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A9 PEST WALLABIES

CONTROL AND MONITORING OF PEST DAMA AND BENNETT'S WALLABIES

PRODUCED BY Bionet.NZ 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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This guide may be updated from time to time, so please check that your version is current by checking the publications section on **www.bionet.nz/library** or contacting info@bionet.nz.

AMENDMENTS IN THIS EDITION

This April 2018 edition has been updated as part of an interim generic review of most NPCA publications. The purpose is twofold.

- » Firstly, to reflect the substantial change in the regulatory regime relating to Health and Safety and use of VTAs (Vertebrate Toxic Agents) in the workplace, which now both sit under the Health and Safety at Work Act 2015, and associated regulations.
- » Secondly, to change links to other NPCA publications and contact details now that NPCA's publications have been transferred to the BioNet portal, run by the Ministry for Primary Industries.

The full nature of the regulatory changes have NOT been fully captured here, and users are directed to the source legislation and website information provided by the various administering agencies.

This interim review is intended to be followed up more fully in due course.

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PART 1 INTRODUCTION

1.1 Purpose

These guidelines were commissioned by the Biosecurity Managers Group through the National Pest Control Agencies (NPCA).

The practical and regulatory aspects of wallaby control and monitoring are updated and made freely available. This standardisation of best practice is expected to contribute to the efficient implementation of regional pest management strategies for controlling wallabies. Dama and Bennett's wallabies are covered as they are the only species to occur on the mainland[1].

The primary audience is field staff and contractors responsible for designing, undertaking and reporting on wallaby control and monitoring. The guidelines allow flexibility for ongoing innovation and tailoring of operational design to local needs.

1.2 Scope

Regional councils have primary responsibility for wallaby control in New Zealand. At the strategic level, policies and goals are set in each 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 document is not intended to provide guidance at these strategic planning levels.

Based on the particular annual plan, staff and or contractors will be allocated specific responsibilities for the control and monitoring of wallabies, involving three stages: preparation, fieldwork and reporting. These stages constitute the scope of this document.

The degree of detail for each operation is variable. Best practice elements pertaining specifically to wallaby control are presented while recognising that local conditions, such as feed availability or ambient noise, can modify wallaby behaviour and may have to be taken into account in particular locations. Also, for example, a safe handling procedure for off-road motorcycles may be required for wallaby control and monitoring. Such generic procedures are not included.

1.3 Layout

The document is in four parts.

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

[1] Some further wallaby species occur on Kawau Island, in the Hauraki Gulf.

PART 2 BIOLOGY AND IMPACTS OF WALLABIES

2.1 Biology of the dama wallaby *Macropus eugenii*

Dama are also known as tammar, kangaroo island or silver-grey wallaby. They are the only wallaby species occurring in the North Island, having been introduced to the Rotorua District in 1912, probably from Kawau Island. Their subsequent spread has been slow and their present range is around 170,000 ha, primarily in the Bay of Plenty Region, and partly in the Waikato Region. Several sightings in the Ureweras, Taranaki and elsewhere have not resulted in new populations becoming established.

The dama is small, an adult weighing about 5 kg, and with an overall body length approximately 0.8 to 1 metre. Fur is grey-brown above, pale grey below, with rufous shoulders. The tail is tapering, uniform coloured and well furred.

Field sign includes distinctive, often almost square and flattened, faecal pellets (but sometimes more elongated and round), and characteristic tracks made on soft surfaces by the long narrow hind feet and dragging tail leaves. Home range has been measured from 10-40 ha.

Although some dama live almost exclusively in forest, they prefer edge habitats, which provide good pasture grazing as well as dense vegetation for cover during the day. Most feeding is at night with some sporadic grazing during the day, particularly during the afternoon and early evening. Damas are wary, frequently stopping to look and listen. A disturbed dama will face the danger, alerting others by posture or hind foot thumping followed, if necessary, by the entire group fleeing i.e. frightened animals communicate fear to the group.

Females mature at 12 months of age and have no more than one young per year. Young are born from mid-January through December, with some late births to July. Most females mate within 24 hours following the birth of a previous young but the embryo stays dormant until December or January when gestation completes over 28 days. Joeys' pouch life is about 250 days. Few adults live beyond five years' of age.

Figure 1. The hand in the left of the picture shows the small size of the dama wallaby.

2.2 Biology of the Bennett's wallaby *Macropus rufogriseus rufogriseus*

Bennett's are also known as red-necked, brush or scrub wallaby. They are the only wallaby species occurring in the South Island, having been liberated in 1874 on the eastern Hunter Hills near Waimate. Numbers increased dramatically, assisted by deliberate relocations to include the Kirkliston, Grampian, Albury and Two Thumb Ranges to an altitude of 2000 metres. Several smaller populations are established at Kakahu Forest, Pioneer Park, Peel Forest and at Quartz Creek. Current range is over about 300,000 ha.

The Bennett's is the largest wallaby in New Zealand, an adult frequently weighing more than 15 kg, and with an overall body length 1.2 to 1.5 metres. Fur is grey above, pale grey below, with rufous-brown on the neck and shoulders. The tail tapers and is dark at the tip.

Field sign includes almost square and flattened faecal pellets (but sometimes more elongated and round). Long-toed footprints leave characteristic tracks on soft surfaces.

Bennett's prefer edge habitats, which provide grazing on tussock grasslands, as well as dense vegetation for cover during the day. Most of the diet comprises grasses and herbs, though palatable shrubs and trees will also be browsed. They keep to cover during the day, feeding in the open only at night. Unlike damas, the Bennett's wallaby is a solitary animal, very wary and alert and generally staying close to cover. When disturbed, a Bennett's flees and will often not stop until out of sight.

Females mature at two years of age and have no more than one young per year. Young are born from February through March, with some late births to July. Most females mate shortly after birth of a previous young but the embryo stays dormant until the following breeding season when gestation completes over 30 days. Joeys' pouch life is about 270 days. Maximum adult age from a shot sample was nine years.

2.3 Impacts

Wallabies compete with stock in a way similar to rabbits, maintaining pasture to a short sward. However, their effect on regeneration of native forest is more serious.

A survey in the Okataina Scenic Reserve showed that dama wallabies were likely to be responsible for inhibiting the regeneration of palatable species such as hangehange, fuchsia, raurekau, karamu, pate and fivefinger. The long term consequence is a substantial structural change to the forest. Bennett's are also thought to inhibit regeneration of palatable species in forest margins and remnants.

The key issue, then, is that only a handful of native species will survive wallaby browsing in the long term, with significant consequences on ecosystem structure and function.

Figure 2. Wallaby impact on Kawau Island

"Nowhere else in New Zealand, has the impact of wallaby browsing advanced so far as on Kawau Island. The mainland observations of species affected are therefore well short of the mark in defining the seriousness of the potential impact of wallabies on ecological and economic values. Technically, wallabies have potential for significantly greater impact on New Zealand ecological values and primary production than possums. Of that I am certain. Of 45 indigenous canopy and sub-canopy species identified on Kawau Island during 1996 only Kanuka (*Kunzea ericoides*) and Kawakawa (*Macropiper excelsum*) stand out as not being attacked by wallabies. With current tools, the cost of eradication may be huge but the job will become impossible if not tackled while the populations are relatively discrete."

Ray Weaver, Pohutukawa Trust New Zealand.

PART 3 CONTROL

3.1 Management options

Until recently, managing wallaby populations on the mainland has been of relatively low priority. As a consequence, research and development of effective control strategies has been limited and this is reflected in a rather sparse toolbox.

1080 is the only toxin presently registered for use against wallabies. Other control techniques include helicopter shooting, ground hunting (with or without dogs) and night shooting.

Previous 1080 aerial control operations using both carrot and cereal bait have achieved kills in excess of 90% of both Bennett’s and dama wallabies, and a trial using 1080 in foliage gel baiting achieved a kill of 87%. 1080 seems an effective tool for initial population knockdown. However, to achieve eradication it is likely that methods not involving acute pesticides will need to be employed.

Experience shows that bait station need to be designed to allow wallabies ready access to bait, as they avoid having their vision obscured. Bait stations of the hockey stick design can be fabricated from 90 mm diameter PVC stormwater pipe and components. Alternatively, commercial bait stations, such as the Philproof (original large size only), can be modified for acceptance by wallabies.

Perhaps because wallabies will take bait from the ground or from bait stations, so long as bait is readily accessible, gel baiting is a technique that is seldom used.

Shooting operations will also achieve an initial population knockdown but survivors learn the game and become wary. Both helicopter and ground hunting of Bennett’s wallabies have not prevented range expansion.

A wallaby research plan is underway in the Bay of Plenty and Waikato regions to support a goal of achieving eradication. This is a multi-agency plan supported by Environment Bay of Plenty, Environment Waikato and the Department of Conservation. This document will be reviewed to reflect the findings of this research as new information comes to light.

Non-lethal options for protecting a resource from wallabies include commercially available repellents for protecting high value trees and exclusion fencing, which has proven effective for localised situations.

Finally, experience has shown, particularly on Kawau Island, that wallabies are very susceptible to non-target poisoning from baits used for possum control such as ‘Decal’ cholecalciferol bait and ‘Pestoff’ brodifacoum baits. As possums occur in all the same places as wallabies, any possum control programmes targeting near zero possum densities, particularly using brodifacoum, are likely to also result in very low wallaby population densities. Brodifacoum is not generally permitted to be used on the DOC estate.

3.2 Shooting

Night shooting can be reasonably effective for initial knockdown of a population. The area to be controlled has to lend itself to night shooting in that access should be good and the cover reasonably open.

The best practice techniques for night shooting wallabies are the same as for rabbits, and the reader is referred to the Bionet publication *Pest Rabbits: Monitoring and Control Good Practice Guidelines* at www.bionet.nz/library/ .

Suitable calibres are .22 or #4 shot for dama wallabies. For Bennett's, .22 magnum is minimum (even that needs a good head or neck shot), and buckshot or BB's with the shotgun, as even 3-inch BB's may just get stuck in the skin.

Additional tips and hints for night shooting of wallabies

In general, avoid shooting in areas where bait stations are operating, to minimise disturbance of the animals. Look for animals feeding and for their eyes, which shine red at night. When shooting, approach the area quietly, into the wind if possible. Move along the edge of the cover, shining a light ahead with steady sweeps. Do not shine the light beyond shooting range and ensure you do not illuminate yourself as this disturbs the wallabies.

Once an animal is sighted, hold it in the outer edge of the light until ready to shoot. If the wallaby starts to move, don't chase it, take the light off it for a few seconds, then put it back on the same spot (wallabies may stop once the light has been taken off them). If it runs to a fence or cover, follow it with the light, as it may stop for a second before going through a fence or into cover.

Ground hunting during the day using dogs to flush wallabies from cover may be effective as an alternative, or in combination with night shooting.

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 alcohol or drugs when handling firearms.

Figure 3. Typical night shooting setup, shooter is also equipped to continue on foot.

3.3 Repellents

Repellent preparations are designed to render plants unpalatable and unattractive to browsing wallabies or rabbits. Repellents are generally applied as foliar sprays, which have to be reapplied periodically to treat new growth occurring within browsing range (40cm - 50cm above ground level). Spray-on repellent solutions should not be applied to the point of run-off, as with garden sprays. Adhesives in repellent mixes can block plant stomata when heavy applications are used, especially on delicate or bipinnate foliage. A coarse droplet size and a 50% foliar coverage overall are adequate for repellent spray application.

Although testing has been confined principally to radiata pine, egg repellents are considered to be suitable for use in horticulture, landscape plantings and gardens.

Egg repellents are reliable, inexpensive and practical. They are easy to apply and most effective, particularly in the initial weeks after planting when damage is most likely to occur. The egg repellent made from fresh eggs and paint is the most suitable for a small number of trees. If larger scale plantings are to be sprayed, it may be wise to purchase egg powder and the acrylic resin adhesive to reduce costs.

Reasonable protection can be obtained with mutton fat and kerosene, however, foliage can be burnt if too much is applied. Not recommended for broadleaf species.

Thiropel spray concentrate was found to be more effective in the longer term than other repellents but it is toxic to humans and difficult to handle. This concentrate product, containing 40% thiram, is still being developed. Thiropel containing 10% thiram, is presently available commercially and designed as a paste. If diluted for spray application it may be too weak to be fully effective.

Repellents should be applied immediately after planting. Liberal applications of the repellents to the ground at fence posts near the new plantings will help deter browsers. Checks should be made following application. If browse does occur, a second application should be considered. This could be combined with the release spraying operation.

Egg-based repellents (*treats 50 seedlings*)

To make one litre:

- mix 80 gm whole egg powder plus 800 ml water, or 5 fresh eggs plus 600 ml water in 150 ml primal AC235 acrylic resin
- mix 150 ml acrylic paint (preferably white with a reasonable percentage solids – white timbacryl was tested).

If using egg powder – mix with a little of the water to form a paste and then add the other ingredients. If using fresh eggs – beat well, then add the other ingredients.
Spray approximately 20 ml of the repellent on and around each seedling in the field immediately after planting. A second application may be needed in the spring.

Mutton fat and kerosene

- 10 parts mutton fat plus 1 part kerosene.
- Melt fat and mix in kerosene. Allow to set.

Wipe seedlings with a lightly greased rubber glove, leaving minimal visible fat. Dab ground at base of tree or supporting stakes, if used, to provide more smell deterrent.

3.4 Fencing

When establishing a small horticultural block or nursery within an area containing a relatively high infestation of wallabies, the most cost effective way of preventing wallaby damage may be exclusion fencing.

Wallaby-proof fencing should comprise a netting fence at least 1200 mm high with mesh approx. 100 mm measured diagonally and with a 300 mm toe of netting in front of the fence along the ground. Fences must be tightly stretched and pegged to the ground to ensure there are no gaps. All drains and depressions must be netted as well. Gates into the block must be netted and closefitting, preferably with a concrete or timber sill. Gates must be kept shut at all times.

A 1 m high netting fence at the Dogger Bank in the Lake Okataina Scenic Reserve has successfully excluded dama wallabies for twenty years.

Alternatively, electric fencing should effectively exclude wallabies. If possible, a mains powered energiser should be used. If using a battery unit, ensure that it is checked regularly and that the batteries are kept fully charged.

The lower four wires on the fence should be about 100 mm apart and should be alternating live and earthed wires. Wires can be fitted to electric fence battens or to posts and insulators. An additional live wire about 100 mm above the ground and 100-150 mm out from the base of the fence will provide additional protection. Fence lines need to be checked regularly, especially during spring and autumn, to ensure that vegetation is not shorting the lower wires.

Electric rabbit netting is ideal for providing temporary protection and can be easily moved when plants are well established or no longer require protection.

Figure 4. Dama wallaby

3.5 Poison baiting

The Vertebrate Toxic Agents (VTA) guidelines[2] (available www.bionet.nz/library/) complement this document with respect to use of VTA's. For guidance on use of hazardous substances in the workplace, from the administering authority, refer www.worksafe.govt.nz.

There is no evidence that poison baiting will fail during any particular season, however, winter control is generally preferred as natural food resources are more limited.

3.5.1 Aerial baiting

Both 1080 cereal and carrot bait have proven effective for wallaby control. Cereal bait has the advantage of more consistent size and predictable quality while carrot bait is possibly more highly palatable[3] to wallabies.

Although experience with modern day practices for aerial baiting of wallabies is limited, the following regime is recommended:

- use carrot or cereal bait;
- use large bait size (approximately 20 grams);
- 1080 toxin concentration 0.15% carrot, 0.2% cereal;
- one non-toxic prefeed, followed approximately one week later by one toxic application;
- application rate[4] 3 kg/ha (may need to be higher where high pest density occurs).

Full operational procedures are not presented as these vary and are regularly updated by aerial control contractors themselves. For procedures on 1080 bait preparation refer to the Bionet publication *Pest Rabbits: Monitoring and Control Good Practice Guidelines* at www.bionet.nz/library/.

[2] *Vertebrate Toxic Agents: Minimum Requirements for Safe Use and Handling*, Bionet publication

[3] While bait quality and size can be assured with cereal bait Lewellyn's research on damas from the late 80's showed the palatability of Wanganui #7 was well down when compared with carrot or Mapua cereal baits which are no longer manufactured. The Okataina and Makatiti poisoning operations in the late 80's where the 90+% kills were recorded used Mapua bait. The most recent Okataina operation used carrot.

[4] This is slightly higher than the 2 kg/ha which is generally adequate for possum control, and the extra is a best guess to allow for the competition for baits where both wallabies and possums are present.

Consistent coverage of bait application must be ensured with GPS technology.

3.5.2 Ground baiting and bait stations

Targeting wallabies with hand broadcast or bait station application methods is essentially identical to established procedures used for possum control. As wallabies graze on vegetation close to the ground and are potentially excluded from accessing bait stations by possums, hand laying bait is likely to be the most effective approach. The only toxin registered for wallaby control is 1080.

A range of bait station designs will suffice, although some styles which require an animal to stick their head in should be avoided, or modified. The Philproof is effective when the sides of the veranda are removed, for instance. Designs that incorporate some form of lid or door should be avoided as there is no evidence to show that wallabies are inclined to interact to that extent with a bait station.

Cereal bait is recommended as it is effective and stays fresh longer than carrot. Alternative bait types are being trialled but no evidence is yet available to justify the use of anything other than cereal baits in bait stations. The following regime is recommended:

- use cereal bait;
- use medium bait size (approximately 12 grams);
- 1080 toxin concentration 0.2%;
- one non-toxic prefeed, followed approximately one month later by two toxic applications, one week apart[5];
- bait stations approximately spaced at 100 m along lines spaced approx. 200 m through habitat, particularly along forest/pasture margins wallabies are known to be using. Where groups of damas are known to be using an area, increase bait station density.



Figure 5. Some examples of suitable bait stations. The Philproof entrance (centre) has been modified allowing ready access to bait and the sides have been cut back so as not to obscure the wallaby's vision when feeding at the station.

[5] The second toxic application will target any animals which may have had restricted access to the bait due to competition. Similarly, where pest densities are high, a second prefeed may also be required.

3.5.3 Brodifacoum – Experimental use

Brodifacoum is not presently registered for wallaby control. It is illegal to use any toxic bait product not registered for use against wallabies in an 'off-label' fashion. However, under a previous 'experimental use permit, 50 ppm baits were deployed via bait stations for wallaby control on Kawau Island to good effect.

3.6 Post operation reporting

Prepare an operational report detailing:

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

PART 4 MONITORING

4.1 Monitoring techniques

Monitoring of wallaby 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.

Three methods of wallaby monitoring are described, night counts, day inspections (Guilford Scale) and faecal pellet counting.

Faecal pellet counting is somewhat labour intensive, and as the Guilford scale has been shown to be closely correlated with pellet frequency, the Guilford Scale suffices for most management purposes.

The Guilford Scale is suited to establish whether some control threshold has been reached. It has only been used for Bennet's and, while there is no reason to suppose it would not work for damas, this fact has not been established. It may also be used for regional trend monitoring. While trend monitoring using night counts provides a more sensitive measure, it is also more expensive. The Guilford Scale cannot be used to provide an estimate of percent kill.

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.

4.2 Guilford Scale

A number (1-5) is assigned, based principally on faecal pellet density, wallaby sign and sightings. The Guilford Scale is used across a total property/block rather than a sampling method such as night counting.

Define the monitoring area on a map (no less detailed than 1:50,000).If the management/monitoring area has significantly different levels of wallaby density then it is advisable to stratify it into areas of similar densities.

The Guilford Scale and its application are set out below.

1. An observer should become familiar with the scale and with assessing wallaby sign by accompanying an experienced person before implementing this method of assessment.
2. Systematically traverse preferred wallaby habitat of the block/property being assessed. If the area being assessed is large, the distance between each traverse should not exceed 500 mIf the area of preferred habitat is relatively small, around 20 hectares, one traverse would usually be adequate to gauge population levels.

3. The assessment can be done from motorcycle or on foot, however, the topography and vegetation of habitat preferred by wallabies will usually limit the observer to a foot assessment.
4. Observe frequency of faecal sign, the amount of tracking (pads) and numbers of wallabies seen[6].
5. Record an average Guilford Scale for every 100-300 m traversed (select the distance as being appropriate to the area concerned) and record the score onto a map of the block/property being assessed.

Guilford Scale[7]	Description
1	No faecal or track sign seen but area known to be within the feral range of wallabies.
2	Infrequent faecal signs seen. Track sign absent. Only 1 or 2 faecal pellet groups seen when traversing 100m. Unlikely to see any wallabies.
3.	Frequent faecal and track sign seen but only in isolated pockets. Likely to see some wallabies.
4.	Faecal and track sign very obvious and consistent. Tracks well used. High probability of seeing wallabies.
5.	High densities of faecal and track sign distributed almost uniformly. Tracks well used. High probability of seeing wallabies.

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

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

4.2.1 Data analysis

For trend monitoring, calculate a mean score for each route, and then a mean score for each stratum. Graph the results over time by strata.

For property assessments the proportional density of a block should be expressed as a percentage of the block containing a certain level. For example:

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[6] It may be difficult to differentiate between possum and wallaby runs.

[7] This 5-point scale was developed with the assistance of Landcare Research. It is based on faecal frequency and is scientifically validated.

40% of the block has Guilford Scale 2
50% of the block has Guilford Scale 3, and
10% of the block/property has Guilford Scale 4.

The rationale for reporting a block/property in this manner is that the wallaby numbers almost double for each step on the Guilford Scale and, therefore, the use of averages would be misleading and should be avoided.

4.3 Night Counting

Draw on a map (not less than 1:50,000) the outer limits of the monitoring area in which the wallaby population is to be assessed.

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 wallaby densities.

It is assumed that accessible parts of the property or control area will be covered. For ease of following in the dark and accessibility, farm tracks are often used. The length of route that can be covered by one observer in one night is expected to be about 25 km. The number of 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. 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.

For regional trend monitoring using night counts, the routes should be randomly selected from amongst all possible routes in the study area.

The field techniques are identical to night counting rabbits and monitoring design and data analysis are also similar. Please consult the Bionet publication *Pest Rabbits: Monitoring and Control Good Practice Guidelines* at www.bionet.nz/library/.

4.3.1 Data analysis

For trend assessment, calculate a mean per kilometre for each route and then a mean per kilometre for each stratum.

Graph the results over time by strata.

Night count data is skewed, so for estimating percent kill, a log conversion is recommended.

The calculations needed for the estimates and confidence limits for abundance and percentage of wallabies surviving a control operation are best explained using the example below:

Line	Mean per km over Line Before	After	Log_{10}-Count Before	After
1	128.1	26.2	2.11	1.42
2	107.3	28.4	2.03	1.45
3	111.5	28.7	2.05	1.46
4	131.0	24.0	2.12	1.38

	Before	After	Change
Mean	2.08	1.43	-0.65
Standard Deviation	0.04	0.04	
Standard Error	0.02	0.02	0.03
t-value[8]	2	2	
Lower Limit	2.04	1.39	-0.8
Upper Limit	2.12	1.47	-0.8

	Before	After	Survival	Kill
Estimate	119.0	26.8	22%	78%
Lower Limit	101.6	23.4	19%	81%
Upper Limit	139.4	30.5	26%	74%

4.4 Faecal pellet transects

The use of pellet counts to measure relative population density is a more precise and quantitative method than the Guilford score. There are three methods of faecal pellet counts: percent frequency, cleared plot and standing crop.

Only the percent frequency method is described here, as the other two methods require a much higher time input (and therefore add to cost). If resources are not a constraint then standing crop and cleared plot techniques are also suitable.

Transect lines should be counted annually or less frequently at the same time of the year to remove any potential seasonal variation. Summer/autumn in considered best where constraints such as access, snow etc, do not exist.

Define the management area. Draw on a map (no less detailed than 1:50,000) the outer limits of the management area in which wallaby density is to be assessed.

Where the management area is likely to contain significantly different wallaby densities the area should be stratified. Each strata should reflect a particular wallaby density. This will allow faecal transect distribution to be relative to density and area of the strata. This is best done by assessing the management area with the Guilford Scale first.

A minimum of 5 transects are recommended and up to 15 for larger areas to ensure reasonable coverage.

[8] An approximate t value of 2 is used (as for analysis of possum trap catch data).

On a 1:50,000 map of the area, number each grid square and randomly to select the number required. The line origin can be the centre of the grid square. It is not necessary to randomly choose compass bearings, but the bearing chosen should be the same for all lines.

Each transect is to have 50 plots placed 15 metres apart. A transect is therefore 750 metres long. Compass, hip chain or running line, peg and string with string marked 40 cm and 80 cm, pen and paper.

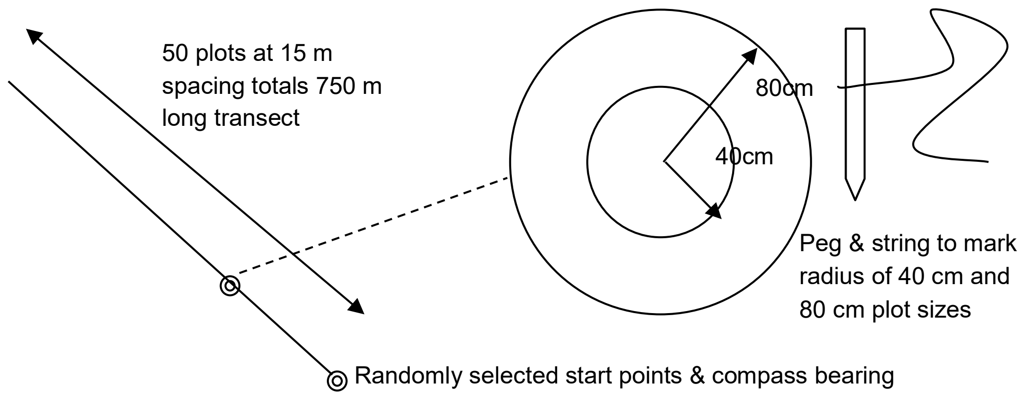

Figure 6. Wallaby faecal pellet transects & plots

- The observer uses the compass to determine the direction of the transect.
- 15 metres is measured off and the peg with string attached is placed in the ground.
- The presence or absence of faecal pellets within a 40 cm and 80 cm radius of the plot centre is recorded.
- The two radii are selected to allow for extreme pellet frequencies. That is pellet frequencies greater than 80% on 80 cm radius plots will be poorly reflected by further increases in pellet frequency. The 40 cm radius plots have lower frequencies and, therefore, a greater range over which to increase, allowing measurement of increases in pellet frequencies at higher levels.
- The process is repeated for every 15 metres until 50 plots have been measured.
- There is a strong correlation between this method and the Guilford Scale ($r^2 = 0.965$, $df = 9$, $p < 0.001$). The relationship is described in the table below (for Bennett's wallabies).

Guilford Scale	Pellet Frequencies (%)
1	0-5
2	>5-25
3	>25-60
4	>60-80
5	>80

4.4.1 Data analysis

Data analysis is best described by example.

Number of plots pellet positive

1995	1996	*Difference*
31	25	-6
18	23	5
0	1	1
4	1	-3
35	31	-4
43	41	-2
19	21	2
14	5	-9
11	7	-4
23	28	5
9	19	10
3	12	9

1. Calculate the difference from year 1 to year 2 as shown above.
2. Calculate mean difference and the standard deviation.

mean = 0.333
s = 6.005

3. Calculate the Standard Errors as s/√n

\|F(6.005,√12) = \|F(6.005,√3.4641) = 1.7334

4. Calculate the C.I. as mean ± (t)(s) and ∞ = 0.1

\ 0.333 ± 1.796 x 6.005 = -10.451 to 11.117

As the C.I. passes through zero there has been no significant change.

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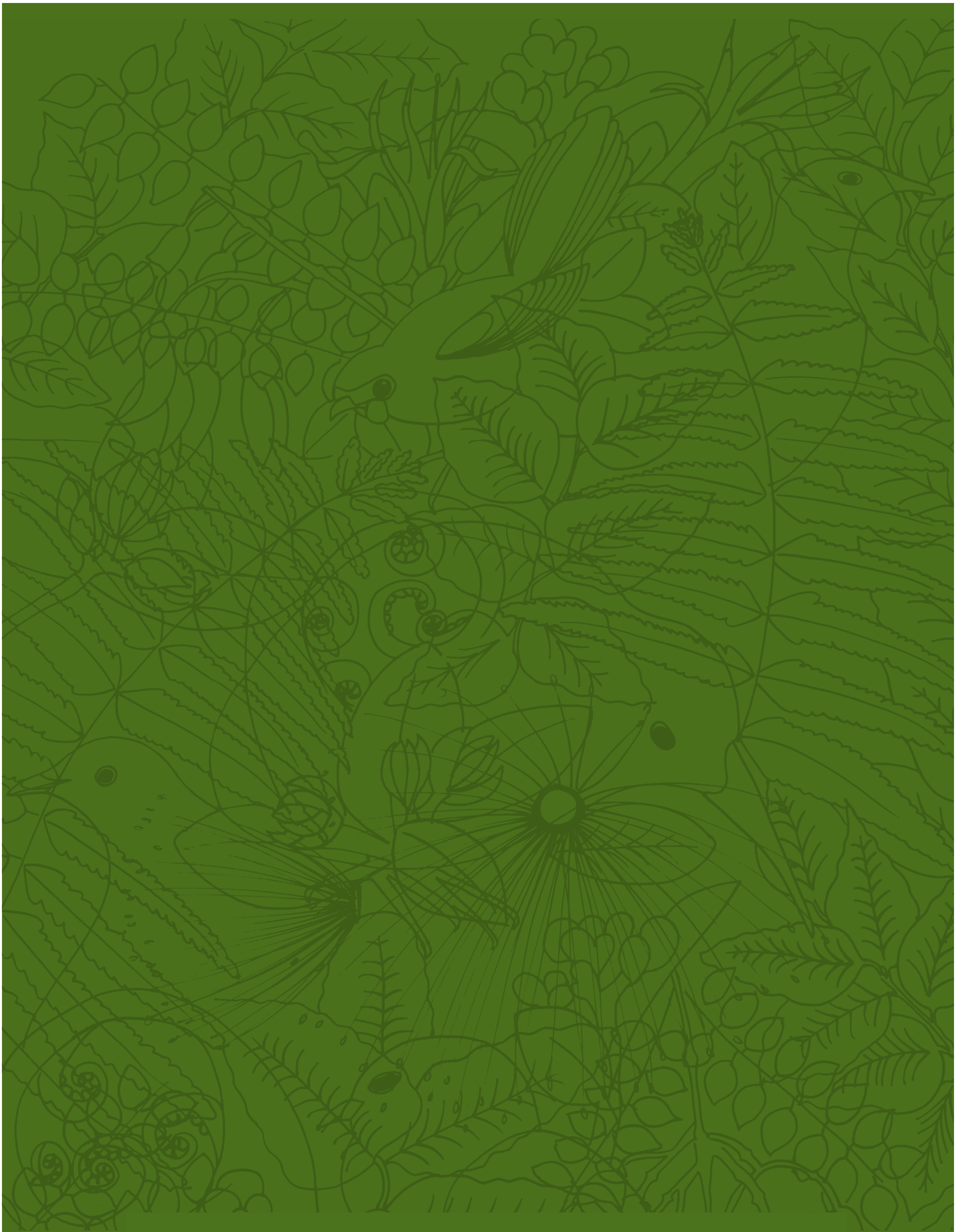

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