Animal pests: faecal pellet counts

Version 1.0

This specification was prepared by Des Smith in 2012.

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Inventory and monitoring toolbox: animal pests

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Department of Conservation
Te Papa Atawhai

Synopsis

In some situations the amount of animal dung present in an area will be related to the number of animals present. This technique is more effective for species that defecate when active, and is ineffective for animals that return to the same site (latrine) to defecate. This method specification focuses mostly on faecal pellet counts for deer, but other wild animals that also leave countable pellets or dung include horses, goats, possums, rats, pigs and hares. Horses often defecate in their core home ranges for social reasons, and goats commonly live in groups and return to night-time rest places, which means their populations are not readily measured with procedures based on dung or pellets. Possums also produce identifiable faecal pellets, but a rigorous method based on trap catch rates is available through the National Pest Control Agencies (NPCA).[1] Rat abundance can be indexed using track rates in small tunnels (see 'Animal pests: tracking tunnel indices of small mammal abundance'—docdm-322684). Pig dung has been quantified in studies overseas, but can be difficult to sample where rooting disturbs and covers the immediate area with soil. Thar and chamois also deposit pellets, but the topography of their home ranges prevents the measuring of good samples. Hares produce an extremely durable faecal pellet, and methods used in New Zealand involve clearing old pellets off small plots and quantifying the rate of recruitment of fresh pellets.

Exactly how to gather counts of pellets and use them to index animal abundance depends on:

- The species being monitored
- The objectives of the monitoring programme (e.g. whether managers wish to measure current relative densities, population trends, or estimate the percentage of the population killed in a control operation)
- The range of densities that are to be measured
- The topography of the site

Earlier faecal pellet count protocols, typically employed by the New Zealand Forest Service (NZFS), thought that an index of deer abundance could be estimated if the following variables were known:

- The standing crop (or amount of pellets)
- The rate which pellets are deposited
- The rate which pellets decay (Forsyth 2005; Forsyth et al. 2007)

There are many faecal pellet survey methods; the main approaches that have been used in New Zealand include:

- Presence/absence: Records the presence/absence of faecal pellets on plots evenly spaced along a randomly located transect. Frequencies (percentage of plots with pellets present) are then calculated from the data.

[1] http://www.npca.org.nz/index.php/publications/a-best-practice

- Total counts: Involves counting the total number of pellets or pellet groups found within plots evenly spaced along randomly located transects. The data is then used to estimate the density of pellets/pellet groups per hectare.
- Recruitment rate (limited to rabbits and hares): Pellets are cleared off permanently marked plots and the plots are resurveyed (after a given time interval) to determine the rate of recruitment of pellets back onto the plots (through animal defecation). The data is used to estimate the number of pellets/pellet groups recruited per hectare, per day. This technique was developed for species or locations where pellet decay rate is likely to be slow. But when decay rates are slow, the same pellets/pellet groups may be counted during consecutive surveys, leading to the index becoming inflated.
- Point distance–nearest neighbour: This method involves measuring the distance between selected points on a transect and the centre of the nearest pellet (found after a concentric search) (Batcheler 1975). This method also estimates the density of pellets/pellet groups per hectare and was developed because researchers had become aware that plot size is a form of bias in estimates, with smaller plot sizes leading to larger estimates of pellet density (Batcheler 1975).

There are shortcomings of these methods that readers should take note of. Determining the recruitment rate and rate of pellet decay is not well known in New Zealand. For pellet count surveys, transects were set up in semi-random designs that usually began at a river and followed a direct bearing to the top of a ridge or high point. This non-random design meant the area of inference (the wider area that the results could be extrapolated to) was not defined. The relationship between pellet index methods and the relative abundance of deer was assumed to be positive and linear (Forsyth 2005; Forsyth et al. 2007). Consequently these methods were really an index of animal use and not of animal abundance because the index had not been calibrated with known animal densities.

Managers often want to know the effect of their management actions on deer abundances and so there needs to be a demonstrable relationship between true animal abundance at a site and the number of pellets counted in samples from that site. This was studied for red deer under New Zealand conditions on safari parks where the true density of deer was known by farm managers (Forsyth et al. 2007). They found that as deer increased, the number of intact pellets counted in small round plots along random transects also increased. This allowed them to construct an index of the relative abundance of deer—a faecal pellet index (FPI). They found there was an approximate linear relationship between faecal pellet counts and deer density, and potentially, it is the best faecal pellet count method that is available because of this demonstrated relationship. The FPI protocol (see 'Protocol for estimating changes in the relative abundance of deer in New Zealand forests using the faecal pellet index (FPI)'—docdm-641685)[2] provides detailed descriptions about how to carry this method out and to analyse data. Refer to Forsyth et al. (2007) to read more about faecal pellet count indices and deer density.

[2] Available online: http://www.doc.govt.nz/upload/documents/conservation/threats-and-impacts/animal-pests/fpi-protocol.pdf

Assumptions

- The density of faecal pellets has a known quantitative relationship with the true density of an area. At low densities they may fail to detect animals and at higher densities they become saturated.
- A calibration undertaken by Forsyth et al. (2007) has shown that the assumption of linearity with true density was met for red deer (*Cervus elephus*). However, it cannot be assumed that this relationship applies to other species.

Advantages

- Faecal pellet counts are logistically simple to undertake compared with many other monitoring methods, meaning that large areas can be surveyed efficiently.
- Requires little skill and so can be undertaken by most individuals.
- It is repeatable.
- Faecal pellet counts are often the only historical data available for presence/absence of animals in a site. However, the NZFS pellet count index methods were a measure of animal use, not animal abundance, because there has been little calibration between pellet counts and known densities of deer until recently with the FPI.
- Faecal pellet counts are a suitable method of sampling for most habitats.

Disadvantages

- It is unlikely that defecation and decay rates are constant between sites or over time, meaning that not all of the variation in collected data will be caused by variation in animal abundance. Therefore faecal pellet counts should only be used to measure large (rather than subtle) changes in abundance.
- Recruitment rates require prior knowledge of the daily defecation rates of the animal of interest and how they vary between individuals, seasons, habitat types and locations. There has been little research into the daily defecation rates of pest species in New Zealand, and past New Zealand estimates have used defecation rates observed in overseas studies. We do not recommend using recruitment rates to estimate animal density until there has been substantial research into pest animal defecation rates in New Zealand.
- Some species (e.g. deer) are known to avoid permanent plots where pegs are visible (Nugent et al. 1997). Therefore methods requiring plot pegs should be avoided.
- Faecal pellet counts can be tedious, therefore the quality of the result is largely dependent on the motivation and concentration of observers in the field.

Suitability for inventory

Faecal pellet counts can be used for surveillance purposes to establish the presence of a species, but cannot reliably establish absence. Absence cannot be established unless it is known that there would be a 100% chance of seeing pellets if they were present.

Suitability for monitoring

The main use of faecal pellet counts is to monitor changes in animal populations. However, when using this method, consideration must be given to the assumptions listed above.

Skills

- Field staff need to be able to reliably identify faecal pellets from the species of interest when they occur amongst the faecal pellets of other species. It is acknowledged that deer and goat pellets are usually indistinguishable.
- Pellet counting is tedious work and differences in concentration spans between observers can create bias. It is essential that field staff are able to maintain concentration along transects.

Resources

The following equipment is generally required for most pellet surveys and the FPI (Forsyth 2005):

- Notebook
- Datacards
- Pencil
- Compass
- Search-radius string (15–25 cm)
- Running line (5 m non-stretch cord)
- Topographic maps and/or aerial photographs
- GPS

A search-radius string consists of a length of nylon cord attached to a small metal peg (such as a bicycle spoke) which assists the observer to search the plot systematically by focusing attention on the area immediately in front of and under the cord. Refer to the FPI protocol (docdm-641685) for more information about the field equipment that is specifically needed for this method.

Minimum attributes

These attributes are critical for the implementation of pellet counting methods. Other attributes may be optional depending on your objective. For more information refer to 'Full details of technique and best practice'.

DOC staff must complete a 'Standard inventory and monitoring project plan' (docdm-146272)

The minimum attributes to record for each plot are:

- Date of the survey
- Site name
- Plot number

- Transect number
- Faecal pellet count (depending on the method being used, e.g. the presence/absence of faecal pellets, or the number of pellets present, or the number of intact pellets in each pellet group in each plot.
- Observer name
- Length of radius used

Data storage

Forward copies of completed survey sheets to the survey administrator, or enter data into an appropriate spreadsheet as soon as possible. Collate, consolidate and store survey information securely, also as soon as possible, and preferably immediately on return from the field. The key steps here are data entry, storage and maintenance for later analysis, followed by copying and data backup for security.

Summarise the results in a spreadsheet or equivalent. Arrange data as ‘column variables’, i.e. arrange data from each field on the data sheet (date, time, location, plot designation, number seen, identity, etc.) in columns, with each row representing the occasion on which a given survey plot was sampled.

If data storage is designed well at the outset, it will make the job of analysis and interpretation much easier. Before storing data, check for missing information and errors, and ensure metadata are recorded.

Storage tools can be either manual or electronic systems (or both, preferably). They will usually be summary sheets, other physical filing systems, or electronic spreadsheets and databases. Use appropriate file formats such as .xls, .txt, .dbf or specific analysis software formats. Copy and/or backup all data, whether electronic, data sheets, metadata or site access descriptions, preferably offline if the primary storage location is part of a networked system. Store the copy at a separate location for security purposes.

Analysis, interpretation and reporting

Seek statistical advice from a biometrician or suitably experienced person prior to undertaking any analysis.

To calculate a relative index from faecal pellet counts using the FPI:

- A full and lengthy description to calculate a change in deer density at a site using the FPI is detailed on pp. 11–21 of the FPI protocol (docdm-641685).

To calculate a relative index from faecal pellet counts using other less preferred approaches:

- Presence/absence: If presence/absence is used then data is analysed by calculating a pellet frequency for each transect, using the following equation:

$$\text{Pellet frequency (\%)} = \frac{\text{no. of presences}}{\text{no. of plots}} \times 100$$

- Total counts: When using total counts the pellet group density (PGD) is calculated for each transect using the following formula:

$$\text{PGD (groups/ha)} = \frac{\text{no. of groups}}{\text{total no. of plots}} \times \frac{10000}{\pi \times r^2}$$

Where r = plot radius (m) and π = 3.1416.

- Recruitment rate: For the recruitment rate method, the recruitment rate (RR) is expressed as the number of pellets or pellet groups recruited per hectare, per day (along each transect), calculated using the following formula:

$$\text{RR (groups/ha/day)} = \frac{\text{no. of groups recruited}}{\text{total no. of plots}} \times \frac{10000}{\pi \times r^2} \times \frac{1}{T}$$

Where r and π are as above and T is the interval between plot clearance and assessment in days.

- Point distance–nearest neighbour: If the point distance–nearest neighbour approach is used then PGD can be calculated in a manner that corrects for dispersion in the data and therefore is less biased compared with other calculations of PGD. The calculations for this are reasonably complicated (using exponential regression formulae); however, refer to Batcheler (1975) and Spurr et al. (1976) for worked examples.

Estimating animal density from the pellet recruitment rate (RR): The actual density of rabbits or hares per hectare (D) can be estimated by dividing the recruitment rate (RR) by the number of defecations per animal per day (DFR). (Note that DFR is not thoroughly researched in New Zealand.)

$$\text{D} = \frac{\text{RR}}{\text{DFR}}$$

Case study A

There is no case study available for this method.

Full details of technique and best practice

- Pellet counts are used as an index of relative animal abundance at a site because it is not possible to undertake a total count of individuals within a population in a site. Older applications

of pellet count methods had problems with their underlying assumptions and applications, and for these reasons they are not recommended.

- Plot size, the number of plots per transect, and the number of transects needed will depend on the species being monitored, the size of the monitoring site, and the level of precision required to answer questions specific to the monitoring objectives.
- Forsyth (2005) describes the FPI protocol (docdm-641685) that has been designed to measure the long-term changes in deer abundance. It has calibrated an index of pellet counts against known densities of deer and it is recommended that this protocol is read thoroughly before undertaking monitoring using faecal pellet counts for deer.

References and further reading

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Appendix A

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

docdm-641685	Protocol for estimating changes in the relative abundance of deer in New Zealand forests using the Faecal Pellet Index (FPI)
docdm-146272	Standard inventory and monitoring project plan
docdm-322684	Animal pests: tracking tunnel indices of small mammal abundance