Introduction to animal pest monitoring

Version 1.2

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Contents

Inventory and monitoring toolbox: animal pests

DOCDM-340712

Introduction

This vertebrate pest module provides a link between the (see Guideline to monitoring population version 1.0, and the decision trees and comparative tables. Appropriate selection of monitoring methods and their rigorous application will ensure a high level of consistency of monitoring across the Department and over time. Monitoring surveys need to be designed carefully to ensure they generate data that are appropriate for the management and associated monitoring objectives and for the desired conservation outcomes. Consequently, as a first step, clearly define your objective(s). Only after your objectives have been defined, can you select the appropriate monitoring method. The design of your study (e.g. number of lines and/or devices) must be sufficient to obtain the precision required to statistically detect a given effect size (see Guideline to monitoring population version 1.0). There is often a compromise between the cost of monitoring and the confidence in the data that are collected. There is always a risk of generating monitoring data that have insufficient statistical power to meet the monitoring and management objectives. It is therefore essential that the person with the responsibility for the monitoring design and selecting the method understands the concepts of spatial and temporal variation, bias, precision, effect size, and the impacts that violation of method assumptions might have. Additionally, some monitoring methods are lethal (e.g. traps) and for these, welfare costs should also be considered along with dollar costs. See the comparative tables for more guidance on comparing different methods for trend and status, inventory or management objectives.

A decision tree will help guide you towards the most suitable monitoring method depending on the objectives of your study and potentially, there may be more than one method available for use. The method specifications define the standards for each method. It is acknowledged that for some recommended methods there is a longer history of established use than for others. The Biodiversity and Monitoring Toolbox endeavours to have the most up-to-date method specifications, and content is updated and amended when and where appropriate. The decision tree should be used as guidelines to assist in your selection of monitoring method along with consideration of all the Guideline to monitoring population version 1.0**.** If the method you choose differs from the method recommended in the decision tree, then it is important to document why those choices were made so these can be considered, and if appropriate, used to update the decision process.

The majority of methods described in the Toolbox generate an index of abundance not an actual estimate of density or the number of animals present. For most management purposes an index will be sufficient, although the assumption of constant detectability must be accepted (see Anderson 2001, 2003, & Engeman 2003). The index of abundance can be from a single survey providing information on the status of the pest population (inventory), or if multiple surveys are carried out over time these monitoring surveys can be either long-term or, if before and after pest control, short-term. Monitoring over time is typically carried out to assess either the effectiveness of some management action (e.g. a pest control operation) or longer-term trend in population numbers in the absence of control. Monitoring pest populations can also assist in prioritising pest control between sites – those areas with higher numbers get treated first everything else being equal.

Generally, small mammals in forest can be monitored using traps to obtain an index of Catch-Per-Unit-Effort (CPUE), or tracking tunnels and interference devices such as waxtags to obtain a tracking or interference rate. Other methods such as mark-recapture are often used by researchers to obtain estimates of actual numbers of individuals and are not recommended for the majority of pest management operations. If there is a need to know actual numbers or density then it is recommended that expert advice is sought.

Potential issues in inventory and monitoring of animal pests

All surveys of animals requires the method used to be able to detect the target animal, and it is important to be sure that any change in an index is actually indicating a change in the abundance of the population and not a change in detectability (see Anderson 2001, 2003 & Engeman 2003). A specific challenge with monitoring vertebrate pests is that the population abundance can change markedly from very low levels (e.g. post control) when high sensitivity might be required, to very high levels (e.g. pre control) when the method used becomes saturated and therefore under-estimates abundance (Caughley 1977). This latter problem is especially relevant to interference methods such as tracking tunnels, waxtags and chewcards that often have interference rates greater than 60%. Removal methods such as trapping can provide more robust indices for higher densities, but because fewer traps are generally used than interference devices, trap-based surveys are often less sensitive at very low densities. Selection of the survey method will always require compromise, but should nevertheless always be based on a sound understanding of the constraints of each method.

Some inventory methods are essentially “walk-through methods” and provide a qualitative estimate of abundance (i.e. Modified Mcleans score for rabbits and Guilford scale for wallabies – not described in the Toolbox yet). These methods enable field staff to rapidly inspect an area and assign some qualitative measure of relative abundance to the area inspected. Such an approach might be useful when first inspecting an area for presence/absence and relative abundance, but will be more generally applicable where there is an area of Public Conservation Land adjacent to private lands which have a pest infestation level stipulated in a Regional Council’s Regional Pest Management Plan (RPMP). Here, there might be good neighbour justifications to ensure pests are managed across boundaries.

Most survey methods recommended are quantitative methods (e.g. spotlight counts, trap catch) and these should be used when more robust estimates of abundance are required, especially for monitoring either short-term (e.g. a percentage kill resulting from a control operation) or long-term population changes (trends). Quantitative methods have best practice methodologies to ensure greater consistency is applied, which makes the estimates more comparable between areas and over time.

Long-term population trend information is valuable both for management and research, and so it is preferable to keep using the method historically used even though new lower-cost or non-target-species-safe methods might be available (e.g. trap-catch vs waxtags). If this is the case and there is a wish to change methods, careful consideration should be given to any changes and preferably several surveys should be carried out using both methods so the new and old indices can be rigorously correlated. Seek specialist advice.

Pest animals that often get exposed to traps and poisons might develop bait or trap aversion, and if monitoring is relying on the animal to interact with a device (i.e. chewing a card or entering a trap) the willingness of the animal to interact may change over time and therefore change its detectability. So, although there are good reasons for keeping the device and any bait used consistent over time, stay alert to the fact that such repeated use might also negatively affect the index obtained. This is particularly relevant to monitoring the same pest at the same site over time.

Selecting a method

For some species there is only one recommended method (e.g. ship rats), therefore no choice, but for others there are three or more options (e.g. possums). Other factors may constrain the method you can choose. For example, species that occupy habitats with low vegetation cover and that are generally nocturnal (e.g. rabbits and wallabies) can be monitored using spotlight counts. For the large ungulates, indices of CPUE can be obtained from routine control operations providing control effort (i.e. person-hours spent actively hunting) is recorded. Your method choices may also be influenced by whether you are monitoring other pest species at the same site (e.g. rodents and possums).

The Toolbox does not cover all monitoring methods that are available and for all vertebrate pest species. For some species (e.g. hedgehogs and cats) there are no accepted monitoring methods available. If such species need to be monitored then expert advice should be sought before commencing any monitoring programme

Small mammals

Because of the secretive nature of New Zealand's small vertebrate pests, their nocturnal habits, and preference for dense cover, these species cannot be directly observed and counted. Consequently, surveys must use devices that can be left in place for a number of days to enable the target species to interact with them and either catch them or obtain tracks or teeth marks. Because most devices are baited to encourage animals to interact with them, it is very important that the baiting specifications are consistently adhered to over time and between sites (see issue of aversion mentioned above).

The behaviour of the smallest of the vertebrate pests (i.e. mice, rats, stoats, and ferrets) that frequently seek prey in holes and hollows, enables tunnels (i.e. tracking tunnels) to be used for detection.

The larger possum cannot be monitored using tracking tunnels and because of its long history of being trapped for fur, trapping evolved as the main monitoring method and became an industry standard as part of an extensive performance-based possum control contracting industry. Nevertheless, recently the use of waxtags and chewcards as detection devices has developed as a lower-cost option and as a method for obtaining more spatial occupancy data when monitoring possums at very low densities. These detection devices

show potential for rodents as well. If monitoring is being carried out as part of a performance contract (i.e. determining whether to pay a contractor or not), it is important to use a method that is defensible. A national trap catch protocol for possums was developed to ensure the method was standardised across New Zealand.

Wallabies

The two wallaby species that occur on mainland New Zealand (i.e. Bennett's in South Canterbury and dama around Rotorua) occupy contrasting habitats. The Bennett's wallabies occupy areas of tall tussock, scrubland, and some native forest remnants. Over the large area of farmland they occupy they are managed by Canterbury Regional Council under their Regional pest Management Plan, and the Council has developed monitoring methods such as the Guilford scale inspection method and fixed faecal pellet plots for monitoring long-term trends. Because this species is often found in relatively open habitat they can sometime be monitored using spotlight counts at night or distance sampling during the day.

Dama wallabies inhabit the dense forests in the Rotorua area, but also feed on adjacent farmland where they can be monitored using spotlight counts. However, because most of their range is within forest the only option available here is to use faecal pellet counts.

Pigs

Pigs occur throughout New Zealand occupying both forest and farmland habitats. They are difficult to monitor and no agreed method has been developed although surveying pig rooting has been used. If this species is being controlled then obtaining a CPUE index will provide a crude index of abundance as long as the effort (time spent hunting and number of dogs used) is well documented.

Forest ungulates

There are several species of deer and goats that occupy forest habitats, and in these habitats where direct observation is impossible, the only option currently recommended is faecal pellet counts. There is a standard protocol developed for using faecal pellet counts to monitor deer, but because goats often use latrine sites where large numbers of faecal pellets can accumulate, faecal pellet counts are not recommended for goats. CPUE indices are an option for monitoring goats.

When carrying out faecal pellet counts in areas where several species might overlap (e.g. deer and tahr in high altitude forest) special care must be taken to ensure pellets are correctly identified.

Alpine ungulates

Chamois and tahr inhabit the mountain areas of the South Island and chamois can also be found through West Coast forests down to sea level. In their mountain habitats these species are best monitored using direct observation either from fixed points on the ground or as part of aerial surveys. In forest areas, they can be monitored using faecal pellet counts but care must be taken to ensure chamois, tahr and deer are not confused.

Potential future options

A method that is growing rapidly, but that has not been developed to the stage of accepted operational practice is the use of trail cameras or camera traps. Because cameras work essentially as passive devices (i.e. do not require an animal to enter or actively interact with a device) they have the potential to overcome some of the problems with current methods (e.g. trap aversion). Additionally, they have the potential to be useful for monitoring a wide range of species from small mammals to goats and pigs and because photos are date and time stamped, they can monitor both pre and post control periods with only two visits to the site (i.e. to set up and to remove).

References

Anderson DR. 2001. The need to get the basics right in wildlife field studies. *Wildlife Society Bulletin 29:* 1294-1297.

Caughley 1977. Analysis of vertebrate populations. The Blackburn Press, New Jersey, USA. 234pp.

Engeman RM. 2003. More on the need to get the basics right: population indices. *Wildlife society Bulletin 31:* 286-287.

Anderson DR. 2003. Response to Engeman: Index values rarely constitute reliable information. *Wildlife Society Bulletin 31:* 288-291.

Using the animal pests module

Read this section carefully before proceeding further. It describes the content you will find in the module and the tools that are available to help you to choose appropriate methods.

Note that the methods in the Toolbox are not an exhaustive list of all possible methods. A limited number of methods are available now and other methods will be added as modules are expanded.

Before proceeding with this module you must have:

- Carefully considered the objectives of your study.
- Understood the key components of project design and sampling. These are found in 'A guideline to monitoring populations' (docdm-870579); specifically the sections 'Design and implementation framework', 'Statistical concepts' and 'Sampling approaches'.
- Use the comparative tables and decision tree tools as guidelines to choose the most appropriate method(s).
- Read the method specifications once you have selected suitable methods. Each method is summarised in terms of its inherent assumptions, advantages, disadvantages, and suitability for inventory or monitoring given the objectives and the skills and resources required. Additional information is provided (or referenced) so you can apply the method yourself. (Each method sets out the minimum attributes to be recorded, appropriate data storage, analysis pathways and interpretation). Case studies highlighting the practical application of each method and problems encountered in the real world are also described.
- Best practice and standard operating procedures for managing animal pests are not covered by this module. For DOC staff use the DOC Operational Planning of Pest Management [1] for support in planning your pest operations and making best use of DOC SOPs and resources. As part of the Framework, the DOC Current Agreed Best Practice system will help you to evaluate possible control methods for your pest problem.
- Determine whether you require mandatory training to use a particular method. If such training is required, it will be noted with the method description.

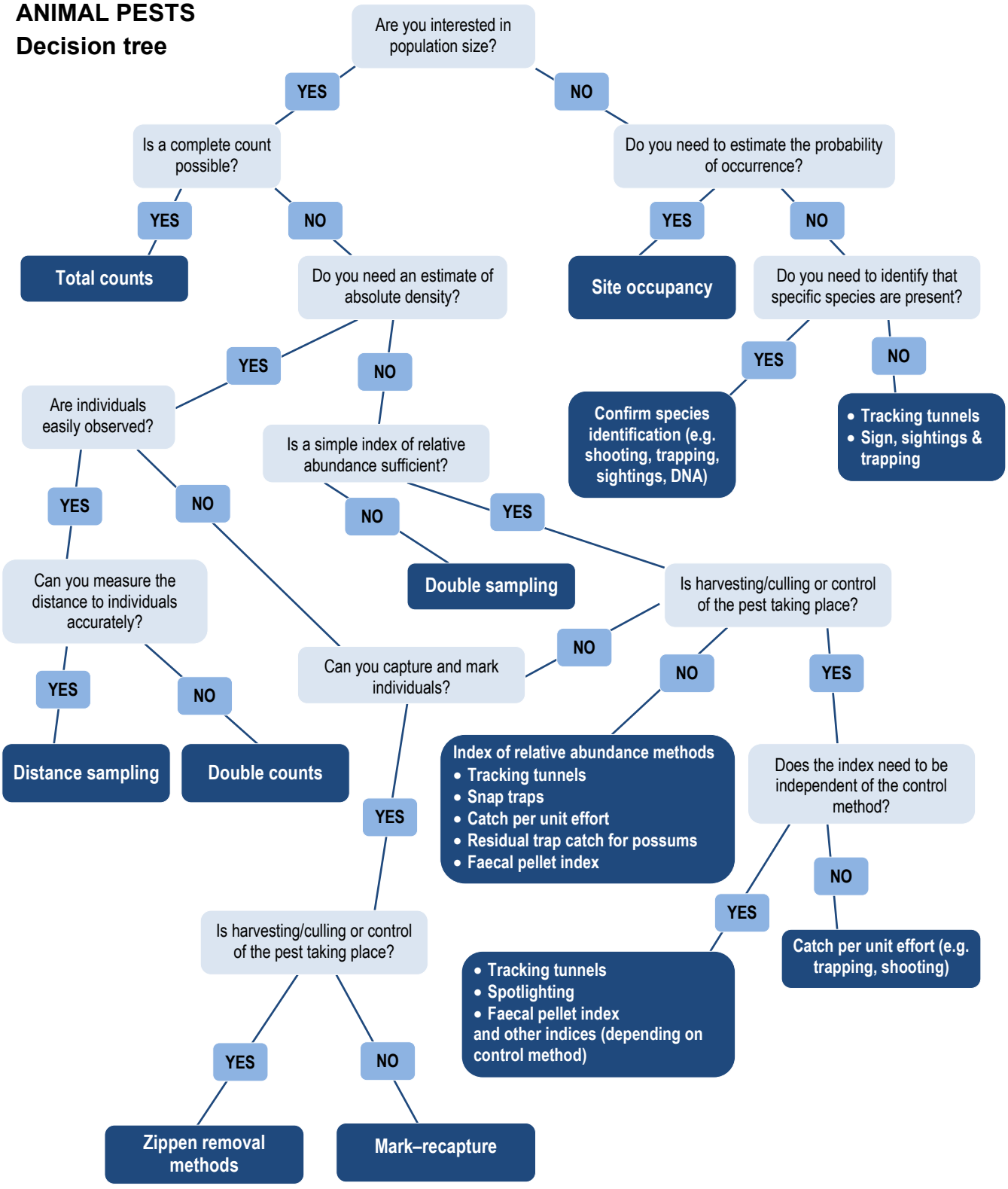
Use the decision trees together with the comparative tables to guide you to the most suitable and cost-effective method to use to answer specific inventory and monitoring questions.

[1] DOC staff may access the DOC resources to plan pest management operations on the DOC Intranet. External users may contact their local DOC office for more information.

Decision tree 1

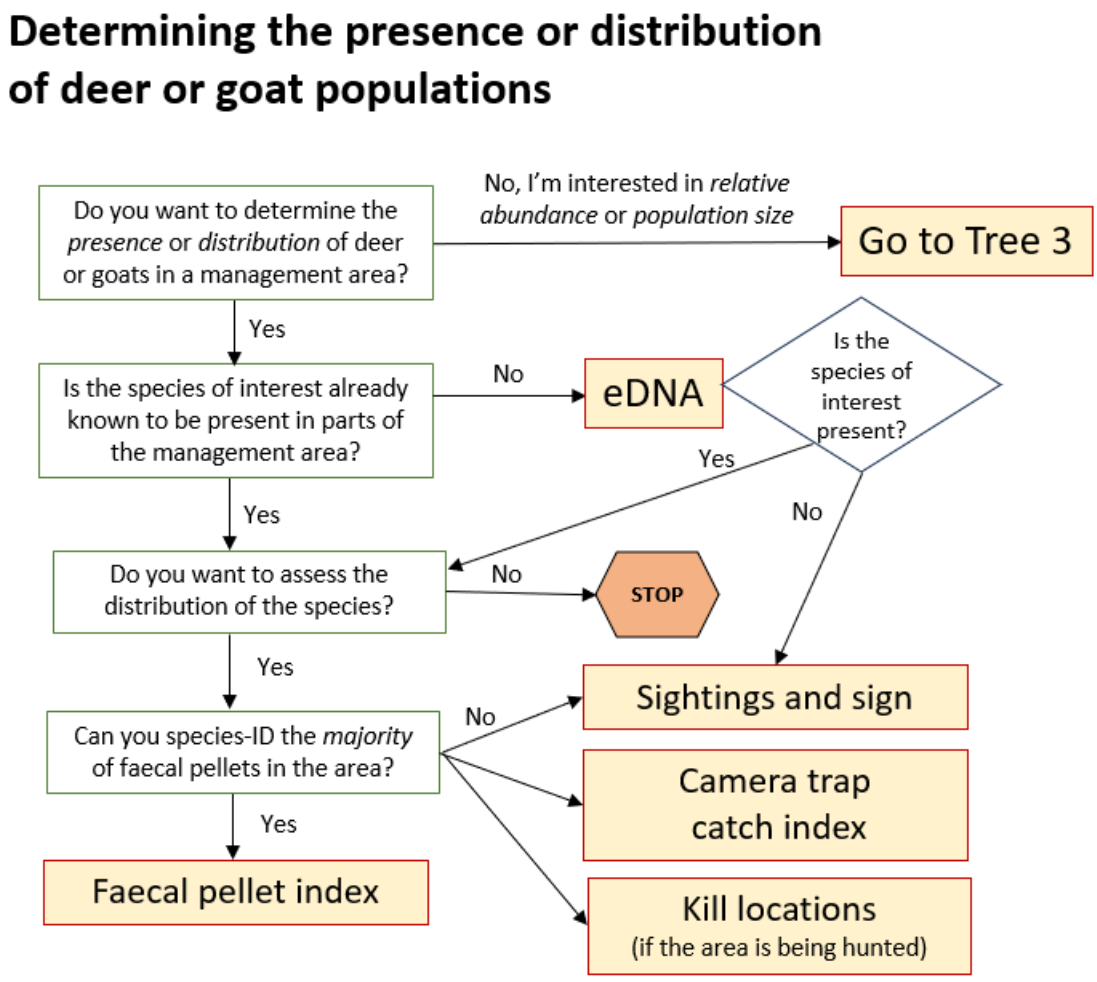
Decision tree 1 guides you through the most suitable methods for determining total or incomplete counts of animal pest populations.

ANIMAL PESTS
Decision tree



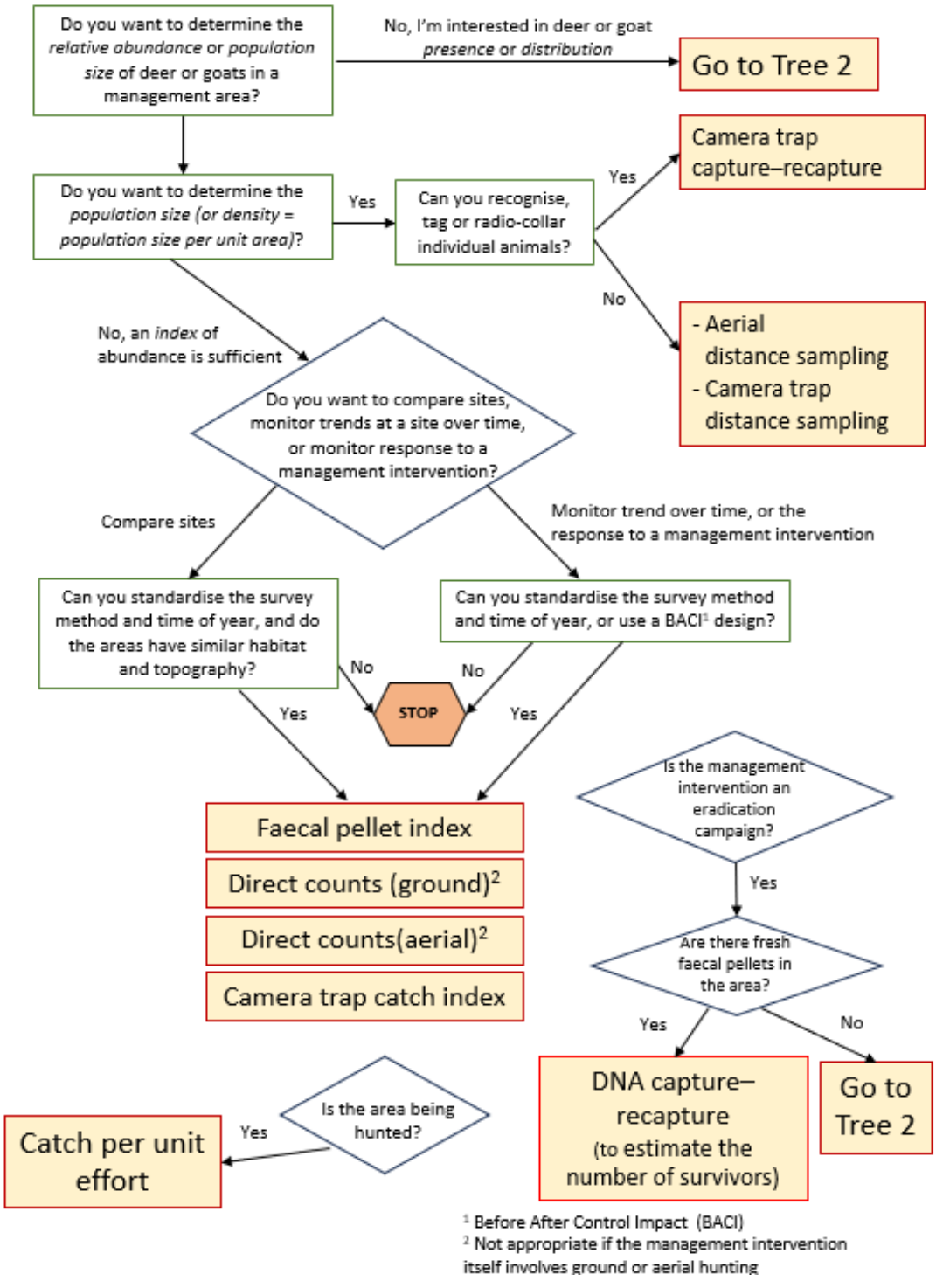
Decision tree 2

Decision tree 2 guides you through the most suitable methods for determining the presence or distribution of deer or goat populations.



Decision tree 3

Decision tree 3 guides you through the most suitable methods for determining the relative abundance or population size of deer and goat populations.



[1] Before After Control Impact (BACI)
[2] Not appropriate if the management intervention itself involves ground or aerial hunting

Comparative tables of methods

Use these comparative tables to guide you to the most suitable and cost-effective method to use to answer specific inventory and monitoring questions. Table 2 evaluates the suitability of the method 'Animal pests: tracking tunnel indices of small mammal abundance' to monitors.

Tables 3 - 5 compare the suitability of methods to monitor goats and deer.

Table 1. Recommended techniques for the inventory and monitoring of animal pests in New Zealand. **Method precision** (relative to objectives): ✓✓✓ Good; ✓✓ Medium; ✓ Poor; X Not Recommended; **–** Not Applicable. **Resources:** L = Low; M = Medium; H = High.

	Inventory objectives*	Resources			Monitoring objectives†			Resources		
Method	Suitability for inventory	Equipment costs	Personnel costs	Skills required	Surveillance[1]	Status & trend[2]	Management[3]	Equipment costs	Personnel costs	Skills required
Complete counts	No methods in Toolbox yet									
Incomplete counts	No methods in Toolbox yet									
Indices of relative abundance										
Snap trap indices of rodent abundance	✓✓✓	M	L	L	✓✓	✓✓	✓✓	M	M	L
‡ Tracking tunnel indices of small mammal abundance	✓	M	L	L	✓✓	✓✓	✓✓	M	L	L
Faecal pellet counts	✓✓	L	L	L	✓✓	✓✓	✓✓	L	L	L
Residual trap catch for possums	✓	L	L	L	X	✓✓	✓✓✓	L	L	L
Night counts for rabbits	✓✓	L	L	M	X	✓✓	✓✓	L	L	M
Estimates of absolute abundance and density										
Distance sampling for Bennett's wallaby	✓	L	M	M	_	✓✓✓	✓✓	L	M	M

‡ Please note: more information about the suitability of this method for small terrestrial mammals is expanded in Table 2 below.

Table 2. This table evaluates the suitability of the method 'Animal pests: tracking tunnel indices of small mammal abundance' (docdm-322684) for inventory and monitoring of small terrestrial mammals in New Zealand. Recommended techniques for the inventory and monitoring of vertebrate pests in New Zealand. **Method precision** (relative to objectives): ✓✓✓ Good; ✓✓ Medium; ✓ Poor; X Not Recommended; **–** Not Applicable. **Resources:** L = Low; M = Medium; H = High.

	Inventory objectives*	Resources			Monitoring objectives†			Resources		
Method	Suitability for inventory	Equipment costs	Personnel costs	Skills required	Surveillance[1]	Status & trend[2]	Management[3]	Equipment costs	Personnel costs	Skills required
Tracking tunnel indices of small mammal abundance										
Ship rat	✓	M	L	L	✓✓	✓✓	✓✓✓	M	L	L
Norway rat	✓	M	L	L	✓✓	7	✓	M	L	L
Kiore	✓	M	L	L	✓✓	✓✓	✓✓	M	L	L
House mouse	✓	M	L	L	✓✓	✓	✓✓	M	L	L
Stoat	✓	M	L	L	✓✓	✓✓	✓✓	M	L	L
Weasel	✓	M	L	L	✓✓	✓	✓✓	M	L	L
Ferret	✓	M	L	L	✓✓	✓✓	✓✓	M	L	L
Hedgehog	✓	M	L	L	✓	7	7	M	L	L

* Inventory is a one-off survey or assessment with no intention to re-measure. If inventory of a site is repeated in the future this can be considered monitoring. Typical inventory objectives include: What species are present at a site and how are they distributed over a landscape? What are the species habitat relationships? What is the wildlife value/significance of an area (SSWI, etc)? Is this a baseline survey? Interpretation of results must be based on the understanding that these are single surveys.

† Monitoring assesses change or trend over time and requires re-measurement of parameters at some pre-determined frequency. Typical monitoring objectives include:

1. What species have moved into an area? Have range extensions occurred for a species of interest (e.g. monitoring for biosecurity risk—illegal introductions and cage bird releases)?
2. What is the population abundance or density of a species or community? Is this stable over time? What are the population trends? Does this relate to habitat use?
3. Do population estimates of density and abundance change as a result of management action? Over what time-scale does this occur? Has a species translocation succeeded? Has management been effective? Has species composition altered as a result of management?

Table 3. This table evaluates the suitability of techniques for inventory and monitoring of free-ranging deer and goats in New Zealand. Sub-methods are indicated by shading and italicised text. Method suitability: ✓✓✓ = good; ✓✓ = medium; ✓ = poor; X = not recommended or not applicable.

Method	Suitable for deer	Suitable for goats	Can differentiate ungulate species	Avoids bias from habitat (e.g. forest vs. grassland)	Avoids bias from weather conditions and season	Usable across a range of animal populations densities	Usable at small scale (i.e. individual mgmt. units)	Usable at medium scale	Usable at regional or national scale	Sufficient information to develop a Toolbox protocol
Ground counts										
Sightings and sign	✓✓✓	✓✓✓	✓✓✓	✓	✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Faecal pellet index	✓✓✓	✓✓[a]	✓	✓	✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Direct counts (ground)	✓[b]	✓[b]	✓✓✓	✓	✓	✓✓✓	✓✓	X	X	X
Double counts	✓[b]	✓[b]	✓✓✓	✓	✓	✓✓✓	✓✓	X	X	X
Distance sampling	✓[b]	✓[b]	✓✓✓	✓	✓	✓✓✓	✓✓	X	X	X
Thermal imagery	✓✓[b]	✓✓[b]	✓✓✓[c]	✓	✓	✓✓✓	✓✓✓	X	X	X
Aerial counts										
Direct counts (aerial)	✓✓[b]	✓✓[b]	✓✓✓	✓	✓	✓✓✓	✓✓✓	✓✓	✓	✓✓✓
Aerial double counts	✓✓[b]	✓✓[b]	✓✓✓	✓	✓	✓✓✓	✓✓✓	✓✓	✓	✓✓
Aerial distance sampling	✓✓[b]	✓✓[b]	✓✓✓	✓	✓	✓✓✓	✓✓✓	✓✓	✓	✓✓
Aerial thermal imagery	✓✓✓[b]	✓✓[b]	✓✓✓[c]	✓	✓	✓✓✓	✓✓✓	✓✓	✓	✓✓
Motion-sensor camera traps										
Camera trap catch index	✓✓[d]	✓✓[d]	✓✓✓	✓✓	✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓
Camera trap distance sampling	✓✓[d]	✓✓[d]	✓✓✓	✓✓	✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓
Camera trap capture-recapture	✓✓[d]	✓✓[d]	✓✓✓	✓✓	✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓
Hunting										
Kill locations	✓✓✓	✓✓✓	✓✓✓	✓	✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Catch per unit effort	✓✓✓	✓✓✓	✓✓✓	✓	✓	✓✓✓	✓✓✓	✓✓	✓	✓✓✓[e]
DNA methods										
DNA capture–recapture	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓	✓✓✓	X	X	✓✓✓
eDNA	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	?	✓✓✓	✓✓	X	✓

[a] Poor for high-density goat populations due to aggregation of faecal pellets at latrine sites.

[b] Better in habitats with open canopy; poorer for dense canopy.

[c] Contingent on adequate resolution of the thermal sensor vs distance of the observer from the target animals.

[d] Good in habitats with open understorey; poor in dense understorey.

[e] Contingent on social licence for the data collection.

Table 4. This table evaluates the suitability of deer and goat inventory and monitoring techniques to address management strategies and survey objectives. Sub-methods are indicated by shading and italicised text. Method suitability: ✓✓✓ = good; ✓✓ = medium; ✓ = poor; X = not recommended or not applicable.

Method	**Inventory (i.e. presence/absence)**	**Comparisons between areas**	**Trend in abundance over multiple years**	**Response to suppression or other management**	**Estimation of population numbers**	**Detection of incursions**	**Tracking geographical spread**	**Proof of eradication**
Ground counts								
Sightings and sign	✓✓✓	✓	✓	✓	X	✓✓✓	✓✓✓	✓✓
Faecal pellet index	✓✓[a]	✓✓[a]	✓✓✓[a]	✓✓[a b]	X	✓✓[a]	✓✓✓[a]	✓✓[a]
Direct counts (ground)	✓✓	✓	✓	✓	X	✓✓	✓✓	✓
Double counts	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓
Distance sampling	✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓	✓✓	✓
Thermal imagery	✓✓	✓	✓	✓	X	✓✓	✓✓	✓
Aerial counts								
Direct counts (aerial)	✓✓✓	✓	✓	✓	X	✓✓✓	✓✓✓	✓
Aerial double counts	✓✓✓	✓✓	✓✓	✓✓[c]	✓✓	✓✓✓	✓✓✓	✓
Aerial distance sampling	✓✓✓	✓✓	✓✓	✓✓[c]	✓✓✓	✓✓✓	✓✓✓	✓
Aerial thermal imagery	✓✓✓	✓	✓	✓✓[c]	X	✓✓✓	✓✓✓	✓✓
Motion-sensor camera traps								
Camera trap catch index	✓✓✓	✓✓✓	✓✓✓	✓✓[b]	X	✓✓✓	✓✓✓	✓✓
Camera trap distance sampling	✓✓✓[d]	✓✓✓	✓✓✓[d]	✓✓	✓✓✓	✓✓✓[d]	✓✓✓[d]	✓✓[d]
Camera trap capture-recapture	✓✓✓[d]	✓✓✓	✓✓✓[d]	✓✓	✓✓✓	✓✓✓[d]	✓✓✓[d]	✓✓[d]
Hunting								
Kill locations	✓✓✓	✓	✓	✓	X	✓✓✓	✓✓✓	✓
Catch per unit effort	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓[e]	✓✓✓	✓✓✓	✓
DNA methods								
DNA capture–recapture	X	✓✓[f]	✓✓[f]	✓✓[f]	✓✓[f]	X	X	✓✓✓
eDNA	✓✓✓	X	X	X	X	✓✓✓	✓✓	?

[a] Good if other ungulate species are not present or if faecal DNA for species ID can be used; poor if species identification is problematic. The Faecal pellet count method is described here.

[b] Poor for short-term (within-year) responses unless a BACI design is possible.

[c] Not suitable for monitoring areas where aerial search-and-destroy operations have been conducted.

[d] Better addressed by using the simpler camera trap catch index method.

[e] Only suitable when population age-structure or population rate of increase data are known

[f] Only suitable for small, closed populations.

Table 5. This table evaluates the resourcing and other practical requirements for deer and goat inventory and monitoring techniques. Sub-methods are indicated by shading and italicised text. Method requirements: H = high; M = moderate; L = low; X = not recommended or not applicable; dashes indicate a range.

Method	Initial equipment / set-up costs	Operating costs	Field staff resources	Field skills training	Analytical costs	Analytical skills training (or subcontracting)	Speed at which results will become available	Potential for AI to accelerate analysis
Ground counts								
Sightings and sign	L	L	M–H	L	L	L	H	X
Faecal pellet index	L	L	M–H	L	L	L	H	X
Direct counts (ground)	L	L	M–H	L	L	L	H	X
Double counts	L	L	H	M	L	L	H	X
Distance sampling	L	L	H	M	L	L	H	X
Thermal imagery	M	L	H	M	L	L	H	M
Aerial counts								
Direct counts (aerial)	H	H	L	L	L–H*	L–H*	L–H*	L–H*
Aerial double counts	H	H	L	M	L–H*	L–H*	L–H*	L–H*
Aerial distance sampling	H	H	L	M	L–H*	L–H*	L–H*	L–H*
Aerial thermal imagery	H	H	L	H	L–H*	L–H*	L–H*	L–H*
Motion-sensor camera traps								
Camera trap catch index	H	L	M	M	H	L	L	H
Camera trap distance sampling	H	L	H	M	H	M	L	H
Camera trap capture-recapture	H	L	H	M	H	M	L	H
Hunting								
Kill locations	L	L	M–H	L	L	L	H	X
Catch per unit effort	L	L	M	L	L	L	H	X
DNA methods								
DNA capture–recapture	L	L	M–H	L	M–H	H	M–H	?
eDNA	L	L	L	M	H	H	M–H	?

* Low for direct observations; high if extensive post-flight analysis of photos or videos is required.

Appendix A

The following Department of Conservation documents are referred to in this method:

docdm-870579	A guideline to monitoring populations
docdm-322684	Animal pests: tracking tunnel indices of small mammal abundance