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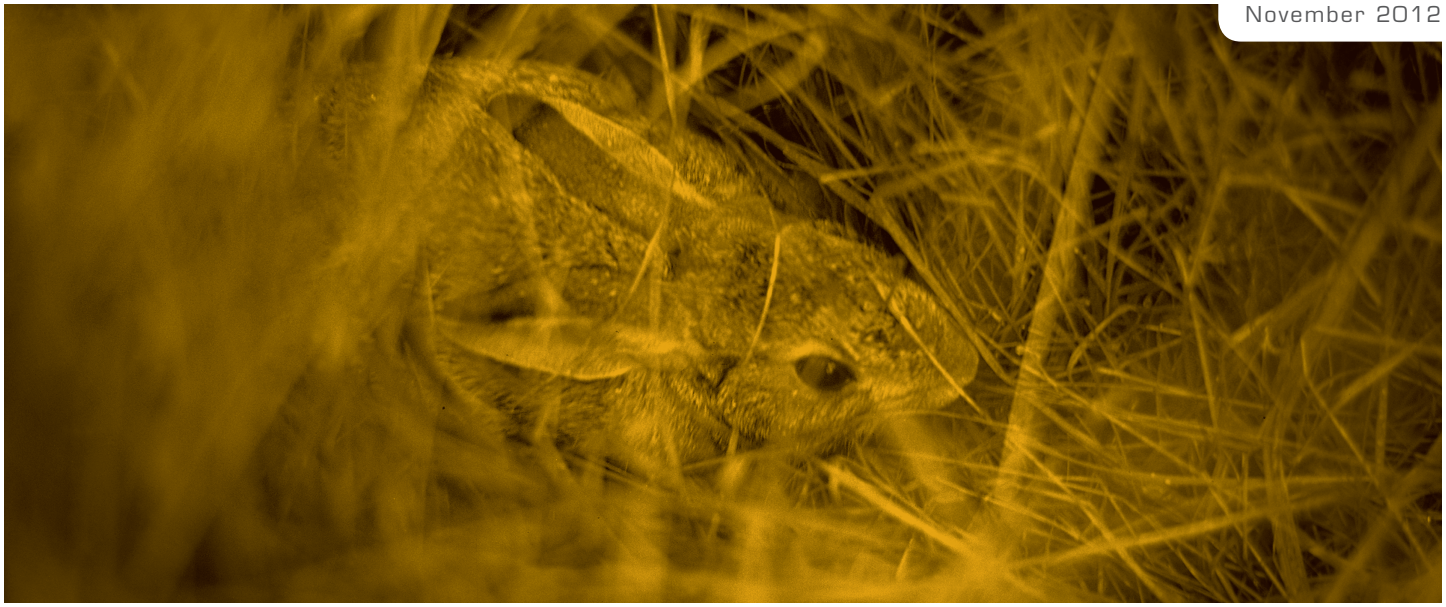

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PEST RABBITS

MONITORING AND CONTROL GOOD PRACTICE GUIDELINES

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National Pest Control Agencies

ABOUT NPCA AND BIONET

This document was published by NPCA (National Pest Control Agencies) which, until part way through 2018, provided a co-ordinating forum for agencies and stakeholders to address vertebrate animal pest control in New Zealand. In 2018 its role was transferred to the Ministry for Primary Industries under its Bionet brand.

PUBLICATIONS

Most of NPCA's publications on animal pest control were partially updated in April 2018 and transferred to the library section of the Ministry for Primary Industries' 'Bionet' online portal. The updates reflect the transfer and also acknowledge the change in the regulatory regime during 2017 and 2018, while not fully incorporating these changes in the interim, pending further reviews of the publications. Written by experienced practitioners, the main titles cover:

- best practice guidelines on controlling and monitoring vertebrate pests; and
- information about relevant regulations.

The transferred publications can be found at www.bionet.nz/library

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National Pest Control Agencies

PEST RABBITS

MONITORING AND CONTROL GOOD PRACTICE GUIDELINES

Published November 2012 (minor revisions April 2020)

Bionet and National Pest Control Agencies (NPCA)
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PART 1. INTRODUCTION

1.1 Purpose

This 2011 edition of *Pest Rabbits: Monitoring and Control Good Practice Guidelines* was commissioned, through the NPCA, by the regional councils' Biosecurity Managers Group to update and replace the previous 2006 edition.

The practical and regulatory aspects of rabbit control and monitoring have been updated in this edition to ensure current knowledge of good practice within the pest control industry is freely available. This standardisation of best practice is expected to contribute to the efficient implementation of Regional Pest Management Strategies for the control of rabbit populations.

The primary audience is council field staff and contractors who are responsible for designing, undertaking and reporting on rabbit control and monitoring.

The guidelines allow flexibility for ongoing innovation and for tailoring operational design to local needs.

1.2 Scope

Regional councils have primary responsibility for rabbit control in New Zealand. At the strategic level, policies and goals are set in each region's Regional Pest Management Strategy. These goals are then pursued via Annual Plans, which dictate when and where control and monitoring will be carried out. This good practice document is not intended to provide guidance on decisions at the strategic and annual planning level.

Based on the Annual Plan, staff and/or contractors will be allocated specific responsibilities for the control and monitoring of rabbits. This will involve the three stages of preparation, fieldwork and reporting. These stages constitute the scope of this document.

The degree of detail is variable. A safe handling procedure for off-road motorcycles may be required, for instance, but such generic requirements are not included. Best practice elements pertaining specifically to rabbit control are presented.

A number of other Bionet guideline documents exist, which support and expand on various elements of these guidelines. These related documents can be downloaded from www.bionet.nz and include:

1. *Aerial 1080 Pest Control Industry Guidelines,(Bionet publication code B9)* **(temporarily unavailable at time of writing)**
2. *Aerial 1080 Control of Possums and Rabbits: Standard Operating Procedures for Regional Government,* (Bionet publication code:A14)
3. *Vertebrate Toxic Agents - Minimum requirements for the safe use and handling of vertebrate toxic agents,*(Bionet publication code B2)

1.2.1 Updated edition

This 2012 edition updates the previous 2011 edition. Changes relate specifically to the Modified McLean Rabbit Infestation Scale, which has been updated in section 4.2 to version1.0 adopted by the New Zealand Rabbit Coordination Group in October 2012. All references to the Modified Mclean Scale in this edition refer to the 2012 scale.

1.3 Layout

This document is divided into four parts:

2. **Introduction**.
3. **Biology and Impact as a pest species.** The biology and habits of rabbits are presented and provide a basis for the nature and timing of control and monitoring. Impacts on primary production are discussed.
4. **Control**. Good practice guidelines are presented for operational preparation, field deployment, and reporting.
5. **Monitoring**. Good practice guidelines are presented for design, deployment and reporting of monitoring.

1.4 Acknowledgements

Thanks to the expert working group involved in the preparation of these guidelines.

We respectfully acknowledge the Rabbit and Land Management Programme, the late Jim Bell, Dr Morgan Williams and Don Ross, whose development of the ‘Rabbit Managers’ Fact Pack’ provided much of the basis for this document.

PART 2. BIOLOGY AND IMPACTS OF RABBITS

2.1 Biology of the Rabbit *Oryctolagus cuniculus*

Rabbits of European or Australian origin were released in New Zealand during the 1850s. By 1876, numbers had increased and were widespread enough to cause concern in some areas. Rabbits spread rapidly and numbers peaked in 1890. Rabbits competed for grazing, causing disastrous reductions in sheep numbers for many property holders. Rabbit numbers have fluctuated since, with peaks in the 1920s and in 1946, after World War II.

Rabbits of both genders are alike but females ('does') have narrower heads. Coat colour is mainly buff sprinkled with black, a reddish neck, white underparts and black fur on the upper tail with white below. There is much colour variation in body fur, from white to light sandy to black. Length of adults is up to 400 mm and weight is 1400 to 2500 gm.

Rabbits commonly occur in areas of lighter soils; in open country, among scrub, in rocky places and in plantations. Good rabbit habitat has less than 1000 mm of rain per year, a sunny aspect, light soil, good drainage and shelter.

Rabbits live in colonies or warrens with a strict social hierarchy. Warrens can be extensive and consist of an interconnected system of burrows with several entrances. They can also live above ground in dense scrub or rocky terrain.

They are nocturnal and active in twilight, spending most of the day below ground and emerging above ground in the late afternoon.

Home range is 2-3 hectares, with males tending to have a larger area. They make well marked runways and deposit faeces or urine at communal latrines or in mounds (known as buck heaps).

Rabbits re-ingest special faecal pellets, principally during the day. These soft pellets are small, dark and membrane-covered, and are swallowed whole from the anus without breaking the membrane. Inside the membrane there is a high bacterial content and undigested cell walls of plant food grazed by the rabbit. The bacteria continue to ferment the vegetable content until the membranous wall dissolves and the contents mingle with the freshly ingested plant material. This releases phosphorus, sodium, potassium and lactic acid to aid digestion and nutrition. The process is similar to rumination in sheep and cattle.

Daily food requirement is approximately 500 gm wet weight of vegetable matter. They can survive on a fibre content of 30% but require green growing feed for reproduction.

Under favourable conditions, rabbits breed throughout the year. On semi-arid lands the main breeding season is spring to early summer.

Gestation is 28-30 days, and young are born in a specially prepared burrow chamber ("stop") lined with grass and with fur plucked from the mother's belly. The female usually becomes pregnant within 12 hours of giving birth and may produce three to seven litters in a year.

Average litter size is 5-6. Changes in the length of the breeding season between regions affect the potential number of young born per female. Where there are more improved pastures, breeding will be almost continuous through the year, with a potential 37 – 47 births per female per year. In the drier, less productive areas of Central Otago, breeding is concentrated over a short period and a potential 23 potential births per female per year.

Pregnant rabbits can reabsorb embryos, usually when pressure of numbers begins to limit resources. Embryos are absorbed at about mid-term over a period of 2-3 days. It is part of the complex self-regulating fecundity mechanism of the rabbit. This process is less wasteful than abortion as the reabsorbed material is recruited into the doe's reserves.

The kittens are born hairless, blind and deaf. At one week they are furred, with eyes open and claws and incisors evident. Weight is 30-40 gm at birth, and 300 gm at 3-6 weeks. The female suckles the young once a day for about 30 days after which they can look after themselves. Initially the doe closes the burrow (breeding stop) at each visit but as her young grow she leaves the nest open. Growth of the young continues for nine months and sexual maturity is reached at 3-4 months.

Average life expectancy for feral rabbits is 18 months, though in captivity they can live up to eight years. In North Canterbury and Hawke's Bay most wild rabbits die in the first 18 months. In semi-arid areas, 5-30% of samples collected in winter were over two years old.

The most likely causes of mortality are coccidiosis, RHD (Rabbit Haemorrhagic Disease), predation and drowning. Young rabbits of up to three months of age are extremely susceptible to coccidial infection, but infection levels are low by seven months. RHD can cause significant mortality after ten weeks of age. Predation is by cats, ferrets, stoats, weasels and harrier hawks. The extended rabbit breeding seasons in most areas provides abundant prey over a long period to support a high density predator population. In the semi-arid regions, predator numbers and their potential to regulate rabbit populations is reduced due to the restricted rabbit breeding season of a few months, the lack of alternative prey and the harsh winters.

Pasture damage

Common latrine

2.2 Impacts

In high numbers, rabbits cause a great deal of damage to pasture, field crops, vegetables and trees by gnawing and nibbling shoots and bark. Soil erosion (water and wind) becomes a problem, especially where areas of bare ground are created by intense rabbit grazing.

It is estimated that 10-15 rabbits eat the same amount of grass as one sheep.

At high density (perhaps 50 rabbits per ha) rabbits reduce pasture to a short sward and woody species become dominant. Rabbit mortality is high at this density during winter.

Some sensitive ecosystems such as sand dunes and semi-arid systems can suffer from the effects of rabbits. One indirect effect includes acting as a food source for maintaining predator populations which have adverse effects on biodiversity values. Similarly, restoration plantings may not establish in the presence of rabbits. Rabbits eat plants in vegetable and flower gardens, as well as small trees. Rabbits may also ring-bark trees by chewing off the bark.

A rabbit-chewed fence post (image courtesy D. Grueber).

PART 3. CONTROL

3.1 Management Options

Integrated rabbit management combines natural mortality, pasture management and various control strategies to regulate rabbit numbers.

There are three principles in an integrated rabbit management system:

- the rabbit is part of an ecosystem;
- the presence of rabbits does not necessarily constitute a pest problem;
- all possible control strategies are considered and the most appropriate selected.

There are no hard and fast rules to solve all rabbit problems. The first step is an analysis of the rabbit problem in the context of the whole property management system.

One technique that is useful is a seasonal profile where the events in the property management calendar (e.g. pasture growth, stock use, planting etc). for each block or combination of several blocks are drawn graphically in conjunction with the ecology of the rabbit and weather patterns. Each event is placed on the same time scale in a separate diagram and arranged under each other. This enables the events for one season or month to all be seen at a glance.

Identify at which stages of the rabbit life cycle various control strategies are most effective. For example, the best time to control rabbits with poison is when they are at their lowest density, in poor condition, least territorial in their behaviour, and food supply is limited. Also be aware of ideal environmental opportunities for effective control as they present themselves e.g. a particularly cold hard winter.

Strategies that can be adopted include:

- **Do nothing.**
  If there are areas in which rabbits remain fairly static irrespective of control actions taken, and impacts are low, no action may be required.
- **Biocide Control.**
  Rabbit Haemorrhagic Disease (RHD) is established in New Zealand and has had significant localised effect. The disease can be applied as a biocide for localised rabbit control. An agreed national protocol determines the use of RCV biocide (Rabbit Calicivirus Suspension) in New Zealand, and this protocol is presented in Appendix One. However, given RHD is now established across most of New Zealand, with RHD immunity relatively high, this option is of limited value.
- **Eradication.**
  In specific locations with clearly defined and permanent boundaries that prevent influx of fresh animals (e.g. islands), elimination of the resident population may be feasible, particularly if a high-value resource is at stake.
- **Change the land use.**
  Certain land use enterprises (forestry, for example) are not favourable for rabbits. Once

the trees completely mask the ground and eliminate pasture and weeds, rabbit habitat is confined to the forest edges.

- **Change the farm management.**
  The farming routine for different parcels of land may favour rabbits. For example, grazing a rabbit-prone block in the spring may keep the pasture sward at the best height for rabbits and increase the survival of their young. Spelling that block at the favourable pasture growth time should lower young rabbit survival.
- **Change the habitat.**
  Rabbits need areas for food, areas to breed, and areas for refuge in adverse events. Altering the habitat will have a permanent effect on the rabbit population's ability to survive in a given area, whereas attacks on individual rabbits do not have a permanent effect on the population. Habitat change can be removal of cover, subdivisional fencing for easier stock management or future control, growing crops etc.
- **Exclusion.**
  Areas that are favourable to rabbits that are difficult or expensive to control may be fenced off, and simply left or the fences used as barriers to make control action more effective.
- **Repellents and tree protectors.**
  High value plants can be individually protected with commercially available repellents or tree protectors. Many nurseries can supply seedlings with tree protectors already fitted.
- **Control.**
  At the policy level, the management options can be either:

  (i) ***Intermittent control*** at a relatively high cost per treatment, when rabbit density reaches a defined threshold, or when impacts on a resource become significant; or

  (ii) ***Sustained control*** at a lower cost to keep rabbit density well below these thresholds.

Control strategies are decided within the context of the property, though some consideration should be given to co-ordination with adjacent properties. The control choices are listed below, and more information about each given in the following subsections:

- nightshooting;
- fumigation;
- poison baiting;
- biocide baiting;
- trapping;
- ripping burrows.

3.2 Night Shooting

Night shooting is a reasonably efficient technique for killing rabbits and can be undertaken throughout the year as required. Often three passes are needed for control to be achieved, and at least 70% of the area must be accessible before contemplating night shooting. Night shooting tackles the rabbit population at a time when they are above ground feeding. Night shooting is also a useful monitoring technique to allow problems to be noted and dealt with if shooting is not making headway.

Factors affecting night shooting include:

1. Rabbits feed actively in the early evening but intermittently later in the night.
2. Young rabbits react more unpredictably to noise, and don't stray far from cover or their burrow. They are therefore less likely to be shot.
3. Bad weather, heavy rain, strong winds and hard frosts all reduce rabbit emergence and consequently shooting efficiency falls off. In light rain, rabbits feed normally but don't run as readily.
4. Full moon makes shooting difficult as rabbits can see the shooter and don't hold in the light as well.
5. Previous night shooting can make rabbits wary, as they react to the sound of a gun shot or to the beam of a spotlight.
6. Stock, cattle, horses and sheep can move in front of the night shooting team and frighten the rabbits away.
7. Night shooting becomes inefficient at higher rabbit population densities.

3.2.1 Pre-Operation

Before proceeding ensure you have:

- been trained in nightshooting;
- a firearms licence;
- a permit issued by the Police Department, (with the issuing officer ranking higher than Police Inspector), to carry a loaded firearm in or on a vehicle, under the Land Transport (Road User) Rule 2004, rule 7.211;
- a current car/motorcycle licence (except for portable (i.e. on foot) night shooting or an entirely off-road night shoot);
- permission of the land occupier where the shoot is to occur;
- advised local Police if shooting on public or peri-urban land.

Equipment you will need:

- First Aid kit;
- 406 EPIRB personal locator beacon (preferably a GPS model)
- GPS, preferably map capable if required;
- earmuffs/plugs;
- tool kit;
- handheld radio telephone or cell phone subject to coverage;

[1] Given that the definition of "road" is broad and includes anywhere to which public may have access, whether as of right or not, it is advisable that this requirement is either met or discussed with the Police Department in all cases. In some jurisdictions private land would not be considered to fall into this category but reserves, beaches etc. would.

- high visibility clothing - white overalls are sufficient;
- secure lockable storage for firearms. Do not leave firearms locked in vehicles overnight;
- helmet-mounted spotlight. Various spotlights are used but all should be relatively light, not reflect back into the operators' eyes, switchable, compatible with the power source and have spare parts readily available. Lights that can swivel are most commonly used instead of a set angle which can cause eyestrain after a while;
- appropriate firearm. If possible both a .22 and a shotgun should be carried. Both have advantages and a motorcycle can carry both on either side of the forks. Sight in your firearm during the day;
- a scabbard fixed in a down pointing direction on a motorcycle (along front forks) or ATV (all terrain vehicle);
- when motorcycle night shooting, ensure that the motorcycle headlight is working and set on low beam. Headlights show up ground form features such as ditches and logs by casting long shadows. Head-mounted spotlights flatten ground form features because of elevation, masking potential hazards such a dips and hollows;
- carry a torch and/or spare sealed beam unit/halogen bulb;
- enough ammunition to do the job x 150%.

Notify all landowners and neighbours. Discuss the operation with the landowner and confirm hazardous areas e.g. tracks, bridges, creek crossings, fences, drains and stock etc. Notify Police and Local Authority when there is an intention to shoot within or close to urban or public areas.

Inspect all properties in your planned shooting area during daylight hours. Identify and locate hazards (houses, sheds etc). Work out a suitable safe route (be familiar with your areas). Identify and confirm both your own and your buddy's work routes and the required time it will take to complete these. Routes may be recorded to a GPS (preferably map capable) so they can be easily followed later, however, the route should vary according to prevailing wind or other conditions, and shooters should be prepared to alter their route to suit. If possible, ensure radio or cell phone communication or, if that is not possible, arrange a suitable time and place to meet during the night.

Motorcycle night shooting is the favoured method to transport a shooter into a position where he can despatch rabbits. The major benefits of motorcycles over 4WD vehicles are manoeuvrability, quietness, economics and that they invariably cover the area more thoroughly. Motorcycles are usually transported to the place of work on specially modified trailers or utes.

Portable (on foot) night shooting may be a good option in some instances.

Typical night shooting setup. The shooter is also equipped to continue on foot.

3.2.2 Operation

Always observe the seven basic safety rules of firearm use:

1. Treat every firearm as loaded.
2. Load the firearm only when you are ready to fire.
3. Always point firearms in a safe direction.
4. Identify your target.
5. Consider your firing zone (especially at night).
6. Store firearms and ammunition safely.
7. Avoid using alcohol or drugs when handling firearms.

Furthermore, observe the following when night shooting:

- Always work separately, but preferably with a partner (one person, one area).
- Know your partner's intended night shooting route and estimated positions, and keep in regular communication by phone or radio if possible.
- Always carry warm waterproof clothing and good boots, not gumboots. (Be prepared for poor weather conditions).
- Check the weather forecast.
- Be familiar with your route.
- Arrange radio or cell phone for distress communication.

- Carry sufficient battery power to ensure your equipment will operate for the full duration of your route.
- Have a pre-arranged meeting time and place at the end of the night.
- Ensure batteries are carried in a properly protected carrier or box (some type of sealed battery is safest).
- Never discharge a firearm from a moving vehicle.
- Don't take risks with your vehicle at night. Only go where you know it is safe.
- When crossing fences, always place firearms through the fence first.
- When crossing streams, avoid rock hopping and, instead, always walk through the stream.
- Never run with a loaded firearm.
- Carry your First Aid Kit and EPIRB.

Sweep the terrain with the spotlight in a steady, side-to-side fashion, avoiding jerky movements. Do not shine the spotlight outside the effective shooting range. The spotlight often picks up the 'eye shine' first and the colour of the reflection from the eye indicates what animal is seen. Rabbits, hares and possums have a red-pink eye shine, sheep are yellow green, cats and ferrets are brilliant green and cattle large, saucer-like and red. The reflection is caused by a layer at the back of the eye (tapetum) which reflects light and is an adaptation in animals for 'seeing' movement at low light intensities.

Portable night shooting entails stalking rabbits at night on foot using a helmet-mounted light with the battery carried in a backpack or attached to a belt. Portable shooting is most useful in areas of limited access such as steep faces or rocky places. The same lights and battery are used for motorcycle and portable night shooting.

Thorough knowledge of the area is imperative. Always try to work into the wind when stalking rabbits. Work the cover areas and fence lines first, and then move into the open areas from the cover.

3.3 Fumigation

Fumigants are poisons that are introduced into a rabbit burrow system, to form toxic gases which are inhaled by the rabbit, causing death by absorption. Fumigation does not require the rabbit to eat a bait and so is effective in areas where bait shyness is a problem. It is labour intensive but can be used effectively in the breeding season to control young rabbits which, because of their small range, may not come across or feed on baits. *Baiting should not be undertaken during the breeding season*. Phosphine is most commonly used.

Phosphine is sold as pellets of magnesium phosphide (Magtoxin®). The pellets combine with water vapour in the soil or air to produce phosphine gas (hydrogen phosphide). Hydrogen phosphide is heavier than air and has a distinctive warning odour, pungent and unpleasant even at low concentrations. Rabbits that are exposed to the gas and escape may die up to a week later. It works well in soil temperatures above 15^0C, with over 10% soil moisture - the more moisture, the faster the gas liberation.

Guidelines for *safe* use of hydrogen phosphide gas:

- Read and comply with the LABEL INSTRUCTIONS and Safety Data Sheet.
- When handling tablets, always wear waterproof gloves.
- Always open the fumigant flask outside and only open the container for immediate use.
- In breezy conditions open the container with your shoulder facing the wind.
- Protect from moisture, open flames or heat and keep away from water.
- Do not breathe dust or fumes.
- During prolonged use, always wear a **suitable face mask** that will filter hydrogen phosphide gas.
- Do not eat, drink or smoke while using, and wash yourself thoroughly before meals and after work.
- Store in the original container (i.e. in which the pellets were supplied), tightly closed, away from foodstuffs and under lock and key.
- After using the content of a flask, there may be considerable dust residue. This should be disposed of by burying (e.g. placing it into the last burrow fumigated).
- Rinse, crush, and bury the empty container. Do not rinse containers which retain considerable dust residue (refer previous).

Procedure for fumigation

1. For rabbit burrows that are open and have obvious signs that rabbits are living in them:
    - cut a piece of turf to block the main burrow entrance;
    - check for and block all other entrances to the burrow or warren system;
    - carefully open the container in open air and downwind of the main burrow entrance. DO NOT breathe the fumes;
    - tip a tablet into your gloved hand (RESEAL THE CONTAINER) and place the tablet at arm's length down the rabbit burrow. For large burrow systems, allow 1 pellet for each cubic metre or as per label instructions. *One pill per working entrance is sufficient for a warren system*.
    - if the ground is very dry, place the tablet on a piece of wet newspaper to speed up the release of the gas;
    - block the entrance of the burrow with the turf (grass side facing inwards). Then proceed to fill the entrance of the burrow with loose earth and tramp down firmly to make the entrance airtight. If available, stone(s) can be used to block the entrance, sealed with earth over top.
2. If you find a burrow that is blocked with loose earth, open the burrow, fumigate and close it as described above. A burrow filled with loose earth is likely to have young rabbits within.
3. The next day check to see if any sealed burrows are open. If so, fumigate again and reseal.

Useful tip: having a dog running around is essential to encourage rabbits hiding above ground into burrows. A major cause of fumigation failure is rabbits above ground level digging holes after fumigators have left, allowing the gas to dissipate. Ensure the dog is restrained prior to fumigating to prevent accidental exposure.

Place the pellet at arm's length down the burrow (left) and then thoroughly seal the entrance (right).

3.4 Repellents and tree protectors

Repellents are primarily used for protecting tree and shrub plantings from browsing by rabbits and hares. As well as reducing or preventing damage to the plant, the repellent must have no adverse effect on it. A number of commercial repellents are available. Most repellents will need to be applied periodically as effectiveness reduces. The following egg/resin adhesive repellent is also known to be effective:

1. Mix egg (whole or powdered) in the following proportions:
    - five eggs plus 600 ml water, or
    - 80g egg powder + 800 ml water.
2. Mix egg solution with 150 ml acrylic paint (e.g. 150 ml Primal AC 235 acrylic resin).
3. Spray approximately 20 ml of the mixture on and around each seedling immediately after planting.
4. A second application may be needed in the spring.

For longer term protection or higher value trees, tree protectors may be a better option. Many nurseries can supply seedlings with tree protectors already fitted.

3.5 Fencing

Effective fencing will slow the recovery of rabbit populations after control, or allow localised eradication to protect a high value resource. Deem's 1914 fencing specifications for corner posts and mesh size are still appropriate today.

> *"Following a good poisoning, reinfestation from adjacent land was a problem until fenced. Mesh was 1½ in [40 mm], 16 gauge [1.3 mm] in 42 in [1 m] wide rolls, buried 6 in [150*

mm] into the ground. Trappers were used after the fences were erected, followed by pick and shovel to destroy the warrens and burrows".

Small mesh netting with a diagonal measurement of approx 40 mm is recommended for clipping to existing or new fences to impede rabbit movement between areas. To rabbit-proof the fence the bottom of the netting should be buried approx 150 mm in the ground or turned onto the surface and packed with stones or earth to hold it down. This prevents rabbits from burrowing under the fence. It is essential that the netting is laid uphill and/or towards the expected rabbit pressure.

Gates should be swung close to a concrete, railway iron, or board sill buried in the gateway so that rabbits cannot wriggle underneath.

Fences should be checked and repairs made at least annually, or as necessary. Regular maintenance will reduce the need for periodic expensive rebuilding and keep the fence in a stock-proof condition.

Rabbit-proof fence (image courtesy D Grueber.)

3.6 Habitat Change

Rabbit populations are more vulnerable to a manipulation of their habitat than they are to a direct manipulation of their numbers.

Where a rabbit population has been reduced by control measures such as shooting or poisoning, the survivors do not have to contend with a deteriorating habitat. The reduction in numbers leaves the quality of the resources used by rabbits intact, while increasing the quantity available to each surviving animal.

Removal of vegetation is one form of habitat modification. Often the clearing of, for example, briar and gorse will improve control results.

Pasture improvement through introduction of new pasture species and better fertility has worked well in the wetter parts of New Zealand. The stop/start nature of pasture growth in the semi-arid lands mean that long wet pasture conditions are too infrequent to encourage debilitating diseases such as coccidiosis.

Warren ripping is another form of habitat modification. Following control efforts, existing warren systems need to be destroyed to prevent rapid re-establishment of the rabbit population. The development of extensive warren systems is less common in New Zealand than overseas, however, and warren ripping does not necessarily prevent re-establishment. For instance, ripping was carried out extensively during the 40s to 60s in Central Otago, with many rabbit control boards owning their own bulldozers to do so; yet, warrens have still developed in the same areas. This is due to two reasons: (a) the area is the best spot for a warren, and (b) ripping loosens the ground and makes digging easier, which makes it even more attractive to rabbits.

3.7 Trapping

Leg-hold trapping is useful for dealing with small numbers of rabbits where alternative techniques are not viable. Effectiveness depends on the skill and experience of the operator.

The Animal Welfare Act 1999 requires that traps are checked within 12 hours of sunrise, and for rabbits this should be as early as possible.

The Animal Welfare (leg-hold traps) order 2007 applies and this effectively means only No.1 double coil spring traps, or No 1.5 padded double coil spring traps may be used. The use of gin style long spring traps is prohibited. It is further prohibited to use any trap within 150m of a dwelling without the occupier's written permission, or anywhere that capture of pets is likely.

The gin trap with its larger trigger plate, and tendency to 'jump up' when triggered made it the preferred choice for rabbit trapping. Now that these traps are prohibited, rabbit trapping is rarely done. However, the principles are presented below. The padded No. 1.5 is probably the most suitable trap for this purpose.

Traps are set where there are signs of rabbits, scratches or accumulations of droppings. They can be set at the entrances to burrows or stops. A trap is set by digging a hole suited to the trap size, and 5 cm deep. All the fine soil is piled in the front of the hole. The set trap is

placed in the hole after the peg and chain have been stretched back to one side of the hole and hammered in. The soil surface under the trap must be level, free of obstructions and must not inhibit the trap mechanism. The pan is supported by the trapping pin or a finger, a small square of paper placed over the catch but not the jaws and fine soil from the pile in front of the trap scattered over the pan. The minimum of soil is used over the jaws so that the movement is not impeded.

Setting two traps (double trapping) minimises the chances of a trapped animal escaping. Two traps are set in the manner described, close together, so that when pegged neither trap can touch the other. If one trap catches an animal and it tries to escape, then it encounters another trap and is securely held.

Check traps early in the morning. This minimises the chances of trapped rabbits being 'legged', i.e. escaping but leaving a leg in the trap. Approach rabbits from behind, grasp by the loose skin on the flank or back and kill them quickly and humanely (generally by breaking the neck).

Heavy rain during the period traps are set has an adverse effect on catch rates. Soil can wash under the plate and stop it springing the trap.

3.8 Poison Baiting

The Bionet publication, *Vertebrate Toxic Agents (VTA) - Minimum requirements for the safe use and handling of vertebrate toxic agents* (available under publication code B2 at www.bionet.nz) complements this document, and is recommended reading for all aspects of toxin use.

The *Aerial 1080 Pest Control Industry Guidelines* **(temporarily unavailable at time of writing)**, and the *Aerial 1080 Control of Possums and Rabbits: Standard Operating Procedures for Regional Government* (available under publication codes B9 and A14, respectively at www.bionet.nz) should be consulted where aerial 1080 control is contemplated.

WorkSafe NZ is the primary source of information on controls relating to VTA's https:// worksafe.govt.nz/topic-and-industry/hazardous-substances/guidance/substances/vertebrate-toxic-agents/

3.8.1 Timing

The optimum time to poison rabbits depends on their breeding condition and the effects of this on territoriality. Natural food sources should be at a minimum.

August to February is the main rabbit breeding season and poisoning during this time is difficult due to territorial behaviour and, typically, an abundance of natural food. Also kittens 14 days old and over, while unlikely to eat poison bait, are capable of feeding on grass should their mother be poisoned.

March to August, immediately prior to breeding, is the optimum time for poisoning. The population is at its lowest from other mortality factors and, moreover, the potential of every female to produce many offspring is eliminated with every female killed.

Poisoning programmes may be conducted in February to April, dependant on property management constraints or control agency resources. Good results can be obtained where food constraints exist (e.g. drought conditions) and as long as there is no breeding activity. Oats, paste or pellets are preferred baits at this time.

3.8.2 Choosing a Baiting Strategy

Various options of bait type, toxin and application method are available.

Bait type

- ***Carrot***. Carrots are the preferred bait and generally used in the winter. They are available most of the year and certainly between April and September, though they cannot be stored for long periods.
- ***Oats.*** Oats may be used February to April, provided that weather conditions are dry. Oats are not widely used these days but may be used for aerial control subject to an adequate level of bait acceptance being established. Oats can be effectively applied to ploughed furrows where ploughable access is at least 80%.
- ***Pellets.*** Cereal based pellets are readily available and store quite well. Results can be variable with ground and aerial application if the environmental conditions are unsuitable. Ground moisture can be absorbed by the pellets making them less palatable.
- ***Paste.*** Paste bait can be readily stored, and allows rapid re-stocking as spits can be turned back. Paste is the only bait medium to which phosphorus can be incorporated. *Paste baits are also of variable results and generally only used in the North Island.*

Application Method

- ***Aerial*** (helicopter, fixed wing aircraft) Aerial application is efficient for larger areas, usually > 400 ha though smaller areas may be targeted where the rabbit population is restricted, or where the operational boundary is secure from re-invasion. See 3.8.12.
- ***Ground***-based broadcast
- ***Furrow***. See 3.8.9 and 3.8.10.
- ***Spit.*** See 3.8.9 and 3.8.10.

Poison

- ***1080***
- ***Pindone***
- ***Phosphorus***

1080 and pindone have different characteristics that affect the choice of when to use them. Where rabbit density is high, 1080 is most effective. Pindone is also suitable for use close to human habitation, or where prompt restocking is desirable.

3.8.3 Avoiding Bait Shyness

Bait shyness can be avoided when correct practices are used.

1. Use a range of techniques. Avoid poisoning the same area using the same bait or toxin at less than three year intervals[3].
2. Apply at least two pre-feeds except for:
   - Pindone carrot bait, for which only one pre-feed is recommended, or
   - broadcast pindone pellets, for which there is no pre-feed requirement
3. Apply toxic bait only when all pre-feed has been eaten. In the case of pindone pellets (where no pre-feed is required) apply two applications of toxin 7-10 days apart.
4. Apply enough bait (refer table in section 3.8.4).
5. Ensure bait is of the highest quality.
6. Never apply lure to bait.
7. Ensure the rabbit population is quiet, with no shooting for at least three months prior.
8. Do not disturb rabbits while the poisoned bait is laid for at least two days.

Control history is relevant. If previous control has been unsuccessful, shyness may be developing and an alternative poison and/or bait matrix should be used, subject to good bait acceptance.

3.8.4 Application Rates

The rate of bait disappearance indicates whether the bait application rate is correct. If it is eaten in less than three days, too little was applied. If bait is still present after a week, too much was applied or rabbits are not accepting the bait.

The table below shows recommended application rates for 1080 bait. Similar rates should be used for pindone bait.

	Medium Pop. Density (Modified McLean Scale 3-4)	**High Pop. Density (Modified McLean Scale 5-6)**	**Very High Pop. Density (Modified McLean Scale 7+)**
Carrot (aerial)	10-20 kg/ha	20-35 kg/ha	40 kg/ha
Oats (aerial)	6-10 kg/ha	15-20 kg/ha	20-40 kg/ha
Carrot or oats. Oats approximately half carrot rate (plough or furrow)	20 kg/km (40 m between lines). 0ne km of line equals 2.5 ha on average	25 – 30 kg/km (30 m between lines)	30-35 kg/km (20 m between lines)
Paste (plough or furrow)	3 kg/km (40 m between lines)	4 kg/km (30 m between lines)	4 kg/km (20 m between lines)

(*Table continued next page)*

[3] As pindone is a chronic poison, repeat usage does not lead to bait shyness. Experience in the Wakatipu demonstrated that repeat usage over a number of years did not lead to aversion during a subsequent 1080 carrot operation. (P Preston pers. com.).

Paste (paste gun and spit lines)	3 kg/km (40 m between lines)	4 kg/km (30 m between lines)	4 kg/km (20 m between lines)
Pellets (plough or furrow)[4]	4 kg/km (40 m between lines)	5 kg/km (30 m between lines)	5 kg/km (20 m between lines)
Carrot or oats (broadcast)	4 kg/ha	6 kg/ha	8+ kg/ha
Pellets	3 kg/ha	4 kg/ha	5+ kg/ha

(See section 4.2 for the Modified McLean Scale.)

3.8.5 Carrot Bait Preparation

The table varieties such as Chantenay, Egmont Gold, Koyo or Top Weight are preferred because they do not grow coarse or woody. Carrots are purchased in bags or loose in bulk.

Carrots should be freshly dug, without tops and as free of dirt as possible. Wash carrots just prior to cutting, because the washing process abrades the skin and speeds rotting. Under no circumstances may deteriorated bait be used for pest control.

The bags of carrots should be stacked in rows with gaps to stop them sweating. In bulk, they should be tipped onto a stone-free area with free drainage.

Carrot can be cut by hand (small quantities only) or by machine. Several machines are available with varying degrees of success in producing a regular shaped bait. Commercial dicing machines (e.g. Halde) have been fitted with petrol motors to dice carrots.

The Reliance is commonly used for large scale operations, producing 6-8 tonnes per hour. Gibson cutters are also used, especially for preparation of pre-feed bait. The less consistent size of baits produced by Gibson cutters means that losses during screening are rather high.

The target bait size for toxic baits is 6 gm *mean*, with 95% of baits weighing 3-9 gm. (This is a legal requirement for 1080 carrot bait). If required, a 16 mm screen is recommended.

3.8.6 Oat Bait Preparation

The best varieties are fat, white oats such as Oare, Markaru, Omihi and Owapuni. The grain must be in top condition, free of weed seeds, loose husks and dust. Purchase dressed oats to avoid contaminants.

Oats are a favoured bait because of the ease with which they can be stored. They should be stored in clean, dry, mouse and bird-proof silos or sheds. Other contamination from fuels, insecticides and fertilizers must be avoided. Silos of oats can be fumigated to kill unwanted insects and rodents. Phosphine is a common fumigant for this purpose.

Oats are lightly boiled to prevent germination. Boiling is also believed to improve palatability.

[4] An alternative view is that the bait application km of line should remain constant, with increased bait application being achieved only by increasing the amount of line per hectare (i.e. lines spaced more closely). The old maxim was “more line, less bait”. (P Preston pers. com.).

For small quantities, a large pot or a drum can be used, but the most common cooking vessel is a redundant pumice copper. Specialist machinery using hoists, steam from boilers or oil fired heaters have been designed to cope with larger quantities but the cooking principle is the same.

Place the oats in a covered cooking vessel and just cover them with water. Bring to the boil and add molasses at the rate of 0.5 L per 35 kg of oats. A little salt may also be added, which is thought to improve palatability.

Boil the oats for about 20 minutes. If the kernel pops out of the husk when squeezed between the fingers, they are ready. Drain off excess liquid and place on tables covered in fine steel mesh to cool them. They are then ready to be distributed as pre-feed or to have toxin applied. Judgement is needed as to how much molasses to add for cooking subsequent amounts of oats because some molasses will remain in any cooking liquid that remains in the cooking vessel from previous batches.

Use the oats as soon as possible after cooking as they ferment after about a day if kept in bulk. Do not use bait if fermentation has commenced (detectable by odour). In cool dry weather they may last up to three days if they are turned daily.

Always transport oats in clean, well aired containers or sacks. Regular washing and drying of the sacks will prevent them smelling musty or sour. Yeasts etc will readily grow in any molasses adhering to the sack.

3.8.7 Applying 1080 Poison to Bait

Refer to the *Aerial 1080 Pest Control Industry Guidelines* **(temporarily unavailable at time of writing)**, and the *Aerial 1080 Control of Possums and Rabbits: Standard Operating Procedures for Regional Government* (available at www.bionet.nz under Bionet publication codes B9 and A14 respectively) for guidance on applying 1080 to bait.

Ensure final bait product and toxicity comply with label directions. Toxic carrot bait should contain 0.2 gm/kg (0.02%) 1080, and oat bait should contain 0.4 gm/kg (0.04%) 1080.

Small quantities of bait can also be prepared on site using a motorised concrete mixer and pre-weighed and screened and cut bait. For example, two 20 litre polypails of cut carrot weigh approximately 26 kg (13 kg per bucket) and can be mixed with 260 ml of field solution (at 10 ml per kg of prepared bait). Baits should be turned in the mixture until uniformly green.

3.8.8 Applying Pindone Poison to Bait

The label instructions and a safety data sheet (SDS) must be available and complied with. Operators must have a Controlled Substance License for aerial or broadcast baiting..

Pindone is applied to carrot at a target rate of 0.17 gm/kg (i.e. 0.17% pindone). Carrot bait must be well screened. It is a legal requirement that no pieces with any dimension less than 16 mm may be included in the final bait product (not applicable when pindone bait is deployed in bait stations).

Prepared carrot bait is sprayed with a field solution at the rate of 10 litres per tonne of bait, similar to the process for applying 1080 to carrot. The field solution comprises (per 10 litres):

- 5 litres of pindone concentrate (34gm/l)
- 5 litres of water and dye mix.

3.8.9 Ground Application of Carrot or Oats

Refer 3.8.3 and 3.8.4 for pre-feeding, application rate, and bait disappearance specifications. For 1080 baiting at least two pre-feeds are required followed by a toxic application. Only one toxic 1080 application is ever appropriate.

Although pindone is a slow acting (chronic) toxicant, a light pre-feed has a significant benefit. Following pre-feeding, two toxic pindone applications should be applied 4-5 days apart.

Ground laying operations are generally undertaken on 'easier' country where the block is accessible to a motorcycle or 4WD vehicle. The bait is usually laid in a furrow made by a device that can plough the line and lay the bait in one operation or separately: usually a quad bike and bait feeder. On difficult areas where ploughing is impossible, baits are broadcast.

3.8.10 Ground Application of Paste

Paste is a very popular bait material in the North Island. It is used for much of the year, although results are inconsistent during the breeding season. In the South Island it is used in only a very few areas and mostly between June and September.

Advantages of paste include:

- can be stored and so is readily available;
- allows areas to be returned to production quickly;
- is useful for poisoning small areas, spits can be quickly made and turned back after a few days;
- it is more acceptable in areas close to habitation or built up areas.

Paste bait (0.06% 1080) is available from Animal Control Products Ltd. Single strength phosphorus is also used in exactly the same way as 1080 paste and is available from Animal Control Products. Phosphorus is less likely to be a problem in terms of secondary poisoning.

Baits are usually laid alongside a scratched furrow or on spits of earth turned up with a grubber.

1. Dig spits in a line across the block being poisoned.
    - The distance between spits should reflect the rabbit infestation (2-3 m for medium infestation).
    - The lines should be 40-50 m apart.
2. At least two pre-feeds should be laid on the spits prior to laying toxic bait. This increases the chances of rabbits eating toxic bait. There should be an interval of 2-3 days between pre-feed and toxic bait being laid.

- Bait size (1080 or single strength phosphorus) should be equivalent to 1 teaspoon. Only use un-lured paste.

Place baits in areas where rabbits feed, not right beside areas of cover where they hide. The latter is usual for very light, patchy infestations. The fresh earth line or series of spits attracts rabbits and allows the operator to see where he has been.

Various devices have been manufactured to apply baits to the ground. The most common is a cylindrical container with a spout at the bottom. A measured amount of paste is forced out by a spring loaded plunger. These paste 'guns' can hold about 1200 5-gm baits. They must be thoroughly washed after use, particularly if thickened paste has been applied through them as the paste ferments within 24 hours. This can impart a sour taste to subsequent paste applications.

The length of time baits remain toxic depends mainly on rainfall. Do not lay bait if heavy rain is forecast. Sunlight can form a skin over phosphorus baits, reducing the detoxifying effects of subsequent rainfall. In very hot conditions, phosphorus baits can spontaneously ignite.

After 5-7 days (or sooner if stock need to be returned to the block), uneaten baits should be buried by turning the spits back over and treading them down. Failure to do this is bad practice as it leaves sub-lethal baits in the field which may create problems with bait shyness later.

Paste gun.

Application of paste bait to earth spit.

Pellets on spit.

3.8.11 Ground Application of Pellets

Cereal based toxic pellets are available with either pindone or 1080. While not considered as effective as carrot bait, good results have been obtained subject to good bait acceptance and suitably dry conditions.

Field procedures are similar to carrot and oat poisoning. Pellets can be applied by either ground or aerial methods during dry conditions.

3.8.12 Aerial Application of Bait

The *Aerial 1080 Pest Control Industry Guidelines* **(temporarily unavailable at time of writing)**, and the *Aerial 1080 Pest Control of Possums and Rabbits:Standard Operating Procedures for Regional Government* (available at www.bionet.nz under publication codes B9 and A14) should be consulted where aerial 1080 control is contemplated. These documents contain detailed guidance for aerial application of 1080 bait.

Procedures for pindone are similar, but subject to the regulatory controls specific to pindone. The primary information source relating to use of VTA's is https://worksafe.govt.nz/topic-and-industry/hazardous-substances/guidance/substances/vertebrate-toxic-agents/

Aerial application of pindone carrot or oat baits is prohibited unless it is carried out by either the Department of Conservation, or a regional council, or a unitary authority. This restriction does not apply for manufactured pindone pellets.

3.8.13 Post Operation Reporting

To assist future management decisions in the area, prepare an operational report detailing:

- location of baiting area (map 1:50,000);
- dates of pre-feeding, and quantity of bait used;
- date of toxic baiting, quantity of bait distributed, and quantity recovered;
- weather conditions for each day;
- location of warning signs, dates deployed, and dates recovered;
- estimates of % kill (refer monitoring part 4 of this document);
- any other field observations that may have affected the operation;
- names of the approved handlers and CSL holders responsible for the operation.

PART 4. MONITORING

4.1 Monitoring Techniques

Monitoring of rabbit populations can be for three purposes:

1. To estimate percent kill after control.
2. To provide population trend data.
3. To establish whether some control threshold has been reached.

Two methods of rabbit monitoring are described: night counts and day inspections (using the Modified McLean Rabbit Infestation Scale 2012[5] shown in section 4.2, and referred to elsewhere as the 'Modified McLean Scale' in this edition).

Night counts can be used for all three purposes, but are not ideal for establishing whether some control threshold has been reached. Night counting is not a suitable method for assessing effectiveness of night shooting as both rely on the same basic technique.

The Modified McLean Scale is ideally suited to establish whether some control threshold has been reached. It has also been successfully used for regional trend monitoring. While trend monitoring using night counts provides a more sensitive measure, it is also more expensive. The Modified McLean Scale cannot be used to provide an estimate of percent kill because the scale is not linearly related to rabbit population density.

4.2 Design for Population Monitoring

4.2.1 Property Inspections

Pest managers need to reliably establish relative rabbit abundance to ascertain when some control threshold is reached. The Modified McLean Scale was developed to meet this need.

A number (1-10) is assigned, based principally on faecal pellet heap density and fresh rabbit sign. The scale has quantitative definitions for scores 3-5 and is, therefore, repeatable and relatively insensitive to operator variability.

For an informal assessment, the monitoring operator may simply traverse a property and assess a number of points over the property to provide an indication of rabbit abundance and distribution. However, where results are likely to be controversial (e.g. in an enforcement situation) or when a higher level of rigour is required for management purposes, a defensible sampling strategy should be deployed: - either random sampling or random systematic sampling (either may be used with or without stratification).

[5] All references to the Modified McLean Scale in this edition refer to the Version 1.0 adopted by the New Zealand Rabbit Coordination Group 12/10/2012.

Define the monitoring area on a map (no less detailed than 1:50,000). If the monitoring area has significantly different levels of rabbit density then it is advisable to stratify it into areas of similar densities, such as areas of significant change in habitat or topography.

For guidance on sampling techniques refer Bionet publication, code A1, *Possum Population Monitoring Using the Trap-Catch Method*, available at www.bionet.nz . For design and analysis purposes, the possum monitoring lines are equivalent to 'Modified McLean Scale Lines' of 5 assessment points each, spaced 50 m apart (for more detail refer section 4.3 herein).

The table below gives an indication of the number of assessment lines required per area.

Size of Block/ Property	Number of Assessment Points	Number of Assessment Lines
< 100 hectares	20 - 50	4 - 10
100 – 500 hectares	50 - 75	10 - 15
500 – 1000 hectares	75 - 100	15 - 20
> 1000 hectares	> 100	> 20

The Modified McLean Scale is set out below, with each score having its own specific description of rabbit infestation.

Modified McLean Rabbit Infestation Scale 2012

1	No sign found. No rabbits seen.
2	Very infrequent sign present. Unlikely to see rabbits.
3	Pellet heaps spaced 10m or more apart on average. Odd rabbits seen; sign and some pellet heaps showing up.
4	Pellet heaps spaced between 5 m and 10 m apart on average. Pockets of rabbits; sign and fresh burrows very noticeable.
5	Pellet heaps spaced 5 m or less apart on average. Infestation spreading out from heavy pockets
6	Sign very frequent with pellet heaps often less than 5m apart over the whole area. Rabbits may be seen over the whole area.
7	Sign very frequent with 2-3 pellet heaps often less than 5 m apart over the whole area. Rabbits may be seen in large numbers over the whole area.
8	Sign very frequent with 3 or more pellet heaps often less than 5 m apart over the whole area. Rabbits likely to be seen in large numbers over the whole area.

(**Note:** this scale is Version 1.0, adopted by the New Zealand Rabbit Coordination Group, 12/10/2012. All references to the Modified McLean Scale in this edition refer to this version.)

4.2.2 Percent Kill

Percent Kill monitoring utilises night counts. The same routes are counted for one night before the operation and again for one night after the operation.

For an informal assessment one (or a few) long route(s) covering most of the area of interest is sufficient to give an indication of % kill but without a 95% CI. However, where results are likely to be controversial, or when a higher level of rigour is required for management purposes, a defensible sampling strategy including a number of separate night count routes should be deployed: either random sampling or random systematic sampling (either may be used with or without stratification).

For guidance on sampling techniques refer Bionet publication code A1, *Possum Population Monitoring Using the Trap-Catch Method*, available at www.bionet.nz . For design and analysis purposes, the possum monitoring lines are equivalent to night count routes.

At least 5 independent routes of between 10 - 20 km are required for a reasonable sample. For smaller monitoring areas, fewer and shorter lines should be used as space allows.

If the monitoring area is to receive different control methods in different parts, then separate the monitoring area into strata based on the control methods being used. Further stratify where you expect significantly different rabbit densities, such as areas of significant change in habitat or topography.

4.2.3 Trend Monitoring

Trend monitoring can utilise either night count routes or Modified McLean Scale lines. For regional trend monitoring, the routes/lines should be randomly or systematically selected.

The number of lines or routes most affects the precision of the abundance index.

Night counting for more than 20 km along a route appears to have little effect on the precision. Similarly, counting for more than one night leads to little or no increase in precision. Therefore, the counts on each route will be made on one night only and routes longer than 25 km should be avoided. For a given effort, it is much more efficient to count more routes for one night, rather than count fewer routes on multiple nights

For guidance on sampling techniques refer Bionet publication code A1, *Possum Population Monitoring Using the Trap-Catch Method*, available at www.bionet.nz .

If the monitoring area has different habitats likely to contain significantly different rabbit densities, or sub-regional trends are needed, then separate the monitoring area into strata based on your criteria (e.g. only land below 1000 m with annual rainfall less than 500 mm). Divide the monitoring area into strata only where any one stratum makes up more than 10% of the monitoring area. The required number of routes/lines should be selected at random or at random systematically within each stratum. The total number of routes should be between 30 - 100 regionally. The majority of routes should be allocated to more rabbit-prone strata. For instance, if you intend to use 100 routes/lines then divide these into three rabbit proneness strata of high (n=60), medium (n=30) and low (n=10).

4.3 Field Technique Modified McLean Scale

For informal assessments, assess and record the Modified McLean Scale (see section 4.2) score at a number of plots across the property. The observer should cover all parts of the block/property to a point where all potential rabbit habitat can be scored. The minimum

number of plots scored should be 20 per block/property to allow for a robust assessment to be made. An observer assessing an average South Island high/hill property on a motorcycle covering 1000 ha/day should have approximately 100 plots.

Alternatively, informal inspections can be done on a continuous basis as the inspector passes through the block. Most of these inspections are assessments of whether or not a control operation should be carried out and, as such, targets likely rabbit habitat for assessment.

For formal assessments, where line start points have been independently selected, navigate to the line start coordinates using GPS. The monitoring line should traverse viable rabbit habitat. If no habitat is available at the planned start point, move to the nearest available habitat to and start there.

Each line is made up of 5 plots spaced at 50 m intervals and on a bearing of magnetic north. The bearing may be adjusted where that is necessary to remain in viable rabbit habitat.

At each plot, visually assess the Modified McLean Scale score. Observe the frequency of faecal pellet heaps and the general distribution of pellets. The observer must take care not to mistake faecal pellets from other feral or domestic animals as belonging to rabbit.

Also measure the distance between a pellet heap and its nearest neighbour for a minimum of 20 pairs. Any one pellet heap should not be used for more than two separate pairs. The average distance between heaps for the 20 pairs is used to confirm the Modified McLean Scale score. Only 'fresh' heaps with recently deposited pellets are used in these measurements.

Assessing rabbit sign requires experience, as the amount of sign varies with the locality and the season. An experienced observer can quickly and accurately score a block/property; however, it should be noted by the novice that the breakdown of pellets can differ between localities throughout the country due mainly to climatic and dietary changes.

4.4 Field Technique Night Counting

4.4.1 Preparation for Night Counting

Weather, vegetation, presence of stock and rabbit behaviour all affect rabbit counts. As might be expected heavy rain, high winds and severe cold decrease the numbers of rabbits spotlighted, as does the presence of tall-growing vegetation because of reduced visibility. High numbers of stock also tend to disrupt rabbits.

Light to moderate winds may increase the numbers seen, possibly because they mask the noise of the vehicle. Light rain with warm temperatures often increases the numbers seen.

Counts should therefore be done under stable weather conditions, when vegetation allows good visibility, and when stock can be avoided.

During daylight, mark the route with reflective markers (delineators) using two colours, white and red. Use the white to indicate the end of a section and the red to indicate to the counter that they are on the route and also to indicate changes in direction. While marking the route

also record all information regarding gates, turns and end of sections on a map and 'Route Description forms. Include a GPS co-ordinate, or preferably capture a GPS route.

A section normally ends after a distance of 1 km, though that can be somewhat shorter if the end of the block/ paddock is reached, or if the landscape changes dramatically.

Therefore, a block (or paddock or major landscape area) may consist of several one-kilometre sections plus a part kilometre section at the end, with the next block starting again with a full kilometre section.

Place a white reflective marker (delineator) on a 50 x 25 mm peg or a Waratah® hammered in at the side of the track away from any traffic (vehicular or stock), making sure that the reflective side is facing towards the direction the counter will come from. If the section coincides with a gateway, nail the marker on the approach side where it will still be seen if the gate is open during counting. Placing the marker on the hinged gate post may reduce the likelihood of interference.

Red reflectors can be placed as the counter sees fit as they are only an aid in direction finding when it comes to the actual counting.

The following equipment is required for night counting:

- section markers (red and white), usually the same as used on roadside markers;
- pegs, approximately 400 mm long, made from 50 x 25 mm timber and sharpened at one end. In lieu of wooden pegs, Waratah®s or metal pegs can also be used;
- hammer;
- night count description forms;
- night count recording forms;
- an option of a minimum of one, and preferably two, sheep tally counters mounted on the motorbike to record rabbit and non-target animal numbers;
- spotlighting equipment: spotlight of either 30 or 55 watts, usually attached to motorcycle helmet;
- power source, usually a motorcycle battery, either connected to the motorcycle electrics or independent from it;
- vehicle, usually a two wheeled motorcycle or a quad bike;
- all operational and safety equipment stated for motorcycle night shooting (excluding firearms). Refer section 3.2.

4.4.2 Night counting

Differences between people may affect spotlight counts. This is the prime reason that personnel changes should be kept to a minimum on long-term monitoring routes. Counts should not exceed 3-4 hours duration as eye strain and decreased concentration can influence results.

The spotlight should be traversed evenly through an arc in front of the counter with an approximate radius of 50 metres. Keep rabbit disturbance to a minimum by not making any

unnecessary noise and avoid shining the light beyond the area being searched. Speed should be kept constant and not exceed 20 kph.

For night counting rabbits, counting from a moving vehicle (including motorcycles) is the most practical and widely used technique; however, when terrain prevents the use of vehicles the counts can be done on foot.

The key aspects of the spotlight counting methodology are:

- the count route must be representative of both the rabbit population and the habitat;
- once established, the same route should be used at all times and any changes (e.g. new fences, farm development etc) should be noted on the records;
- the same person should count each route whenever possible;
- the same lighting equipment and vehicle type and speed should be used at all times;
- counts should be done under weather conditions that favour rabbit feeding or general rabbit activity in the survey area. Counts should not be made in snow or heavy rain, as this could lead to an underestimation of abundance. The first three hours of darkness are the best for counting due to high rabbit activity;
- populations of over 200 rabbits per kilometre necessitate counting in clusters of 10 but these tallies should be treated with caution;
- only one count should be carried out per route per survey.

At the end of each route section record the number of rabbits, non-target animals and other information such as vegetation and visibility.

At the end of the count, record the relevant weather and ground conditions.

4.5 Data Analysis

4.5.1 Property Assessment (Modified McLean Scale)

Modified McLean Scale results should be expressed as a percentage of the block containing a certain level. For example:

> 40% of the plots (or lines) have a Modified McLean Scale of 3 or less
> 50% of the plots (or lines) have a Modified McLean Scale of 4, and
> 10% of the plots (or lines) have a Modified McLean Scale of 5 or greater.

This replaces the earlier and historic method of adding up the scores of all the assessment points and dividing by the total to get an average for the block/property. The rationale for reporting a block/property as a percentage is that the rabbit numbers almost double for each step on the Modified McLean Scale and, therefore, the use of averages would be misleading and so should be avoided. However, for individual lines, the scores of the 5 plots are still averaged to provide a line score.

4.5.2 Trend Assessment

For the Modified McLean Scale technique, calculate a mean score for each line, and then a mean score for each stratum.

For the night count technique, calculate mean rabbits/km for each route, and then calculate the mean rabbits/km (= total rabbits seen/total length of route in km) for all routes in each stratum. Calculate the standard error and 95% confidence intervals for each stratum mean. (This can be achieved, for example, by applying the 'descriptive statistics' function under the analysis tools in Excel to the series of numbers comprising mean rabbits/km calculated for each line).

Graph the results over time by strata.

4.5.3 Percent Kill Assessment

The calculations needed for the estimates and confidence limits for the percentage of rabbits surviving a control operation are best explained using the example below. Note that the formulae are shown next to the calculated values. To use these formulae in Excel you need to include '=' in front of the formula, and make sure the cell references are correct:

Night Count % Kill Analysis		
For pre/post counts of same lines within same stratum		
Mean rabbits/km PRE	88.7	AVERAGE(B20:B1000)
Mean rabbits/km POST	17.0	AVERAGE(C20:C1000)
SE PRE	16.4	STDEV(B20:B1000)/SQRT(COUNT(B20:B1000))
SE POST	4.2	STDEV(C20:C1000)/SQRT(COUNT(C20:C1000))
Coeff of Variation PRE	0.2	C7/C5
Coeff of Variation POST	0.2	C8/C6
Proportion Remaining	0.2	C6/C5
Proportion Killed	0.8	1-C11
SE of the Kill	1.9	SQRT(C11^2*(C9^2+C10^2-2*C9*C10*CORREL(B20:B1000,C20:C1000)))*100
% remaining	**19.2**	IF(COUNT(B20:B1000)=COUNT(C20:C1000),C11*100,"PAIRS!!")
% kill	**80.8**	100-C14
.+/- 95% CI	**4.8**	C13*TINV(0.05,COUNT(B20:B1000)-1)

Enter pre and post line data in the columns below.

Line number	PRE rabbits/km	POST rabbits/km
1	128	26
2	107	28
3	53	7
4	131	24
5	79	12
6	34	5

4.6 RHD Survey

If RHD epidemics are going to occur, they generally do so during spring or autumn.

The optimal time for RHD survey work is therefore late summer, prior to an epidemic. This ensures a reasonable estimate of the proportion of the population immune to RHD can be determined. Surveying shortly after an epidemic has passed through provides a falsely inflated picture of immunity levels because many of the rabbits which were not immune would have been killed by the recent epidemic.

Procedure for blood collection:

1. Rabbit must be bled immediately after being shot.
2. Using either a sterile 18 gauge 1.5 inch (1.25 x 38 mm) needle or vacutainer needle and 5 ml syringe or vacutainer remove 1-5 ml of blood from the heart[6]. Insert the needle through the chest cavity into the heart. A minimum of 1 ml is required, though a greater volume is preferable. If using a syringe and needle, inject the blood into a vacutainer (Brand serum separation tube - Becton/Dickinson 4 ml Draw, Record 6514).
3. A new syringe and needle must be used for each rabbit.
4. Label each sample with:
    a. Date collected
    b. Location of sample
    c. Sample number

4. Allow sample to cool.
5. Record details about the rabbit from which the sample was taken i.e. -sex, age, (mature or young = <8 weeks); site map co-ordinates.
6. Store and transport in insulated shock-proof container.
7. Remove eyeball, store in container with a 10% solution of formalin, & label with the sample number.

[6] It is not recommended that the chest cavity is opened with a dry sterile knife or scissors to expose the heart. While this makes sampling easier, it creates a real risk of cross contamination between samples in the field, as the test is very sensitive.

PART 5. BIBLIOGRAPHY & APPENDICES

5.1 Bibliography

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http://rabbits.landcareresearch.co.nz/

This site provides access to a searchable database of published and unpublished articles and references relevant to wild rabbits and their management in New Zealand. Most of the material is from Australia, New Zealand and the UK. The more than 3000 references cover a range of topics including basic biology, ecology, population monitoring and control methods, and span almost a century of research and management. The database was developed as a resource not just to ensure all available information and knowledge was available for research, but also to ensure that it was accessible to rabbit managers, farmers and the public. This work was contracted by the NZ Foundation for Research Science and Technology as part of Landcare's Small Mammal Pest Control Research Programme.

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- RAB003 Aerial baiting of rabbits with 1080
- RAB004 Ground baiting of rabbits with pindone
- RAB005 Diffusion fumigation of rabbit warrens
- RAB006 Rabbit warren destruction by ripping
- RAB007 Rabbit warren destruction using explosives
- RAB008 Trapping of rabbits using padded-jaw traps
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5.2 Appendix One – RCV Biocide Protocol

RCV Users Protocol
for the
Importation, Distribution, Sale and Use of Rabbit Calicivirus Suspension

INTRODUCTION

A consortium of ten regional councils and two unitary authorities, termed the RCV Users Group, has gained approval to import Rabbit Calicivirus Suspension (RCV-Suspension) from Australia and to register it here for use as a rabbit biocide.

Approvals to import RC–Suspension, through Ministry of primary Industries and to have it registered as a veterinary medicine by Agricultural Compounds and Veterinary Medicines Group(ACVM) have been undertaken by Environment Southland on behalf of the consortium members. The product contains live rabbit calicivirus and is to be used as a rabbit biocide for oral baiting. It is manufactured by the NSW Agriculture in Australia.

The consortium members have agreed to be bound by a protocol which sets best practice guidelines for the importation, distribution, sale and use of RCV-Suspension.

RCV Suspension will only be made available to those members of the consortium when they have signed off on the RCV Users protocol.

It is intended that RCV-Suspension will be used specifically as a biocide, delivered orally in a bait form, to target small, isolated populations of rabbits. Its use will focus on peri-urban and/or high public use areas where normal rabbit control methods, ie., poisoning, shooting, are not possible.

It is not intended that RCV-Suspension be used as a biocontrol, i.e., to start natural epidemics. Experience has shown that using RCD baiting only starts epidemics at the time of year when large-scale epidemics are expected in any event (usually in the spring or more commonly the autumn).

There is operational and scientific evidence to show that attempts to artificially initiate epidemics, by introducing the virus on a wide scale, can have the effect of stimulating induced immunity in rabbit populations. This may reduce the value of rabbit haemorrhagic disease as a biocontrol.

There is still considerable uncertainty and scientific debate about the epidemiology of Rabbit Haemorrhagic Disease (caused by the rabbit calicivirus) and how it can be utilised to provide the greatest benefits for rabbit control. This protocol has been developed on a conservative basis to minimise the risk of immunity development.

The sale of RCV-Suspension will be restricted solely to those pest management agencies that belong to the RCV Users Group. It may be used by other suitably qualified agents only if they are specifically authorised by the regional council/unitary authority concerned.

Representatives of Environment Southland, Otago Regional Council and Environment Canterbury who have specialist expertise in the use of Rabbit Haemorrhagic Disease for rabbit control have developed this protocol on behalf of the RCV Users Group. The guidelines take account of current best practice.

THE COMPOSITION AND ROLE OF THE RCV USERS GROUP

The RCV Users Group comprises representatives of each of the member regional councils and unitary authorities that jointly funded the regulatory approvals process. These include Northland Regional Council, Auckland Regional Council, Environment Waikato, Environment Bay of Plenty, Taranaki Regional Council, Hawke's Bay Regional Council, Horizons Regional Council, Greater Wellington Regional Council, Marlborough District Council, Tasman District Council, Environment Canterbury and Environment Southland.

Each Regional Council or Unitary Authority, unless otherwise specified, will be represented by its respective member of the Biosecurity Managers Group.

The RCV Users Group will operate as a sub-group of Biosecurity Managers Group, and will be responsible for maintaining this protocol and for monitoring the use and effectiveness of RCV-Suspension as a biocide in New Zealand.

Where necessary it will report and make recommendations to the Regional CEO's Group on operational and policy matters relating to the use of RCV-Suspension as a biocide.

The RCV Users Group will review the RCV Users Protocol when and where necessary and make appropriate changes to the protocol.

The RCV Users Group will ensure that RCV-Suspension is imported, distributed, sold and used according to this protocol. Where necessary it will take appropriate action to prevent the abuse or misuse of the product.

IMPORTATION

The import approval and registration of RCV-Suspension is held by Environment Southland on behalf of the RCV Users Group.

RCV-Suspension importation from Australia and distribution in New Zealand is contracted to a commercial organisation selected on tender basis. The contractor will be in the business of import and distribution of similar products and will have the expertise and systems in place to meet the needs of the RCV Users Group. The services will be provided on a basis where the costs of handling, storage and distribution will be passed on through the purchase price of the product at agreed rates. In recent years single 10ml vial of RCV Suspension, which is sufficient to treat 15 Kg of cut carrot, has been charged at NZ$200.

The Australian manufacturer NSW Agriculture has agreed (yet to be formally ratified) that it will only supply product to the importer authorised by the RCV Users Group.

The current importer and distributor of RCV-Suspension is:

Connovation
36B Sir William Drive
East Tamaki

Manakau, 2013
New Zealand

DISTRIBUTION

The importer/distributor is responsible for storing the product and for distributing it to members of the RCV Users Group on an "as needed" basis.

Each member organisation of the RCV Users Group will nominate one person who will be responsible for ordering, receiving, storing and using the product.

For long term storage, the virus needs to be kept below -80^{0}C. At freezer temperatures (-10^{0}C to -20^{0}C) it deteriorates and has a half-life of 6 months.

SALE AND PURCHASE

The importer/distributor will be authorised to supply RCV-Suspension only to the members of the RCV Users Group. This is a condition of both the Import Approval.

The purchase process is coordinated through Environment Southland.

A regional council/unitary authority that is a member of the RCV Users Group will become eligible to purchase RCV Suspension when it has formally ratified and agreed to observe the RCV Users Protocol.

Importation will only be carried out on an annual basis. RCV User Group members will need to place orders for the number of vials required with the importer by 30 April and will receive orders 31 May in that year in readiness for winter biociding operations over the June/July period.

Each member of the RCV Users Group will nominate one person who will become the 'purchasing officer'. The importer/distributor will only supply RCV-Suspension to that person.

The importer/distributor will keep accurate records of all product imported and supplied which will be reported to the RCV-Users Group on an annual basis.

The product will be supplied in 10 ml vials. This is sufficient to manufacture 15 kg of chopped carrot bait.

At present the retail purchase cost of the product is $150/10 ml vial.

The product will be air freighted to users in a frozen state. It can be kept for a period of weeks at <-5^0 C but once it is thawed it must be used within 48 hours. It cannot be refrozen.

REGULATORY CONTROLS

The MPI approval (date 31 May 2004) to import RCV-Suspension contains two conditions for use of the product.

1. **Rabbit Calicivirus Suspension shall only be used as a pest control agent for the management of rabbit populations within the biosecurity responsibilities of regional councils and unitary authorities.**

2. **Any use of Rabbit Calicivirus Suspension shall only take place after the appropriate Conservator of the Department of Conservation (or nominee) for the area in which the application of bait is to take place has been notified.**

The product label and data sheet as approved by ACVM contain instructions and conditions for use which must be observed.

USE OF RCV-SUSPENSION

RCV-Suspension is intended to be used only as a rabbit biocide targeting specific sites. If the product is not used as required under the protocol it has the potential to vaccinate rabbits and thus reduce the effectiveness of rabbit haemorrhagic disease as a biocontrol. It is critical that only fresh, live virus be used.

Technical experts in rabbit control have developed the protocol for use of RCV-Suspension. Their aim has been to maximise its benefits for rabbit control while minimising the risks for its misuse.

It is will be a condition of supply that each member of the RCV Users Group develops Standard Operating Procedures (SOPs) for the use of RCV-Suspension as a biocide based on the requirements set in this protocol.

PUBLIC EDUCATION

It is critical that those affected by rabbits clearly understand that the RCV-Suspension product is not a 'silver bullet' but just another tool. The RCV Users Group must ensure that the public expectations of the benefits are realistic. This will involve publicity and direct communication with the affected parties before and after biocide operations.

The public and stakeholders must understand that operational experience shows that even in the most favourable conditions RCV-Suspension used as a biocide will at best achieve a 60% reduction in rabbit populations. Normally a 40-60% reduction is obtained.

In particular it will be necessary to stress that as a biocide RCV-Suspension will only be used in specific situations, i.e. in peri-urban/high public use/high value habitat areas where normal rabbit control method cannot be used. It can only be used at certain times of year when its biocide effect will be greatest and even then it may not meet the affected parties' expectations. Its effectiveness will depend on a range of biological and environmental variables including the pre-existing levels of RHD immunity in the target rabbit population.

PUBLIC CONSULTATION

It is recommended that public information should be provided to ensure that all affected stakeholders are aware that RCV-Suspension is available for use in the region as a rabbit biocide and what its effects will be. This may be done through the normal public communication channels, e.g. media releases, pamphlets, web sites, etc. Domestic rabbit owners and breeders should be advised that their rabbits can be readily vaccinated against RHD at low cost by any veterinarian.

It is a condition of the MPI import approval that the Department of Conservation must be notified about the areas in which biociding will take place before it is carried out.

For actual biociding operations it is advisable to warn affected property holders at and around target sites before they are conducted.

TIMING OF BIOCIDING OPERATIONS

To obtain the maximum benefit for rabbit population reduction from the use of RCV-Suspension as a biocide the same principles as those applied to other toxins, e.g. 1080, must be followed.

It is strongly recommended that RCV suspension be used as a biocide only during the late winter months of June and July. This is to target core rabbit populations when they are at their lowest levels and to maximise the consumption of bait due to scarcity of food. This is also when breeding is least likely to be occurring. Exposing young rabbits (<12 weeks of age) increases the risk of them contracting the disease and surviving and then retaining the immunity gained for the rest of their lives.

OPERATIONAL METHODOLOGY

The directions for use of RCV-Suspension are contained in the instructions on the vial box label and the accompanying leaflet. These are based on procedures developed in Australia which also apply equally in New Zealand.

RCV User Group members will only allow experienced operators to use RCV-Suspension as a biocide. This will include Regional Council/Unitary Authority staff members or experienced and reliable contractors who are formally authorised by them to do so. Ideally users should have the APDC or equivalent qualifications.

Regional Councils and authorised operators must ensure that in any operation, particularly those undertaken on a cost recovery or commercial basis, that the efficacy of RCV-Suspension used as a biocide cannot be guaranteed. This is due to the fact that the action of rabbit calicivirus on a rabbit population is governed by a range of variable factors which are difficult to define and /or measure.

Operators must ensure that prospective customers are made fully aware of the costs and potential risks involved in a biocide operation before they proceed. Furthermore it may be advisable to obtain a written acknowledgement from customers to the effect that they understand and accept that the use of RCV Suspension may not achieve a desired decrease in rabbit density. **It should also be made clear that the RCV – Users Group, Environment Southland or the authorised importer will not accept responsibility or liability for any perceived failure of a biocide operation using RCV-Suspension to meet a customer's expectation.**

If immunity levels in a rabbit population are shown by blood sampling to be above 40-60% (based on a cut off of 50% inhibition at 1:40 titre.) then it would be wasted effort to continue with a biocide operation. Conventional control methods would be much more effective and would also reduce immunity levels.

This protocol makes a number of specific 'best practice' recommendations to maximise its effectiveness as a biocide. These recommendations include:

- Only those users formally authorised by RCV User Group members may carry out rabbit biocide operations.
- Rabbit populations are targeted in specific, discrete areas where normal rabbit control methods are not possible or are very difficult to implement.
- All stakeholders directly affected by the operation are notified beforehand.
- Where possible information about RHD immunity be gathered before biociding.
- Chopped carrot is the only bait type used in New Zealand.
- Bait should be prepared according to the label instructions.
- Those mixing the bait should wear protective equipment and clothing.
- Biociding be restricted to the months of June and July.
- Two successful pre-feeds of carrot bait are used prior to biociding.
- Bait should be laid so as to avoid the effects of ultraviolet radiation as far as possible.
- All pre-feed bait is consumed before the inoculated bait is laid.
- All baits should be laid on fresh spits or scratch plough lines.
- Bait must not be applied using aerial methods.
- All toxic bait not consumed should be collected less than 24 hours after being laid.
- Detailed records of each operation be made and summaries reported to the RCV Users Group annually.

COLLECTION AND ANALYSIS OF INFORMATION

The RCV Users Group will coordinate the systematic collection of information about the use and efficacy of RCV- Suspension as a biocide. This will be used to review and improve its performance as a rabbit control tool.

The RCV Users Group will encourage the collection of data about both rabbit populations and RHD immunity levels before and after biocide use. This will include where possible pre and post operational night counting information based on standard industry techniques.

The collection RHD immunity information is expensive and is only feasible at sites where a minimum of 30 rabbit blood samples can be taken. The cost of analysis is around $30/sample.

CLAIMS FOR DAMAGES AND COMPENSATION

Regional Councils may from time to time receive claims for damages and/or compensation, e.g. from owners of pet or commercially bred rabbits which may have been affected by RHD.

It would be extremely difficult to prove that an infection in rabbits was caused by RCV-Suspension used as a biocide rather than by wild virus which is already present in the environment. The virus contained in RCV-Suspension is the same as that was illegally imported into New Zealand in 1997 and the same as that used commercially in RCD-Zen which was sold until May 2002.

Part V of the Biosecurity Act 1993 provides the statutory mechanisms for the control of pests such as the rabbit through pest management strategies. Section 86 of the Biosecurity Act states that a regional pest management strategy shall not provide for compensation but may make provision to do so under certain circumstances. We are not aware of any regional council that has made such a provision in their regional pest management strategy. Nor would the circumstances with respect to RCV justify that any changes be made.

Regional Councils can protect themselves from such claims by following the conditions of the MPI Import Approval and the NZFSA Registration as a veterinary medicine.

They can further protect themselves by following the guidelines contained in the RCV Users protocol. Using RCV Suspension, as a biocide according to the protocol, will reduce the risk of initiating epidemics of the disease.

Regional Councils may gain further protection by advising the public that any owners of rabbits who have not already taken precautions to protect their rabbits by way of vaccination or other means should do so.

Regional Councils should also determine with their insurers whether or not they may be covered for such claims and what under what conditions such claims may be met.

Richard Bowman
11 March 2011

RCV Users Group Member: (including include Northland Regional Council, Auckland Regional Council, Environment Waikato, Environment Bay of Plenty, Taranaki Regional Council, Hawke's Bay Regional Council, Horizons Regional Council, Greater Wellington Regional Council, Marlborough District Council, Tasman District Council, Environment Canterbury and Environment Southland.)

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AGREEMENT

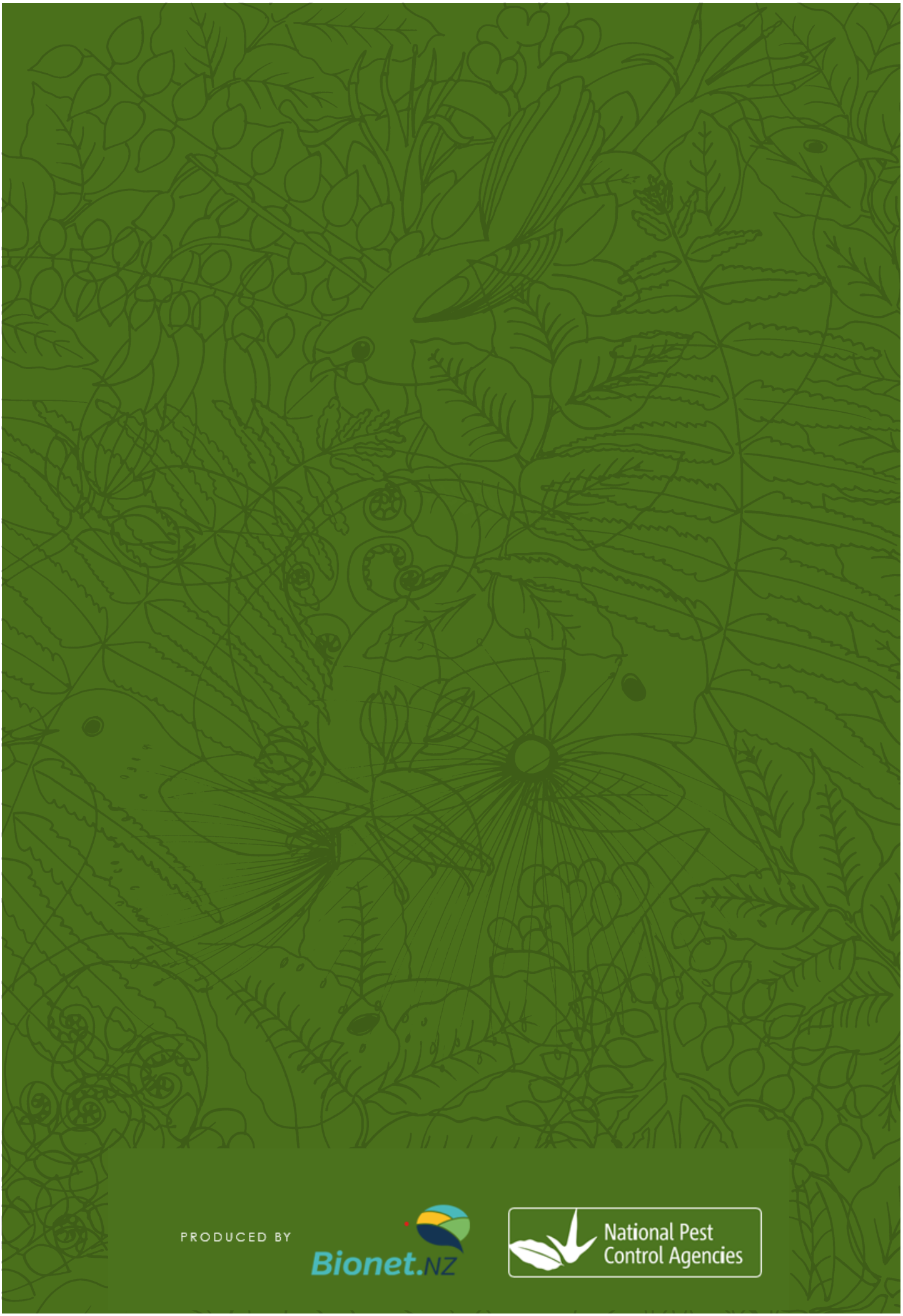
_____

Agrees to observe the guidelines contained in the RCV Users Protocol.

Signed:

_____

Date: _____



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