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Purple Peaks Curry Reserve Pest Animal Management Plan

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Executive Summary

Introduction

The purpose of this report is to create a pest animal management plan for Purple Peaks Curry Reserve. The work was commissioned by NZ Native Forest Restoration Trust in June 2017, and the plan was written by Lyne McFarlane and Dr James Ross of Lincoln University.

Background

Purple Peaks Curry Reserve is a 190 ha native forest remnant on Banks Peninsula. The Reserve has only recently been obtained by the Native Forest Restoration Trust and is managed by the Maurice White Native Forest Trust. It borders on Hinewai Reserve, which has had a restoration project running for 30 years, and has recently re-introduced tui (*Prosthemadera novaeseelandiae*). Pest animal control work is undertaken on Hinewai Reserve, and predator control is required to ensure low numbers of pests in Purple Peaks Curry Reserve. No official pest control work has been undertaken on Purple Peaks Curry Reserve to date; however, the Purple Peaks Curry Management Plan has been prepared by Wilson (2016) and the key pest species identified. Based on the above, the aim of this plan is to expand on the current management plan for the Reserve and develop a specific pest animal management plan.

Objectives

The objectives of this plan are:

1. To propose control options for key pest species on Purple Peaks Curry Reserve and;
2. To advise on the best options for ongoing pest monitoring.

Methods

Information gained from the Management Plan (Wilson, 2016), and email contact with Sharen Graham of the Native Forest Restoration Trust, were used to develop the final recommendations. Animal pest control has not previously been undertaken in the Reserve, and the locality of nearby Akaroa and the town's water supply located on the Reserve means there may be low public support for predator control options using toxins, such as 1080 or cyanide. Given that the use of 1080 and cyanide maybe unacceptable, we have outlined three different control options that focus on the key predator species use different combinations of toxins and trapping.

Recommendations

This plan recommends the following:

- A combination of trapping and toxins is the preferred strategy to control all key pest species on the Reserve. This requires an initial programme of trapping aimed at possums, mustelids and cats, followed by pulsed baiting of diphacinone for rodents.
- Monitoring should be undertaken at regular intervals using chew cards for possums, with tracking tunnels used for rodents and mustelids, to determine the ongoing success of the control and to help determine when maintenance control needs to be undertaken.

1. Introduction

The purpose of this report is to create a pest animal management plan for Purple Peaks Curry Reserve. The work was commissioned by NZ Native Forest Restoration Trust in June 2017 and the plan written by Lyne McFarlane and Dr James Ross of Lincoln University.

2. Background

Purple Peaks Curry Reserve is a 190 ha reserve recently purchased by the Native Forest Restoration Trust and is managed by the Maurice White Native Forest Trust. The Reserve comprises of steep slopes and bluffs with 55 ha podocarp-hardwood bush gullies and park-like forest, 35 ha gorse scrub and 100 ha of rough pasture. The forest is a large example of diverse second-growth, broad-leaved hardwood forest in the Akaroa Ecological District (CCC, undated). The Reserve provides an important ecological link between indigenous vegetation and habitats on the west-facing slopes of Akaroa Harbour with the neighbouring Hinewai Reserve (CCC, undated). Akaroa's town water supply is derived from springs and small streams from the Grehan Catchment on the Reserve (Wilson, 2016).

The Purple Peaks Curry Management Plan (Wilson, 2016) and the Christchurch District Plan (CCC, undated) identify several threatened plant species with one nationally At Risk (climbing groundsel *Brachyglottis sciadophila*); two uncommon within the ecological district, raukawa (*Raukawa edgerleyi*) and leathery shield fern (*Rumohra adiantiformis*), and two plant species at their distributional limits on Banks Peninsula, pigeonwood (*Hedycarya arborea*) and kawakawa (*Piper excelsum*). Mistletoe species are also present (Wilson, 2016) and a small area of snow tussock (*Chionochloa spp.*) grassland and shrubland is of particular significance as it contains two Banks Peninsula endemic shrubs, the Banks Peninsula hebe (*Veronica strictissima* – At Risk/Naturally Uncommon) and the Banks Peninsula sun hebe (*Veronica lavaudiana* - At Risk- Declining; (de Lange et al., 2013; Wilson, 2016).

Significant fauna includes the Akaroa tree weta (*Hemideina ricta*), which is an endemic species to Banks Peninsula and other localised species; the jewelled gecko (*Naultinus gemmeus* – Declining) and the spotted skink (*Oligosoma aff. lineoocellatum* 'Central Canterbury' – Nationally Vulnerable) as the most threatened lizard on Banks Peninsula (Hitchmough et al., 2016; Trewick et al., 2016; Wilson, 2016).

All the above species remain at risk due to introduced predators, such as ship rats (*Rattus rattus*), Norway rats (*Rattus norvegicus*), mice (*Mus musculus*), stoats (*Mustela ermine*), hedgehogs (*Erinaceus europaeus*) and possums (*Trichosurus vulpecula*). In addition birds such as kereru (*Hemiphaga novaeseelandiae*) have declined in numbers on Banks Peninsula (Parkes, 2009). Of note, is that tui have recently been successfully reintroduced to Hinewai (BPCT, 2016) and have been observed in Purple Peaks Curry Reserve (Molles, 2016).

The Purple Peaks Curry Management Plan (Wilson, 2016) identifies several key pest species for the Reserve and these are listed below in order of priority:

1. Possums are the primary pest target in the Reserve as they can destroy the forest canopy and can also compete with native birds for habitat and food. It is well documented that

possums are responsible for the declines in bird populations from direct predation on nestlings and eggs (Brown et al., 1993). Parkes (2009) has also reported that possums persist at higher densities in scrub and forest habitats on Banks Peninsula. There has not been any previous official possum control in this area and reducing possum numbers should have a significant and positive impact on the remnant forest. In the neighbouring 1,270 ha Hinewai Reserve, approximately 18,000 possums have been removed since 1987 and independent monitoring by Environment Canterbury has estimated a residual trap catch estimate (RTCI) of close to 0% (BPCT, 2010). Unfortunately, possums will continuously reinvade so sustained control programmes will be required to suppress them.

2. Rodents are likely to be present in reasonable numbers due to the abundant food sources (seeds fruit, invertebrates, eggs). Ship rats are significant contributors to nest mortality and they also eat large amounts of fruit and seedlings (Allen et al., 1994). Rats will reinvade continuously so sustained control programmes will also be required to control them. No surveys have been carried out to estimate the numbers of rodents on Purple Peaks Curry Reserve or at neighbouring Hinewai. It would be of benefit to monitor pre-control numbers by running tracking tunnels in key habitat areas, such as the forest remnant, with nesting area/trees to get an idea of the relative abundance of rodent numbers. This may also help with deciding whether to use poison or traps as the initial knockdown tool.
 - 1) Stoats (including weasels) are widely distributed throughout Banks Peninsula, at varying densities, depending on seasons and rodent numbers (Parkes, 2009). Stoats feed on birds, eggs, mice, rats, rabbits, invertebrates and carrions. Ferrets are generally found near forest margins and farmland, and predominantly feed on small mammals, small birds and eggs. Home ranges are generally large, 60-200 ha, and they can travel considerable distances over short periods of time. They have high dispersal ability and individual juveniles have been known to travel over 70 km in two weeks. Control will need to be continuous and/or targeted annually over large areas to be effective, as ferrets and stoats have large home ranges; with continuous invasion by juveniles into new areas.
 - 2) Feral and domestic cats are likely to be present in the forest fragments on farmland and along the forest margin, where they pose a threat to birds, invertebrates and, particularly, native lizards. Prey items will also include rabbits and rodents. The home range of feral cats can be in excess of 200 ha; however, this depends on cat density, prey density and habitat type (NPCA, 2015f). Cats will also reinvade continuously, but numbers can fluctuate due to the weather and prey abundance, so targeted annual control programmes could be most effective. If there are concerns about the capture of domestic cats, then the use of live capture cage traps should be considered.

3. Objectives

Based on the above background information, the objectives of this plan are:

1. To propose control options for key pest species on Purple Peaks Curry Reserve and;
2. To advise the best options for ongoing pest monitoring.

4. Methods

Information gained from the Management Plan (Wilson, 2016), and email contact with Sharen Graham of the Native Forest Restoration Trust, were used to develop the final recommendations. Animal pest control has not previously been undertaken in the Reserve, and the locality of nearby Akaroa and the town's water supply on the Reserve means there may be low public support for particular predator control options using toxins such as 1080 or cyanide. Given that the use of 1080 and cyanide may be unacceptable, we have outlined three different control options that focus on the key predator species and use different combinations of toxins and trapping.

5. Initial planning and site assessment

Prior to undertaking any pest control, it is recommended the Trust consider their long-term goals for pest control. These goals may be the recovery of forest birds or recovery of seedlings, etc. These goals will help decide the intensity of control required, its timing and duration, potential risks that might occur and how to minimise these.

A site assessment is also recommended to provide an overview of the current status of the Reserve and to identify key biodiversity values and threats. Important native species, as outlined in the Introduction, could be used as key indicator species for monitoring the recovery of the Reserve.

The site assessment would also help identify key habitat areas for future monitoring and control (such as trapping/bait station grid placement). Future control strategies could be based on key habitat classes such as: 1. Forest Habitat; 2. Pasture; 3. Regenerating bush etc. Agencies, such as Formak, have good information on planning site assessments (see www.formak.co.nz for more information).

6. Control options

Animal pest control has not previously been undertaken in the Reserve and the locality of nearby Akaroa and the towns' water supply on the Reserve means there may be low public support for control options, such as 1080 or cyanide. Given that the use of 1080 and cyanide may be unacceptable, we have outlined three different control options with a focus on the key predator species, as detailed above. These options include: 1) Trapping only; 2) Toxins only (using alternatives to 1080/cyanide); and 3) A combination of trapping and toxins.

Eradication of key pest species at this site is very unlikely due to continuous reinvasion. As such, sustained control of possums, rats, mustelids and cats to low levels, using ground-based methods (e.g. traps and bait stations), will be essential for the success of any revegetation and native fauna enhancement on the Reserve. In addition, sustained control of predators at low densities after the initial removal operation is a more cost-effective option compared with any attempt at localised eradication (Curnow & Kerr, 2017). For example, Curnow and Kerr (2017) report that the removal of 95% possums in an area costs approximately \$20-\$30 ha⁻¹, while an operation targeting 100% of possums is considerably more expensive and is estimated to cost approximately \$400 ha⁻¹.

7. Monitoring targets

Monitoring of pest species is important for two reasons:

1. To measure the success of the pest control operations undertaken in the Reserve and to measure whether the conservation targets are being met; and
2. To provide information to determine when control operations need to be repeated so the key native species remain protected.

In terms of conservation thresholds, the Wildside Project on Banks Peninsula aims to lower predator numbers to below 5% using either traps, chew cards or tracking tunnels (BPCT, 2010; see the Monitoring methods section below). Based on reports, such as BPCT (2010) and Thomas (2005), it is recommended the Reserve should carry out something similar with a control aim of reducing pest numbers to $\leq 5\%$, with 10% as a potential upper threshold that indicates the need for more control work.

8. Control infrastructure

This section outlines the trapping/bait station grids required to undertake the control options for each pest species.

NZLandcareTrust (2015) recommends using at least 1- 2 traps or bait stations per ha for possums and avoid creating any gap greater than 150 m x 150 m. We recommend using 1 trap or bait station per ha in a 100 m x 100 m grid near well-defined bush/pasture margins or along tracks through larger areas of forest (NPCA, 2015c; NZLandcareTrust, 2015).

Rodent control relies on more extensive bait stations or trapping networks. To control rats it is recommended setting up a network of traps or bait stations 100 m x 50 m apart (i.e. 2 traps or bait stations/ha) and perimeter traps or bait stations spaced at 100 m x 25 m apart (i.e. 4 traps or bait stations/ha) (NZLandcareTrust, 2015). This should provide at least one trap or bait station within most rats' home range. At higher rat densities, trap or bait station spacing may have to be reduced further to maximise control; i.e. to 5-6 traps/devices per hectare.

To control mustelids, NPCA (2015e) recommend setting up a permanent network of traps every 200 – 400 metres on established tracks or with a grid design at 800 m x 800 m spacing. Trapping densities can vary, depending on the terrain and mustelid density. Traps can be placed at a lower

density (1 trap/15 - 20 ha) in open grassland or at a higher density in continuous forest or mosaic habitat (NZLandcareTrust, 2015). Placement of 10 traps per square kilometre in strategic locations, such as along forest – pasture boundaries rather than a uniform layout, has also been suggested by Ragg (2010) for ferret control. We recommend a trapping grid of 400 m x 1000 m; i.e. 1 trap/40 ha to target mustelids on the Reserve.

For feral cats, it is recommended traps should be at densities of about 1 trap per 15 ha in forest fringe areas; and 1 trap per 20 ha in the core forest areas (NZLandcareTrust, 2015). Tracks and sites where there are other traps already present are the best places to locate these traps. Although not proven, human scent on traps may deter cat encounters so minimise handling of traps and use clean gloves to reduce human scents (NPCA, 2015c).

9. Timing

Timing is critical and depends on what is being protected and when species are at of high risk. Defining the sensitive areas and high-risk periods of the year on the Reserve is recommended. For example, for maximum benefit to birdlife, possum poisoning/trapping is best concentrated just before, and during, the bird breeding season which, for most species, runs from August to about January (NZLandcareTrust, 2015).

Intensive rat control is best carried out from late winter to the end of summer during the bird breeding season (NZLandcareTrust, 2015). If the Trust aims to increase seedling germination then rats will need to be controlled all year round (NZLandcareTrust, 2015).

For mustelids, ferret control is best done in autumn when the dispersing juveniles are seeking new habitats (NPCA, 2015e). Trapping and poisoning is effective in late summer through to autumn. Stoats generally need to be trapped throughout the year (NPCA, 2015e).

10. Control using trapping only

Possums:

To target possums, we recommend using single kill Sentinel Traps or Trapinator Traps. Sentinel traps and Trapinator traps have both passed the National Animal Welfare Advisory Committee's (NAWAC) humane standards for kill traps. It is best practice to raise each bait station or trap off the ground as this helps minimise any non-target bycatch (NPCA, 2015c, 2015d). The traps can be baited with a peanut butter, feeder paste or a flour/icing sugar mix and they then need to be serviced monthly. Resetting gas-powered Goodnature® traps, such as the A12, can be effective for possums and may be worth considering. Although more expensive initially, these can be more cost effective over long periods in the field; however, current DoC best practice recommends that the lure is refreshed monthly. These traps also comply with NAWAC standards (Goodnature, undated).

Rodents:

The downside of trapping rodents is the expense, as it is labour intensive and there has been limited success with the large scale control of rats in areas >10 ha (Brown et al., 2015; Curnow & Kerr, 2017). However, the option to use traps to keep rat numbers low once poisoning operations for possums is completed, could be considered. Traps that are NAWAC compliant are the Victor Easy Set rat trap set in a tunnel or a cover. Use of the modified Victor Easy Set rat trap in a tunnel, or the DOC 200 (set in wooden boxes), which can also trap hedgehogs and stoats, is worth considering. Multi-kill traps could also be used (Goodnature A24); however, current DoC best practice recommends 4-5 traps per hectare; therefore, making rodent control prohibitively expensive. Best practice recommends the use of a lure or bait, such as a peanut butter and rolled oat mixture (NZLandcareTrust, 2015).

Mustelids:

The number of mustelids, such as stoats and ferrets, in the Reserve will vary due to the season and the presence of rabbits and rodents, which are their primary prey. The DOC150, DOC200 and DOC250 traps have passed NAWAC humane standards and, while the DOC250 trap is more expensive, it is designed to simultaneously trap rats, hedgehogs, stoats and ferrets. To decrease overall costs a combination of DOC250 and Timm's traps could be used; Timm's traps have been used successfully for ferrets (although these are not NAWAC approved for mustelids). Baits, such as fresh rabbit, chicken eggs, long-life rabbit (ERAYZ™) bait or salted rabbit, are preferred (NPCA, 2015e). Ferret traps need to be checked and the bait replaced weekly, between January and May, and monthly, between June and December (NPCA, 2015e). Stoat control needs to be undertaken throughout the year depending on the resource being protected. Monthly trap checks are recommended (NPCA, 2015e); a good source of information about mustelid trapping can be found at <http://www.predatortraps.com/> and NPCA (2015e). Again, the Goodnature A24, which is NAWAC approved for rats and stoats, could be an option; however, they do not successfully target ferrets.

Feral Cats:

Cat invasion will be continuous and needs to be controlled in perpetuity. Cats can be targeted when sign is observed, by cage trapping and/or shooting. Cats can also be trapped using modified Timm's traps (i.e. an elevated Timm's trap with an access ramp that avoids capture of non-target species;

see NPCA 2015c). Timm's traps are NAWAC approved for cats (LandcareResearch, undated-c) and if there are concerns about domestic cat capture, then the use of live capture cage traps should be considered. This is more labour intensive as the Animal Welfare Act 1999 requires any live capture traps to be checked daily within 12 hours of sunrise (see NPCA 2015f). Fresh bait is essential for cat control. Fresh rabbit or fish mince is best although it will need to be replaced fortnightly as it does not last very long. Cat capture rates are often highest in winter when their prey, such as rats and rabbits, are limited.

Costs of trapping:

Trap (Supplier)	Cost including GST	Target pest
Sentinel Trap (Pest Control Research Ltd)	\$37.38 each; 101 ⁺ = \$30.48	Possums
Trapinator Trap (Pest Control Research Ltd)	\$56.35 each; 21 ⁺ = \$51.75	Possums
Victor Easy Set rat trap (Pest Control Research Ltd)	\$7.53	Rats
Modified Victor Easy Set rat trap (Pest Control Research Ltd)	\$13.69	Rats and stoats
DOC150 (Single stainless steel trap in wooden box – Haines Pallet Co Ltd)	\$72.45	Rats, hedgehogs and stoats
DOC200 (Single stainless steel trap in wooden box – Haines Pallet Co Ltd)	\$78.20	Rats, hedgehogs and stoats
DOC250 (Single stainless steel trap in wooden box – Haines Pallet Co Ltd)	\$149.50	Rats, hedgehogs stoats and ferrets
Timm's (Pest Control Research Ltd)	\$56.93 each; 21 ⁺ = \$51.75	Cats, ferrets and possums
Goodnature® A12 possum trap, lure and counter	\$ 219.00	Possums
Goodnature® A24 stoat trap, lure and counter	\$199.00	Rats and stoats
Mustelid and cat lure (Polymer bait - Pest Control Research Ltd)	\$0.58 for 10 lures	Mustelids and cats
Erayz Paste mustelid lure 10 kg (Connovations Ltd)	\$287.50	Mustelids

11. Control using toxins only

A two-phase poisoning operation is recommended as a cost effective method to maintain low numbers of possums and rats on the Port Hills (Thomas, 2005). As such, the Purple Peaks Curry Reserve could do similar, with an initial knockdown programme followed up with maintenance control, for possum, and three bait pulses for rodents over the year as a way to reduce baiting costs and to provide lower secondary poisoning risks for non-target species.

Possoms:

As possum numbers in the neighbouring Hinewai Reserve are already at low numbers (<5% RTC) it is recommended to use cholecalciferol (Feracol®) in permanent bait stations, initially to lower numbers and then to maintain possum numbers at low levels. Cholecalciferol, although more expensive than other baits, is a good choice for Purple Peaks Curry Reserve as no licence is required; it is effective at reducing medium-to-high numbers of possums; has a low toxicity to birds; is of low risk for secondary poisoning; and does not persist in soil or water (NPCA, 2015). Sentinel bait stations are recommended for Feracol paste; however, a less expensive bait station that could also be used for possum control is the CKD bait station for paste and pellets. In addition, there is a multi-species bait station option (see section below).

Pre-feeding with 200 g Ferafeed 213 paste (Connovations Ltd) should be carried out once per week for two weeks prior to poisoning. Pre-feeding is best practice for a fast-acting toxin like cholecalciferol as it maximises bait uptake and reduces bait shyness (Connovation Ltd, 2013; NPCA, 2015b). Residual pre-feed bait needs to be removed prior to using toxic bait as this can result in possums becoming sub-lethally poisoned and bait shy (LandcareResearch, undated-a; NPCA, 2015b). Approximately 100-200 g of Feracol should be put in each bait station and left out for 5-10 nights. Bait stations can then be checked once every 2-3 days and bait replenished if eaten during the initial baiting session (LandcareResearch, undated-a; NPCA, 2015b). If rat numbers are high, top up bait stations with more bait within 1 or 2 days (use as much as may be required depending on the take over the previous night/s). After 10 days remove all bait. This operation should be repeated twice a year initially, or it can be continuous until target densities are achieved. Once effective control has been achieved, a maintenance phase of control, using cholecalciferol in bait stations once every 2-3 years in winter, can be used (Thorsen, 2016). The use of cholecalciferol any more frequently than this may result in bait shyness.

Rodents:

The use of the first-generation anticoagulant diphacinone is recommended as a cost-effective option to reduce and maintain rat numbers at low levels. Diphacinone (Pestoff® Rat bait or Ratabate® from Connovation Ltd) breaks down quickly in the food chain and is far less persistent than second-generation anticoagulants. Rats are also susceptible to Feracol used in possum control (see above). Sentinel bait stations can be used for both paste and pellet baits; however, a less expensive method is drain coil bait stations or PVC pipe, especially if there are no problems with ground-nesting birds (see NZLandcareTrust, 2015). It is recommended to set up bait stations to allow rodents to get accustomed to them; they can be pre-fed with peanut butter but this is not generally required when using an anticoagulant (see NZLandcareTrust 2015). Rats have to feed on the poison for at least five days and bait stations must not be allowed to become empty during this period to ensure rats ingest sufficient poison to kill them (see NZLandcareTrust 2015). Maintain an uninterrupted supply of fresh bait for at least 10 days. Once initial knockdown is achieved, bait stations can then be checked once every 2-3 days over the next month until target densities are achieved. After the initial knockdown, pulse baiting three times a year (with 2 monthly checks) from August to about January (or around key bird breeding time – see above) should be considered to reduce costs and lower secondary poisoning risks.

Mustelids and Feral Cats:

Poisoning operations are currently not recommended for cats and mustelids; however, new techniques using the toxin PAPP for mustelid and cat control may be available in the near future (Eason et al., 2015).

Multi-species bait station:

Using an OSKA bait station (One Station Kills All), although more expensive than other bait stations, could be an effective method to target both possums and rodents simultaneously using different bait types. These bait stations have a spring-loaded treadle that possums push past to access the cholecalciferol possum bait and they have a tunnel with bait that only rats can access (Curnow & Kerr, 2017); they could be used alongside PVC bait stations.

Costs of ground based toxins:

Bait station and bait (supplier)	Cost, including GST	Target pest
OSKA bait station (Pest Control Research Ltd)	\$28.18 each	Possums and rats
CKD bait station (Pest Control Research Ltd)	\$2.01 each	Possums
Sentry Bait Station 200 g possum/rat bait (Pest Control Research Ltd)	\$8.63 each 300 ⁺ = \$8.05	Possums and rats
Pre-feed – Ferafeed 213 Paste 10 kg (Connovations Ltd)	\$74.75	Possums and Rats
Feracol Paste 10 kg (Connovations Ltd)	\$799.25	Rats and Possums
Pestoff Rat bait 10 kg (0.05g/kg diphacinone pellet bait) (Pest Control Research Ltd)	\$80.25	Rats

12. Control using toxins and trapping

Given the size of the Reserve we recommend a combination of trapping and toxins as the preferred strategy to control all key pest species in the Reserve. This requires an initial control programme of trapping aimed at possums, mustelids, hedgehogs and, possibly, cats, followed up with diphacinone for rodents. We summarise the control plan as follows:

- Sentinel/Trapinator traps targeting possums in a 100 m x 100 m trapping grid (1 trap/ha). Initially, traps should be checked monthly until target densities are achieved and then control could focus around bird breeding times (August-January).
- A combination of DOC250 traps targeting ferrets, rats, stoats and hedgehogs, and Timm's, targeting cats, in a 400 m x 1000 m trapping grid (1 trap/40 ha). Initially trapping with weekly

checks and then ferret traps should be checked, with bait replaced weekly, between January and May, and monthly, between June and December (NPCA, 2015e). Stoat control may need to be throughout the year, depending on the resource being protected, with a focus on late summer through to autumn.

- Drain coil (or PVC pipe) bait stations targeting rodents using 100 m x 50 m grid (2 bait stations/ha). Initially, with continuous baiting and then pulse baited three times a year to maintain low rat numbers, with a focus around bird breeding times.

Costs of toxins and trapping:

Task	Estimated cost of materials
Establishment of the trapping grid possums - 1 traps/ha	Traps = \$37.38 (Sentinel) Track Markers =\$3.68
Establishment of trapping targeting ferrets (but will also trap stoats, rats, cats and hedgehogs)- 1 trap/40 ha	Traps = \$56.93 (Timm's) - \$149.50 (DOC 250) each Track Markers =\$3.68
Establishment of the bait station grid for rodents -2 bait stations/ha	Bait stations = between \$17.26 - \$56.36 Track Markers =\$3.68
Three bait pulses for rodents	500g Feracol paste = \$39.96 1 kg Diphacinone (Pestoff Rat bait) = \$8.25

13. Monitoring

It is also recommended that any control programme integrates a surveillance programme to monitor possums, rodents, mustelids and feral cat population trends over time. Monitoring is an essential part of pest control and needs to be undertaken before the initial control work and then post-control to measure if the targets have been achieved (Thomas, 2005). Monitoring is best carried out using a multi-species approach according to best practice from the Department of Conservation and the National Pest Control Agency. Key native species, as outlined in the introduction, could be also used in a monitoring programme as indicator species for measuring the success of recovery.

Monitoring is essential to:

- Measure the effectiveness of current pest animal control regimes on the Reserve;
- Identify changes and trends in pest animal populations over time;
- Provide information to determine when control operations need to be repeated so the key native species remain protected. The trigger level (e.g. 10%) will initiate further control to protect key native species;
- Gain a better understanding of pest animal population dynamics in the ecosystem; and
- Identify changes and trends in the native species populations over time.

Monitoring Methods

Possums:

Best practice for possum monitoring recommends the use of chew cards (NPCA, 2015a). Chew cards are a recent development evolved from wax blocks and wax tags, as a low cost tool for monitoring the relative abundance and distribution of small mammals (Sweetapple & Nugent, 2011). Tooth marks on the chew cards are identified and assessed for the presence-abundance of pest species to provide an index of each species' relative abundance (Jackson et al., 2016). Chew cards can also be used for other species, such as rodents, hedgehogs, mustelids and cats (LandcareResearch, undated-b). Chew cards are efficient at mapping the distribution of pest animals at low densities (Sweetapple & Nugent, undated). They are easy to deploy as they are small and light weight compared to traps, with only two visits required. Chew cards are baited with peanut butter or commercial baits, such as Connovation's "smooth in a tube".

Chew card monitoring lines need to be 200 m long with chew cards at 20 m spacings; i.e. 10 chew cards/line (NPCA, 2015a). The protocol from NPCA (2015a) gives information on determining the number of lines and placement needed. Initially, monitoring needs to be undertaken prior to control

to establish the pre-control abundance of possums and, post-control, to measure the effectiveness of the control; i.e. whether the operation has reduced possum abundance to target density. Best practice recommends monitoring lines to be run over seven nights annually in late winter (NPCA, 2015a). The chew card bite mark (CCI) index is a standardised possum monitoring method used to assess the possum population density as expressed as a percentage; this can also be applied to other species (see NPCA 2015a).

Possum Chew card lines can also be used to monitor cats using chew cards filled with fish-based bait) every third Chew Card (i.e. 300 m spacing). Landcare Research provides identification guides to interpret the tooth marks of animals on the chew cards (LandcareResearch, undated-b; Sweetapple & Nugent, undated).

Costs of Monitoring:

Monitoring equipment (Supplier)	Cost, including GST	Target pest
100 baited chew cards (Pest Control Research Ltd)	\$40.25	Possum
Track Markers (Pest Control Research Ltd)	\$3.68	

Rodents and Mustelids:

Tracking tunnels are commonly used to index rodents and mustelids (Gillies, 2013). Information can be gathered on a variety of animals that pass through the tunnels. This is a non-destructive sampling technique so does not impact on the target or non-target species.

There are a number of tracking tunnels available of varying sizes. Te Anau DoC provides a design to make your own; Gotcha Traps Ltd (Black Trakka®); Pest Control Research Ltd and Philproof Pest Control Ltd (Philproof Monitoring Tunnel), are the main suppliers. The national standard for using tracking tunnels to monitor rodents and mustelids is set out in ‘DOC tracking tunnel guide v2.5.2’ (docdm-1199768). Best Practice documentation is available through DoC with four useful documents: a tracking tunnel calculator; a tracking tunnel guide v2.5.2; a standard inventory; and a monitoring project plan. DoC and Landcare Research also provide documentation of various small mammal prints.

Monitoring lines usually run with 10 tunnels set at 50 m spacing for rodents and five tunnels set at 100 m intervals for mustelids. It is possible to use the same lines for rodents and mustelids (Gillies & Williams, 2013). NPCA (2015e) and Gillies and Williams (2013) provide information on determining number of lines needed. Best practice suggests tunnels to be set out at least three weeks (or longer for mustelids) prior to the first monitoring session (Gillies & Williams, 2013). Monitoring of rodent abundance should occur at critical times of the year, such as bird breeding seasons and/or after control operations. We recommend that the minimum number of monitoring sessions is four times per year; e.g. February, May, August and November (Gillies & Williams, 2013); however, more frequent monitoring (e.g. once a month or every two months) will give a better picture of any gross fluctuations in relative abundances (Gillies & Williams, 2013). Mustelid monitoring should also ideally occur once per season (Gillies & Williams, 2013). The peak time for stoat activity is over summer and monthly monitoring in November, December, January and February should pick up any population pulses (Gillies & Williams, 2013).

Costs

Monitoring equipment (Supplier)	Cost, including GST	Target pest
Tunnels (Pest Control Research)	\$9.78	Rodents, mustelids
Removable cards(Pest Control Research)	\$0.98	Rodents, mustelids
Tracking Ink (Pest Control Research)	\$29.90	
Track Markers (Pest Control Research Ltd)	\$3.68	

Biota Monitoring:

This section, although not part of the brief, has been added to give some options that could be used to monitor the recovery of the Reserve following pest control. Where funds and the time for monitoring are limited, intensive monitoring of a few key species can provide an indication of ecosystem recovery. For example, rare species, such as mistletoe or raukawa (*Raukawa edgerleyi*), or a more widespread species, such as tree fuchsia (*Fuchsia excorticata*) and mahoe (*Melicytus ramiflorus*), could be monitored for possum browse, growth and recruitment. Banks Peninsula weta could be monitored for age class distribution and site occupancy; tui and kereru could also be monitored for changes in abundance over time.

Techniques recommended are as follows:

- Five minute bird counts;
- Permanent plot vegetation monitoring;
- Seedling Ratio Index (SRI) monitoring to provide information on the understory response to browser control and as an indication of whether control effort needs to be altered;
- Foliar Browse Index (FBI) monitoring to provide information on canopy vegetation in response to possum control; and
- Weta hotels, artificial cover objects and pitfall traps to monitor the response of invertebrate and lizards to pest control.

Procedures for monitoring biota should be undertaken following best practice from the Department of Conservation's monitoring toolbox (see <http://www.doc.govt.nz/our-work/biodiversity-inventory-and-monitoring/>). Agencies, such as Formak, also have good information on vegetation monitoring (see www.formak.co.nz).

14. Recommendations

This plan recommends focussing on the following tasks:

- A combination of trapping and toxins is the preferred strategy to control all key pest species on the Reserve. This requires an initial programme of trapping aimed at possums, mustelids and cats, followed by pulsed baiting of diphacinone for rodents.
- Monitoring should be undertaken at regular intervals using chew cards for possums, with tracking tunnels used for rodents and mustelids, to determine the ongoing success of the control and to help determine when maintenance control needs to be undertaken.

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