22.2
Maintenance (annual)	With wireless	2 610	4.35
	Without wireless	1 976	3.30
Installment	Savings without wireless	8 600	14.3
Maintenance (annual)		634	1.1

Table 3 illustrates that differences in costs for wireless vs non wireless networks for installment and maintenance. There is very little cost savings for maintenance networks annually especially when compared to the high installment costs.

Hot Traps

Wireless optimisation – where do we put wireless? Where we catch 80% of pests (hot traps)

As managers of trapping networks, over time some traps catch more than others with a rule of thumb estimated that ~20% of traps catch ~80% of all animals. If these traps can be identified within the first 12 months of deployment, there is potential to only use wireless on these 'hot' traps to further economise the network.

On Okahu, only 5 traps caught more than two animals over a 12 month period (see table 4 below). Please note for the May period only 12 traps of the whole network were checked.

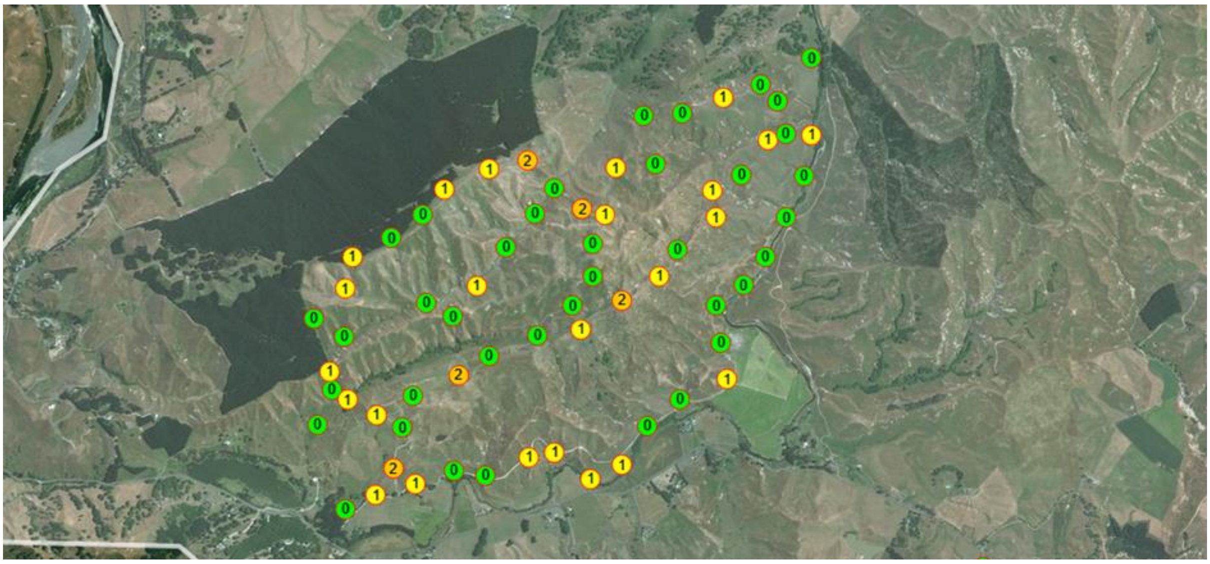

Figure 2: Total animals caught per trap from April – December 2017

Table 4: Number of catches for individual traps April-December 2017

Number of Catches	Number of traps	% of Network	Poutiri Ao ō Tāne network 2011-14.
None	37	56.0	71.0
One	24	36.4	19.0
Two	5	7.6	6.5

Table 5: Species caught April-December 2017

	Ferret	**Stoat**	Hedgehog	Rat	Rabbit	Mouse	Total
April	2	1	9	1	3	0	16
May	0	0	2	2	0	1	5
July	1	1	3	0	0	0	5
Dec	0	0	2	6	0	0	8
Total	3	2	16	9	3	1	34

Note: Target species ferrets, stoats and cats. Of 34 total catches, 5 were target species (14.7%).

Only 6.5% of traps in Poutiri Ao ō Tāne's network have caught more than two animals in the three years from 2011-14, and an even smaller proportion are target species. This pattern is repeated from trapping data from Okahu during 2017 with only 7.6% of traps catching two animals.

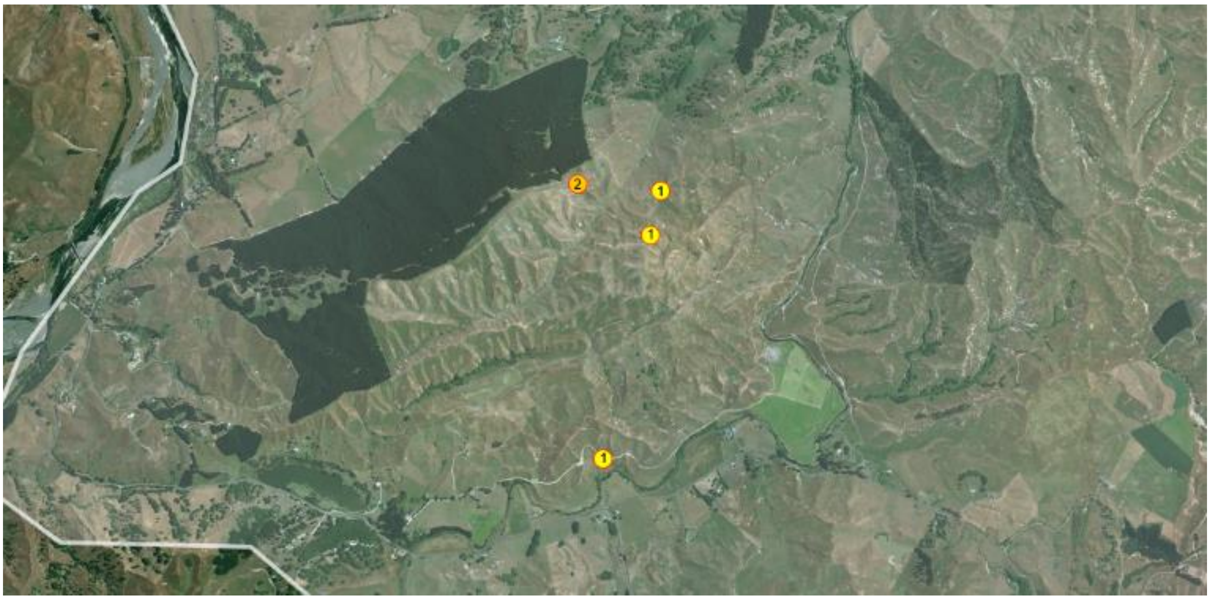

Figure 3: Traps caught target species (Cats, mustelids) on Okahu

Optimal time to check trapping networks – trigger levels

Table 5: Percentage of network sprung (needing reset)

	Catch	% Network triggered (catches)	None (sprung & empty)	Total Traps Sprung	% Network triggered
April	16	24.2	50	66	100.0*
May (12 traps checked)	5	41.6	7	12	NA
July	5	7.6	47	52	78.8
December	8	12.1	51	59	89.4

*this number may be reflective of a reset of the network following a wireless update.

The difference in time and labour costs is very much dependent on the percentage of the network which is triggered and needs resetting. There is a significantly higher incidence of sprung and empty traps in the kill trap context than compared to the live capture trial (see Table 5).

Based on the three full checks from 2017, any benefit of having a wirelessly monitored network would have been neutral i.e. 60% of labour savings based on the live capture trial is not possible because of % of the network needing to be reset at each check.

We need further clarification on whether these high trigger rates are real results, are a function of stock curiosity in the first few months of a new network, if there is a mistake in the database, and if this property is reflective of the whole network.

Farm Management Context

Wireless optimisation – where do we put wireless? Which areas of the farm – remote or near the beaten track areas

The usefulness of the wireless network must be considered in context with management of the trapping network.

Farmers will visit parts of their farm as part of day-to-day farming operations, the design of the podiTRAP means that it is possible to tell from a distance whether a trap has been triggered (see figure 3 below). The red handle in the upright position indicates a trigger event and need for reset. Traps located in often visited parts of the farm are less likely to benefit from wireless, but wireless may be useful for out of the way areas that are visited less regularly.

Concerning the Okahu case study, 18 traps (27%) of the network are considered to be in an 'out of the way' areas. Of these traps, only 7 are considered "hot" traps (see Figure 5), accounting for only 10% of traps on the property. If this figure is reflective across the Hawke's Bay landscape, it could reduce the number of wireless nodes required by 90%.

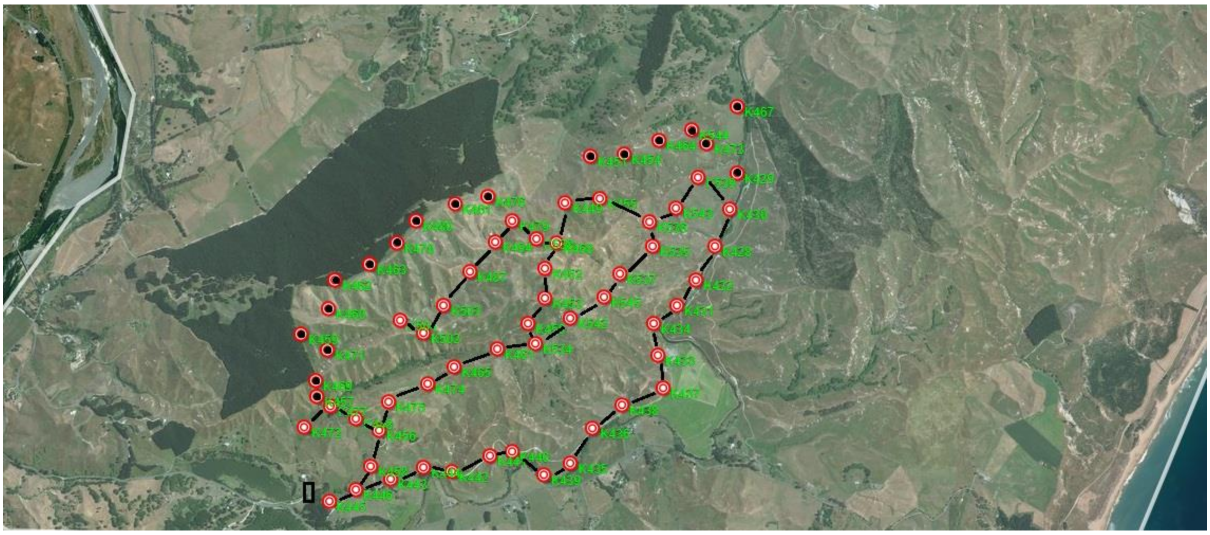

Figure 5: Black dotted traps are visited least often as part of day-to-day farming operations. The black square indicates location of the farm office.

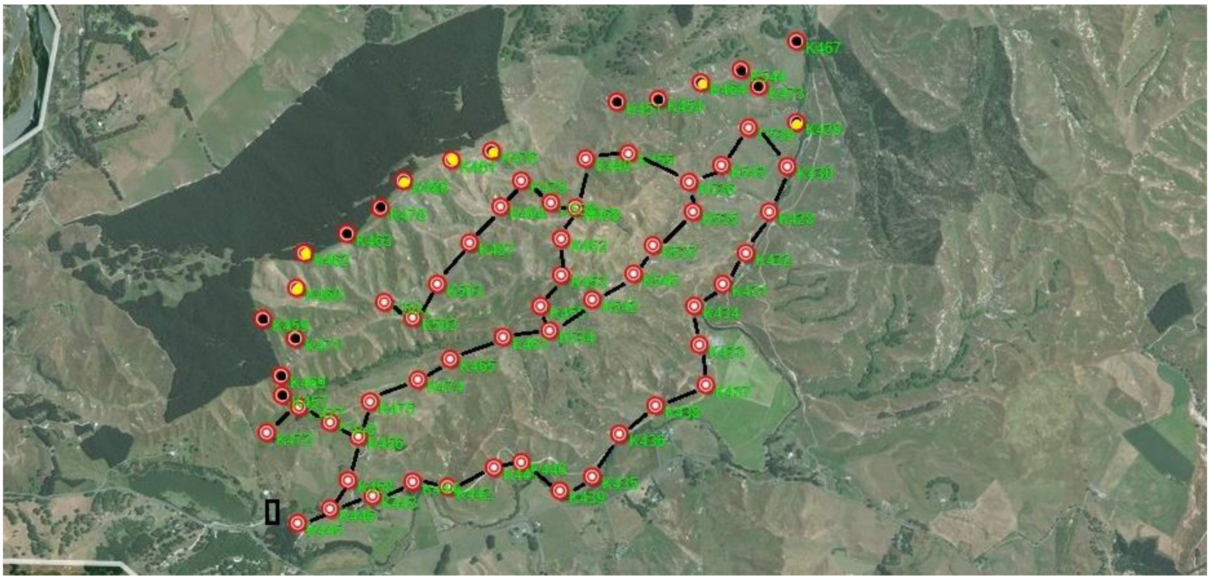

Figure 6: Yellow dotted traps are those both considered out of the way and “hot”

How long can we leave triggered traps before they need to be re-checked?

Gormley, A., and Warburton, B. 2015 Optimising a kill-trap network for cost-effective predator control, Unpublished Landcare Research Report.

Gormley and Warburton examine opportunities for optimising the Poutiri Ao ō Tāne maintenance trap network. For the first phase of the project, traps were checked monthly. The authors used individual-based spatial model to simulate trapping across the network.

Preliminary analysis suggests that traps that caught a target animal in any given fixed length period were twice as likely to catch another target animal in a subsequent period of similar length. The simulation showed that even when 75% of traps are removed, close to 80% of the actual targets animals caught could still be captured. If 50% are removed, 89% would still be captured.

Table 6: Model results of % target species still caught if a % of traps are removed from the network

Traps % Removed	Target animals still captured (%)
75	80
50	89
25	95

If low capture traps were removed in preference to ‘hot’ traps, the overall effectiveness of the modified trap network might be greater than simulated.

Note this modelling doesn’t factor in leaving “hot” traps preferentially in the landscape – this is something the project team is keen to explore further with Manaaki Whenua.

In 2014 the incidence of checks decreased from once a month to one every three months in the Poutiri Ao ō Tāne project. The change in catch rates has not yet been analysed, therefore more work needs to be done to answer this question.

Network Fill Rate

Within the Cape to City project, it appears network fill rates (i.e. how quickly traps fill up and are therefore redundant) are dependent on stock presence, and the type of stock. With wireless (or trap sensors) we could understand when a trap was triggered and how long it was open to potentially catch. This would enable effective optimisation both of the network layout, and also optimal times between checks.

Compliance

Camera Trap Monitoring
(Refer to Glen et al 2016 Predator monitoring for compliance in Cape to City)

Camera trap monitoring might be used to monitor predators on individual farms for compliance purposes i.e. to be able understand if the predator control is keeping predators below a required level.
Glen and others report potential modelling approaches to dealing with camera data from monitoring.

The authors also identify potential risks and issues;

- The number of predators detected may be too small to generate reliable estimates of Camera Trap Rates.
- A minimum number of camera trap nights are required for acceptable precision.
- On properties <100ha it is not possible to set 10 or more cameras at 500m spacings.
- Monitoring the level of trapping effort should be considered for all properties, and may be particularly important for smaller properties, where small area precludes estimation of predator abundance.
- Owned cats could inflate the camera trapping rate.

Summarised potential approach

- Estimate the daily probability of encountering predators at each of the 38 cameras used for annual monitoring in the Cape to City area.
- If probability of encounter exceeds the accepted threshold, compliance monitoring is triggered on all properties ≥ 100 ha within a 2-km radius of that camera.
- Properties of 100 ha would have nine cameras placed in a grid at 500-m spacing. For every additional 10 ha, another camera is added, up to a maximum of 20 cameras.
- Cameras should be deployed for a minimum of 280 camera trap days, e.g. 10 cameras for 28 days; 20 cameras for 14 days.
- Camera trap rate is estimated for each property, pooling data for cats, stoats and ferrets.
- A compliance threshold would be based initially on results from Waitere Station; this may be refined as additional knowledge is gained on the relationship between camera trap rate and biodiversity outcomes
- Trapping effort should be monitored on all properties – regardless of their size – using the wireless trap monitoring system.

Wireless Trap Monitoring

Wireless monitoring would give the ability to know when a trap is triggered and when it is checked to ensure landowners are meeting their requirements. This would be a prescriptive based approach as opposed to outcome monitoring that the current PCA programme is based on. However, if an alternate monitoring system was more cost effective, or based on outcomes this could supersede wireless monitoring and yield few benefits especially when compared to the cost.

PAWS Monitoring

PAWS has the ability to integrate a cheap mini-cam into a device to take a picture of a cats face. This would mean when the unit knows it has detected a cat, it immediately takes a close-up colour picture and sends that to someone to analyse. Experience is that it is easy to identify individual cats from a close-up colour photo of their face. This process could be automated via simple image recognition but would need further investment in research and development.

Despite costs that would be associated with these upgrades it should be compared on par with current costs of wireless technology.

Additional Opportunities

If a wireless network could be integrated into the wider farming operation – such as controlling gates and reading trough levels, there could be cost efficiencies with utilising the same network.

There is also potential to attract crowdfunding by being able to remotely monitor traps – i.e. an individual purchases a trap with wireless, and can monitor when it is triggered, and then can see what was caught.

Further Questions

1. Given trap data collected from Poutiri Ao ō Tāne, how quickly could we have determined which traps are “hot” traps, and were these consistent through time (or prone to randomness)?

2. If hot traps were checked more frequently, how would this influence overall catches?

Live Capture Wireless Use in Whakatipu Māhia – 2019 Update

Due to the unknown reliability of newly developed wireless reporting systems, use of wireless in Cape to City and Poutiri Ao ō Tāne has been restricted to kill traps. As previously discussed most wireless testing has occurred on two properties in Cape to City using Encounter Solutions and then Econode.

The Animal Welfare Act 1999 has now been updated to include wirelessly monitored traps.

36 Obligations relating to traps

(1) A person who, for the purpose of capturing alive a mammal, bird, reptile, or amphibian, sets a trap or causes a trap to be set must—

(a) manually inspect that trap, or cause a competent person to manually inspect that trap, within 12 hours after sunrise on each day the trap remains set, beginning on the day immediately after the day on which the trap is set; or

(b) manually inspect that trap, or cause a competent person to manually inspect that trap, within 24 hours after the capture of an animal in the trap, but this paragraph applies only if—

(i) the person monitors the trap with an electronic monitoring system (such as a system of capture sensors and a wireless communication network) that is maintained by the person and that is reliable; and

(ii) the monitoring system operates in such a way that it promptly communicates the fact that an animal has been captured in the trap and enables the person to meet the person's obligations under subsection (2) within that 24-hour period.

Extract from Animal Welfare Act 1999

In October 2019 the first wirelessly monitored live capture traps were installed in Whakatipu Māhia. The traps used are Zero Invasive Predators (ZIP) PosStop leghold trap. These are being installed along roads and tracks as part of the lean detection surveillance network. The network is designed to act as surveillance, not the primary control tool, to contribute zero detection data required to confirm zero density has been achieved.

The ZIP system has been rigorously tested and is highly reliable. Additionally, the daisy chain design system means 3 lines of up to 63 traps can be run on one 'sat box' (device that transmits over iridium). Data charges are per satellite box, not per node as in all other systems. This ensures data costs are kept to a minimum, even over large networks with many traps.

The ZIP team spent three days with the team in Māhia during mid-October 2019 to train the team in set up and management of the lines. Despite the weather and planned rocket launch, 25 traps were deployed along the Māhia East Coast Road. Distances between nodes were reaching 200m+, well beyond their anticipated range and the following two nights, two possums were caught and reported on.

The project team's view has been that the major cost savings in wireless use will come from live capture traps, and in the time saved not needing to check traps every day.

This ZIP leghold network will allow the team to efficiently monitor large areas over long periods of time in order to collect the data required to declare zero density. Logistics of running the network over weekends, holidays, and during severe weather events are currently being worked through.