Field protocols for Tier 1 monitoring

- invasive mammal, bird, bat, RECCE surveys

Version 14



Contents

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Department of Conservation
Te Papa Atawhai

Inventory and monitoring toolbox

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1. Overarching sampling design

Sampling will occur on sampling locations selected from a national 8 × 8 km grid which overlaps with Public Conservation land (PCL).

At each sampling location, a series of vegetation, soil and animal surveys will be carried out: 20 × 20 m vegetation plot measurement; RECCE; soil sampling; possum monitoring; ungulate, rabbit and hare faecal pellet counts; swabbing ungulate faecal pellets for DNA; 5-minute bird counts; bird acoustic recordings; bat acoustic recordings and ground surveys for birds and a range of mammal pests.

These surveys will all be centred on the 20 × 20 m vegetation plot (Figure 1 and Figure 2). The primary aim of this inventory and monitoring programme is to provide unbiased, repeatable ecological-integrity-indicator estimates for Public Conservation lands.

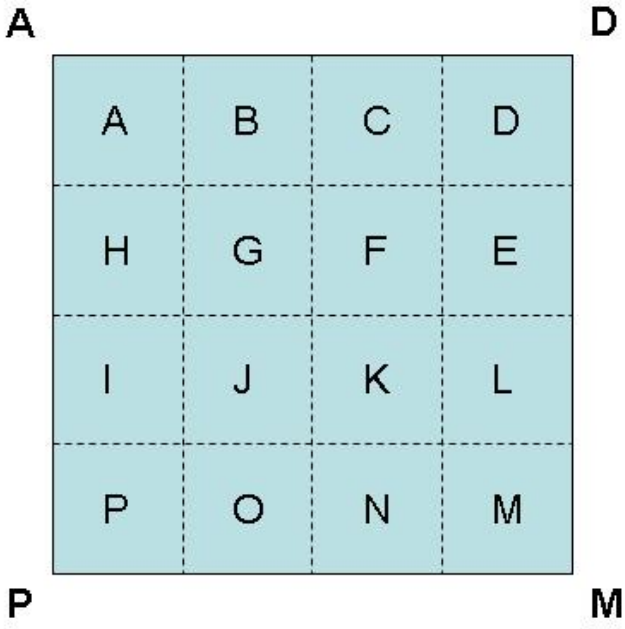


Figure 1. Outline of 20 × 20 m vegetation plot, illustrating the labelling system used to identify each corner of the plot and each of the 16 (5 × 5 m) subplots within it.

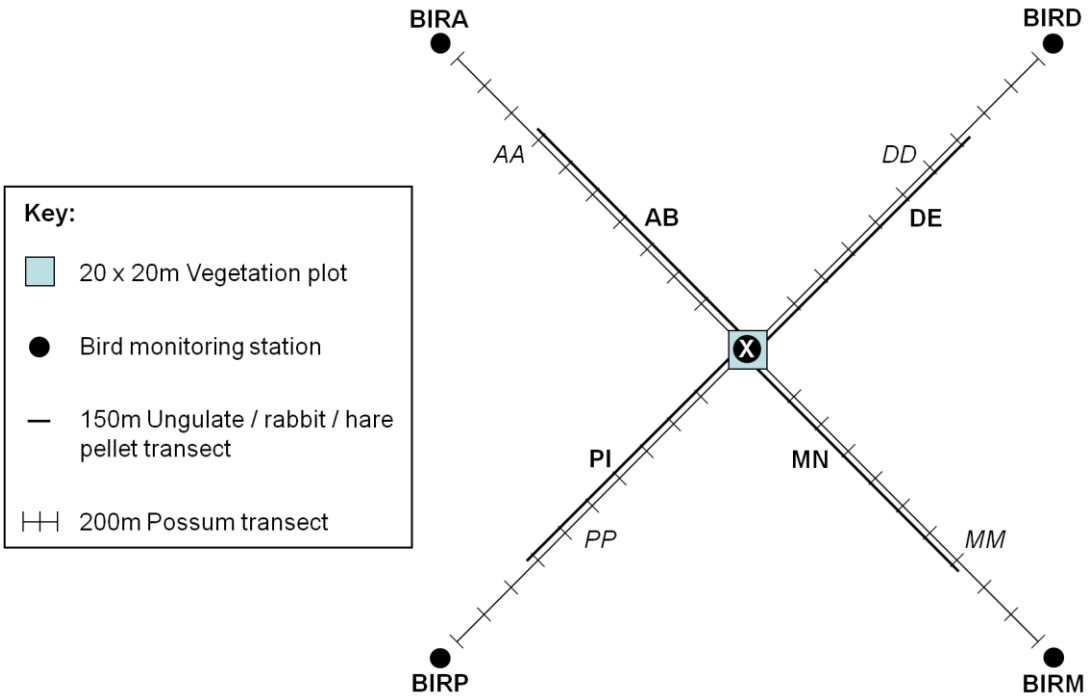


Figure 2. Layout of animal survey sampling units in relation to the vegetation plot at each sampling location. Additionally, RECCE surveys are conducted in bird count stations BIRA, BIRD, BIRM and BIRP.

2. Operational delivery

Health and Safety

SAFETY IS PARAMOUNT do not attempt to establish or remeasure transect lines or Bird Stations that you deem unsafe, or that puts the safety of yourself, your team or subsequent teams at risk.

For new plots refer to Protocol for possum transect lines; Encountering barriers on transect lines on page 17.

For existing plots, refer to Remeasuring plots; Mammal monitoring on Page 6 and Bird Count Stations on Page 7 for guidance on methods to apply.

Coupled versus de-coupled sampling

The sampling programme is delivered using a mixed operating model for deploying teams:

1. **Coupled sampling:** vegetation sampling is completed **with** animal sampling at a single plot visitation.
2. **De-coupled sampling:** vegetation and animal sampling are conducted separately on **two** plot visitations.

In a **coupled** sampling scenario, the vegetation and animal team collaborate to fulfil the required tasks on the plot.

In a **de-coupled** sampling scenario, the team that visits the sampling plot **first** is required to capture essential plot data and communicate the results to the team that visits the plot next.

Paired methods

In all cases, including when lines transition from one habitat to another (e.g. Forest to Non Forest grassland), the bird count station and a pellet line must remain paired with a possum transect line even if it results in shortening of ungulate lines or abandoning the bird count station.

Logistic and sampling time recording

These data are an integral component of the programme for planning, decision making and reporting. Teams are required to document as accurately as possible the time taken to complete each of the survey techniques.

- **Logistical travel times** (e.g. travel from base to-and-from plot location) is recorded as part of the Metadata Record Sheet.
- **Sampling method duration times** are recorded by team members using the Metadata Record Sheet or the Field Diary Data Record Sheet in the Field Data Record Sheets for Mammal Surveys. If you identify any other time-consuming tasks that are not included in the

data record sheets during the sampling, please make sure that you highlight this information in the appropriate Notes section of the data record sheet.

Photographs

For any photographs, other than the compulsory and incidental photographs defined in the measurement protocol, record in the relevant 'Notes' section of the field data record sheets; a description of the photo and location details, e.g. GPS or plot number.

Historical data

Historic Animal measurement data for plots will vary depending on the measurement history. Measurement history is recorded on Metaform for each plot (e.g. 'New' or 'Remeasure'). Take copies of the data record sheets listed below.

Remeasure plots

For all existing plots, Take copies of the:

- Metadata Record Sheet (i.e. permission contact details, time allocation times (e.g. travel from base to-and-from plot location))
- RECCE Site Description Record Sheet (i.e. approach details and location diagram)
- Photos of plot layout to aid in relocation (if available)

In addition, for all sites where Animal methods are being remeasured, take copies of the:

- Animal Remeasurement Reports
- Previous photos of animal transect' s and bird stations to aid in relocation (if available).

DO NOT take any of the previous data record sheets listed below. It is important to avoid any bias in the data collected due to knowledge of previous data/species.

- 5MBC or incidental sightings
- Ungulate counts
- Possum monitoring data
- DNA results or casual observations
- Bird RECCE

New plots

For all new plots or existing plots that have no historical animal measures, check if the Vegetation team has already visited and established the plot.

If already established by the Vegetation team take copies of:

- Metadata Record Sheet (i.e. permission contact details, time allocation times (e.g. travel from base to-and-from plot location))

- RECCE Site Description Record Sheet (i.e. approach details and location diagram)

Photos of plot layout to aid in relocation (if available) If not established take copies of the

- Relocation Record Sheet (i.e. alternative plot location details defined by pre-determined sequence of options).

Remeasuring plots

The bird and mammal methods are analysed as a repeated measure and comparisons made between measures. **It is important that as many of the transect lines and bird stations are remeasured in the same locations as last time** to enable this. Note: Do not attempt to replicate ungulate transects from previous measure. Ungulate lines should be paired with the current possum transect as per standard protocols.

When a plot has been measured previously, follow the procedures outlined below.

Mammal monitoring

Measure all possum and ungulate transect lines that were established and measured previously. Apply the following:

- Make every attempt to follow the previous transect line in order to get as close to the previously established bird station as possible.
- Start from the 20 × 20 m plot corners as normal. Using your compass and the Animal Remeasure Reports, follow the previous transect line placing chewcards as normal.
- Apply the following:
  - If a transect line had divergences at last measure (breaks/turns etc.) these should be repeated again where possible.
  - Where turns were made at last measure (this is indicated on the Animal Remeasure Reports), make the same turn and bearing. These do not need to be repeated ‘exactly’ (i.e. there may be small deviations depending on individual’s assessment of terrain).
  - If a possum transects had breaks/turns at previous measure and it is now possible to run the transect line without turns (i.e. barrier has been removed), repeat the turns from previous measure.
  - If a possum transect was established differently to current methods, do not correct these. Measure the transect lines as they were established.
- Mark all turns with a GPS and record these and the bearings in the GPS Data Record Sheet.
- When remeasuring existing transect lines, SAFETY IS PARAMOUNT, do not attempt to follow transect lines that you deem unsafe.
- If a transect line was not established at last measure but can be established this time, complete the transect lines established previously as highest priority. Then establish and measure all other transect lines if possible.

- If a transect line was only partially completed at last measure (e.g. due to hazard) and no associated BIRD station was established, extend and complete the transect line in full if the hazard is no longer present. Establish a bird station at the end of the possum transect line (refer to Section 11) if the possum transect line is long enough (at least 140 m of its length; i.e. at least seven PMDs are set). Ensure bird count stations remain a **minimum** of 150 m apart (horizontal distance).
- Where it is not possible to repeat the transect lines as they were established, apply the following:
  - If transects have become unsafe since previous measurement, apply standard protocols for barriers (see Encountering barriers on transect lines p.17), and:
    - At the next possible location, turn transect lines back to realign with the previous transect and end as close to the bird stations as possible.
    - Note: A maximum of one device (20 m) movement is allowed to realign with historical transect (Figure 3).
    - If it is not at all possible to realign, attempt to run as close as **safely** possible.
    - See Bird Count Station rules in the following section in these cases.

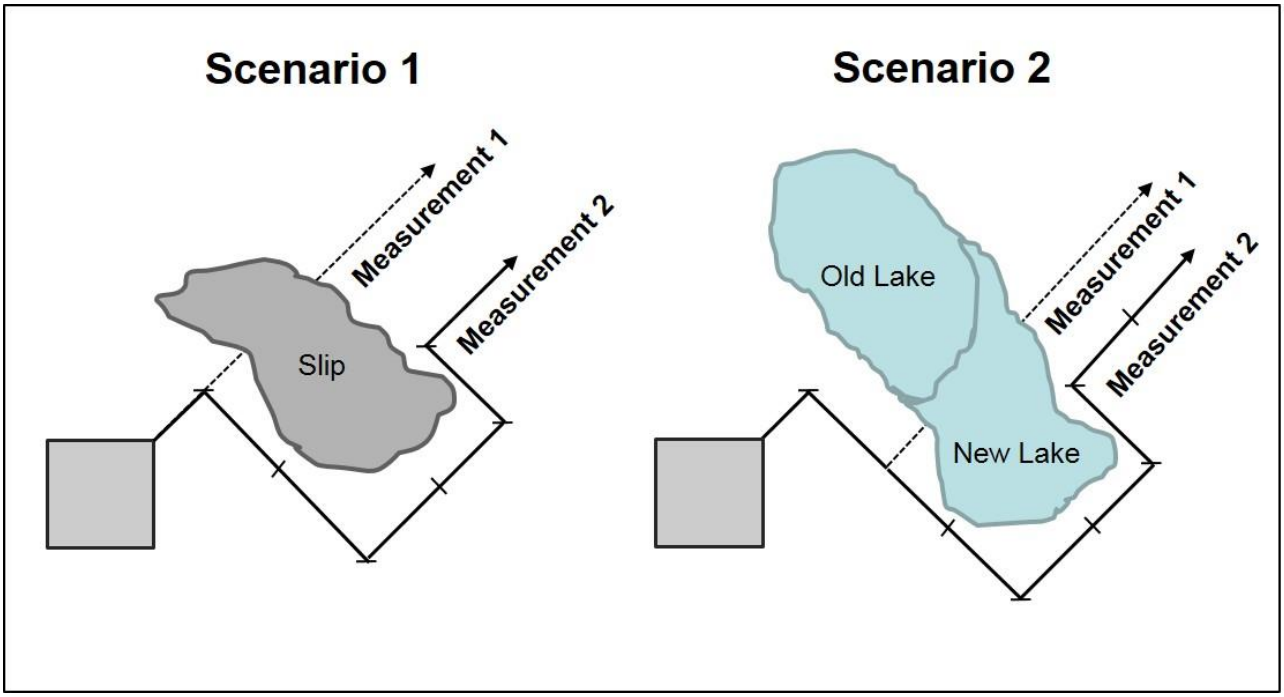


Figure 3. Examples of realignment where it was not possible to repeat the original measurement of transect lines as they were established.

- If the information you have to remeasure the line is not making sense, e.g. Animal Remeasure Reports does not record a turn when you are at a barrier or information seems incorrect, then:
  - Check the bearings provided – these may be back bearings?
  - Check any information you have to see if can reinterpret what was done last time

- THEN: If no clear explanation, treat the line as for a new plot and apply standard protocols for barriers (see Encountering barriers on transect lines p.17), and

Possum transect remeasurement terminology

- **New**: New plots where transects are newly established or existing plots where transects were not established previously.
- **Exactly Repeated**: Existing plots where Animal methods are being remeasured and a transect line is remeasured the same as last time. Circle 'Exactly Repeated' in the 'Transect Remeasurement' field on the Field Data Record Sheets for Mammal Surveys.
- **Deviated**: Existing plots where Animal methods are being remeasured and a transect line is not measured the same as last time. Circle 'Deviated' in the 'Transect Remeasurement' field on the Field Data Record Sheets for Mammal Surveys and provide the reason why in the 'Notes' field.
- **Not measured**: Existing or new plots where transects lines are not measured (e.g. abandoned due to health and safety risks). Tick the 'Transect Not Measured' box on the Field Data Record Sheets for Mammal Surveys and provide the reason why in the 'Notes' field

Bird count stations

Measure all existing bird stations that were established and measured previously and in their original locations. Using the distance from the end of the transect line and GPS location of the station on the Animal Remeasure Reports to locate ALL existing bird stations. Apply the following:

- If a bird station was not established at last measure but can be measured this time, complete the bird stations measured previously as highest priority. Then establish and measure all other bird stations if possible.
- If at the last measure two bird stations were established with less than 150m horizontal separation, do not move stations. Re-measure these in the exact location of establishment.
- Make a thorough attempt to find all previously established bird stations.
- The station will be marked with permolat or aluminium pole.
- From the end of the possum transect, use your GPS to determine the distance from the end of the current possum transect to the bird station.
    - If within 60 m, attempt to find and measure these in the original location they were established.
        - If the station is located, circle **'Re-found'** in the 'Station Remeasurement' field on the Distance Sampling (5MDist) Data Record Sheet and record the distance from the end of the current transect line in the 'Bird Station Notes' field in the Field Data Record Sheets for Bird Surveys.
        - If the station is not located (after thorough searching), replace the bird station 20 m from the end of the current line using standard protocols (see p. 47).

Permanently mark the new station with permolat. Circle '**Replaced**' in the 'Station Remeasurement' field on the Distance Sampling (5MDist) Data Record Sheet and provide the reason why in the 'Reason' field. GPS the bird station and record in the GPS Data Record Sheet in the Field Data Record Sheets for Bird Surveys.

  - If greater than 60 m, do not attempt to find or remeasure the station; move and replace the bird station 20 m from the end of the current line using standard protocols (see p. 47). Permanently mark the new station with permolat. Circle '**Replaced**' in the 'Station Remeasurement' field on the Distance Sampling (5MDist) Data Record Sheets and provide the reason why in the 'Reason' field. GPS the bird station and record in the GPS Data Record Sheet in the Field Data Record Sheets for Bird Surveys.

- If a bird station has become unsafe since previous measurement, you can move and replace the bird station 20 m from the end of the current line using standard protocols (see p. 47). Permanently mark the new station with permolat. Circle '**Replaced**' in the 'Station Remeasurement' field on the Distance Sampling (5MDist) Data Record Sheet and provide the reason why in the 'Reason' field. GPS the bird station and record in the GPS Data Record Sheet in the Field Data Record Sheets for Bird Surveys.
- If a bird station has become unsafe since previous measurement, and cannot be replaced, abandon this station. Tick 'Station not measured' field and provide the reason why in the 'Reason' field on the Distance Sampling data Record Sheet.
- To ensure maintenance and repeatability of bird stations, damaged permolat must be repaired or replaced. Record "permolat replaced" in the 'Bird Station Notes' field on the Distance Sampling (5MDist) Data Record Sheet and provide the reason why.

Noise

- If at this measure there is too much noise at an existing bird station and this noise is temporary (e.g. high winds at the time of measurement), move on to the next station and re-visit this station again later when the noise may have abated. If at this stage it is still too noisy, abandon the measures at this time. Tick the '**Station Not Measured**' box on the Distance Sampling (5MDist) Data Record Sheet and provide the reason why in the 'Notes' field.
- If at this measure there is too much noise at an existing bird station, and this noise is a permanent issue (e.g. station was established next to a waterfall) you can move the bird station up to 20 m from its current location along the same bearing, or if necessary, back along the current line as far as PMD 7, using standard protocols (see p. 47). Permanently mark the new station with permolat and record as **'Replaced'** and provide the reason why in the 'Reason' field on the Distance Sampling (5MDist) Data Record Sheet.

Bird count timing and frequency

- When remeasuring plots, complete bird counts within ± 1 hour of the start time from the previous measure, if possible.

- If, at the previous measure, two sets of bird counts were completed at each station, this can be repeated.
- A second round of counts should only be completed if there is sufficient time available to **complete counts at all established stations** (avoids biased sampling).

Bird station remeasurement terminology

- **New**: New plots where a bird station is newly established or existing plots where a station was not established previously. Circle '**New**' in the 'Station Remeasurement' field on the Distance Sampling (5MDist) Data Record Sheet.
- **Re-found**: Existing plots where animal methods are being remeasured and an original bird station is found and remeasured. Circle '**Re-found**' in the 'Station Remeasurement' field on the Distance Sampling (5MDist) Data Record Sheet.
- **Replaced**: Existing plots where animal methods are being remeasured and an original bird station is not found and a new station is established. Circle '**Replaced**' in the 'Station Remeasurement' field on the Distance Sampling (5MDist) Data Record Sheet and provide the reason why in the 'Reason' field.
- **Not Measured**: Existing or new plots where a bird station is abandoned (e.g. found but not measured or not established). Tick the '**Station Not Measured**' box on Distance Sampling (5MDist) Data Record Sheet and provide the reason why in the 'Notes' field.

Non-key methods: Priority order for abandoning

While on a plot, situations may arise when teams need to abandon **non-key methods** (see below for a list of non-key methods). For example, there is significant weather on its way that effects team safety.

It is not acceptable to abandon non-key methods earlier than 11:00am if the only reason for this is to set up the next plot on the same day.

If non-key methods are abandoned teams do not need to stay longer, nor is there a requirement to return to complete these methods.

Below is a ranked list of **non-key methods** indicating the order in which these methods can be abandoned or changed first (1) - last (5):

1. 2nd round of bird counts
2. Bird RECCE vegetation description (complete as many as possible)
3. Bird RECCE site description (complete as many as possible)
4. DNA sampling (complete as many as possible)
5. Pulling acoustic recording device (ARD) before 1300 hours. While it is preferable for the ARDs to be left in position until the end of the recording period (1300 hours), they can be collected as early as 11:00am (Refer to Deploying the recorder in Section 12).

Key methods: Priority order for postponing

IMPORTANT: SAMPLING OF PELLET LINES, POSSUM LINES, 1ST ROUND OF BIRD COUNT STATIONS AND ARD's MUST BE COMPLETED UNLESS TERRAIN OR SAFETY CONCERNS PREVENT IT.

However, situations may arise, whilst on a plot, when teams cannot complete all **key measurements** and need to postpone measurements (e.g. significant weather on its way or safety concerns). Abandoning these methods is **not** permitted.

Animal survey methods should be conducted over 1 night. If these methods are not completed, then either:

A. **Stay longer and measure the plot over multiple days, or**
B. **Return to the plot within 30 days.**

Important in all cases:

- It is imperative that measurement takes place on a fine night as marginal conditions will significantly affect the data.
- In all cases, teams will need to consult with their Supervisor immediately and while still at the site.

A. Standards for measuring on multiple days

- Teams should prioritise establishment of easier lines to maximise the number of lines completed on Day/Night 1. This is to reduce potential bias in the data from measuring over multiple days. Note: This does not mean that the team should **only** complete easy lines. The only acceptable reason for not completing a line is terrain (i.e. physical barriers preventing establishment).
- In the event of establishment of lines on different days during the same visit, teams need only measure a line once; it does not matter if transect lines are set on different nights, but you need to shut down lines that have already been measured.
- Part-lines should not be established on Day 1 and then completed on a second day. When a line is started, and it is clear that the line cannot be completed in time for monitoring that night, possum monitoring devices (PMDs) should be unset/removed and lure removed (if required). This line should be completed on the second day and set that night.
- For bird counts it is also acceptable to measure the five stations over more than one day. It is assumed that bird distributions and abundances do not vary over a few days within the sampling area.
- ARD recorders should not be left out for multiple days. ARD's must be coupled with bird counts and deployed the night before the observer counts at each bird station, to capture the nocturnal and diurnal recording sessions within the same 24-hour period.

Below is a ranked list of **key methods** indicating the order in which these methods can be postponed **from 1 (first to postpone) to 3 (last to postpone):**

1. Pellet lines
2. Possum lines
3. Bird counts (including ARD's)

B. Standards for returning to the plot

If circumstances dictate staying extra nights is not possible—e.g. measurements are split over 2 nights and significant weather prevents completion of 2nd night—teams are required to return to a plot **within 30 days** to complete the postponed measurements as follows:

- Complete only the possum lines you did not complete on the first visit.
- Complete only the ungulate lines you did not complete on the first visit.
- Complete, if time allows, all bird count stations (observer-based counts and ARDs). If time is limited, complete only those stations that were not measured on the first visit. It is optimal to re-deploy the ARD recorders the night before the observer counts, to capture the nocturnal and diurnal recording sessions within the same 24-hour period.

In the case that teams return to a plot **beyond 30 days**, all three key animal methods must be completed again in full.

3. Labelling protocol for GPS points

Each survey protocol specifies which key GPS points need recording in your **GPS unit** on the GPS Data Record Sheet. Each GPS point label will consist of three elements: [Sampling location] [survey type] [sampling unit] or [additional point identifier]. The concatenation of the different elements that make up the labelling system are illustrated in Table 1.

Table 1. GPS labelling protocol.

Sampling location	**Identifier**	**Survey type**	**Identifier**	**Sampling unit**	**Identifier**	**Additional point**	**Identifier**	**Examples of GPS labels**
Unique code for each 8 km grid point consisting of capital letters and numbers.	e.g. ABC123	Animal team		Corner P	**P AN**	year	**16**	**ABC123PAN16**
		Bird	**BIR**	Count station	**X, A, D, M, P**			**ABC123BIRX**
		Possum	**POS**	Transect	**AA, DD, MM, PP**			**ABC123POSAA**
		Ungulate/ rabbit & hare	**UNG**	Transect	**AB, DE, MN, PI**			**ABC123UNGAB**
		Ground	**G**	2 × 2 km^2		Ungulate and wallaby sightings	**Species name**	**ABC123GREDDEER** **ABC123GGOAT**
		Note: Some early National Vegetation Survey (NVS) plots have labelled the plot corners 'A', 'B', 'C', 'D' rather than 'A', 'D', 'M', 'P'. When this lettering system is encountered, keep to the animal protocol labelling system and **do not** follow the old labelling system. Make a note about the original plot labelling divergence on the Metadata Record Sheet.				Start points End points Turning points	**START** **END** **T1, T2,** etc.	**ABC123POSAASTART** **ABC123POSAAEND** **ABC123UNGABT1** **ABC123UNGABT2**
						Transport: Landing area Landing area Car parking	**HELILAND** **BOATLAND** **CARPARK**	**ABC123HELILAND** **ABC123BOATLAND** **ABC123CARPARK**
						Base	**BASE**	**ABC123BASE**
						Camp	**CAMP**	**ABC123CAMP**

4. Mammal survey overview

At each sampling location, a series of mammal surveys will be conducted:

1. **Possum monitoring**
2. **Ungulate, rabbit and hare faecal pellet counts**
3. **Swabbing ungulate faecal pellets for DNA**
4. **Ground survey for introduced mammal pests**

These surveys are centred on a 20 × 20 m vegetation plot (Figure 4 and Figure 5).

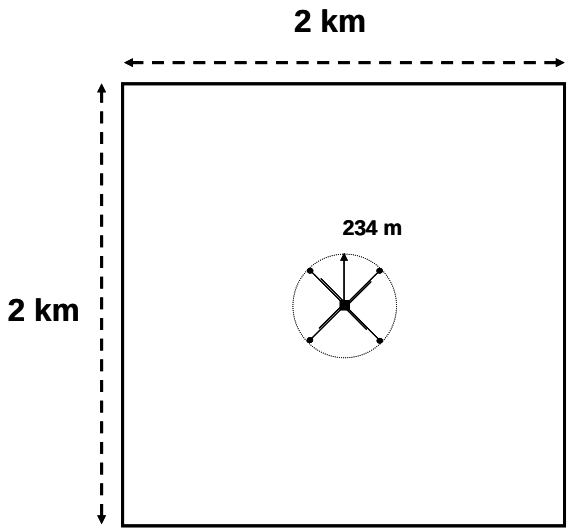


Figure 4. Layout of two ground survey areas centred on the 20 × 20 m vegetation plot:

1. 2 × 2 km area defining the boundary for the ground survey for ungulates and wallabies
2. 234 m circle defining the boundaries for possums, rabbits and hares, and DNA sampling

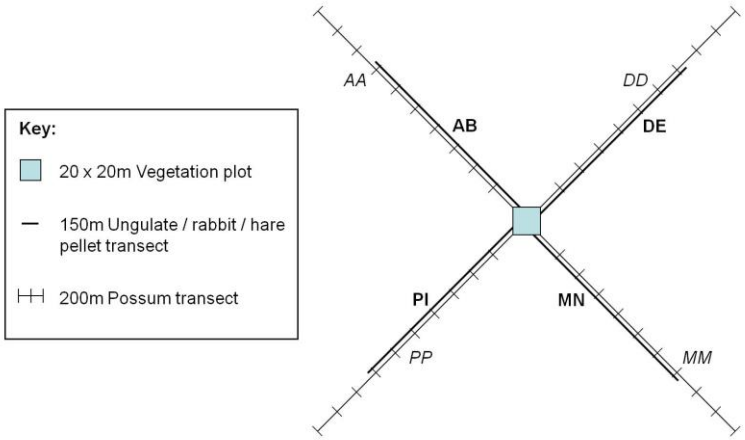


Figure 5. Layout of mammal survey sampling units in relation to the vegetation plot at each sampling location. The mammal sampling units labelling system is consistent with the vegetation plot labelling.

5. Protocol for possum transect lines

Overview

Possum monitoring will be carried out along four 200 m transects. Possum transect lines extend from each of the vegetation plot corners at 45° angles away from each plot edge. Possum monitoring devices (PMDs) will be set at 20 m intervals along each transect. Ungulate pellet transect lines will run parallel to the possum transect line maintaining a 3.5 m distance from each other (Figure 6 and Figure 7).

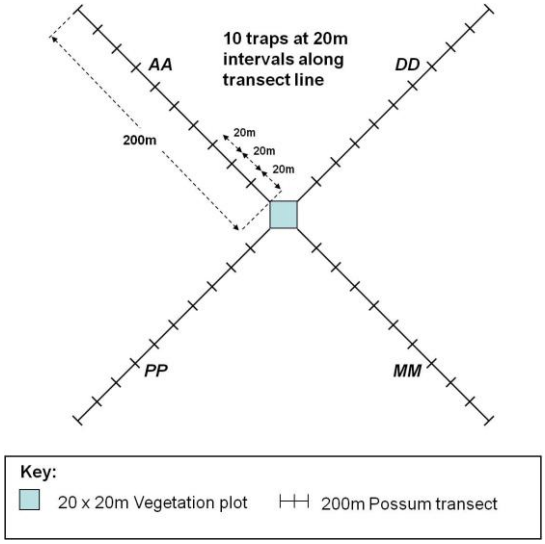


Figure 6. Locations of the four 200 m possum transect lines in relation to the vegetation plot layout.

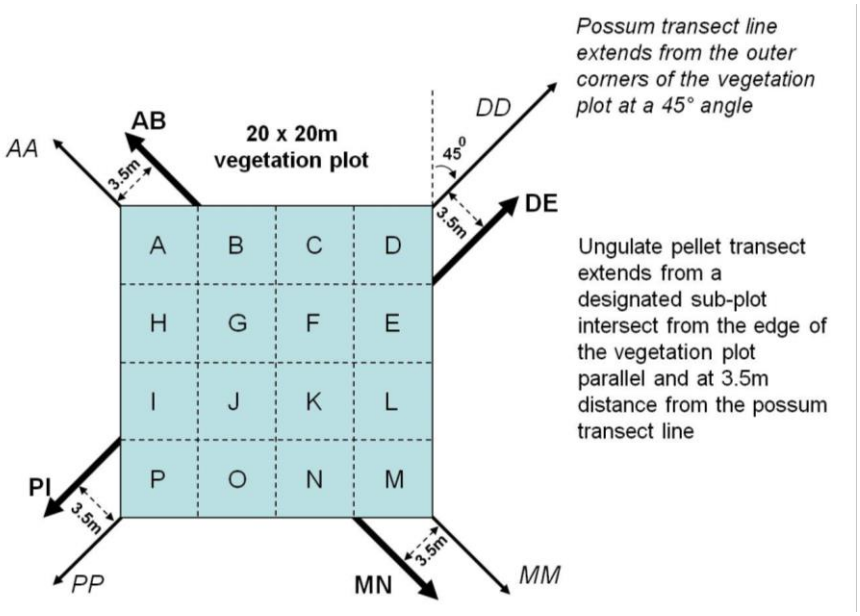


Figure 7. Location of possum transect lines in relation to pellet transects and the vegetation plot layout.

For each of the four possum transect lines:

1. Navigate to the start point of the transect line. Possum transects start at the four corners of the 20x20m vegetation plot. Corners are marked by an aluminium peg in the ground with permolat denoting the corner (A, D, M, P). Permolat may also be on nearby trees with a distance and bearing to the corner peg to aid in relocation. It is not required that you find the peg to start a transect, it is acceptable to use the plot boundaries and tree permolat to locate the start to ±1m.

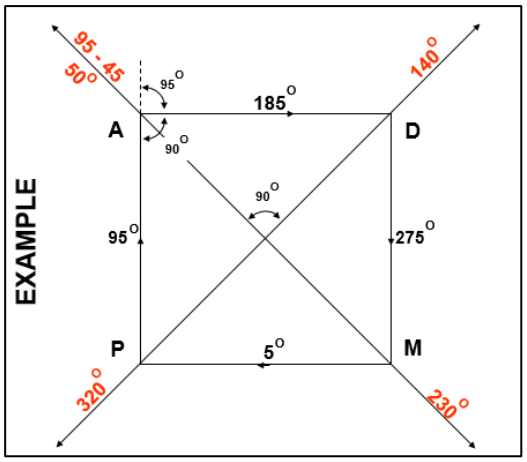


Figure 8. Transect bearing example

2. Record the following in the Possum Monitoring Data Record Sheet:
    a) **Sampling location identifier** (e.g. **ABC123**)
    b) **Transect identifier** (e.g. **AA, DD, MM, PP**)
    c) **Observer**
    d) **Date** (day/month/year)
    e) **Transect bearing** (calculate this—extends from the outer corners of the vegetation plot at a 45° angle (Figure 8), e.g. if the bearing for the P-A edge of the vegetation plot was 95°, the AA transect bearing would be 95° less 45° =50°).
3. For newly established sites, mark the transect start point with flagging tape for the vegetation team to use when establishing the 20 x 20m plot.
4. Record the GPS waypoint of the transect start point and record the coordinates in the GPS Data Record Sheet at the back of the Field Data Record Sheets for Mammal Surveys. Note that 'averaging' of waypoints, when the point is originally marked, is not compulsory except for CORNER P. All other points can be 'averaged' to increase accuracy as time permits (e.g. on 2nd day). CORNER P waypoint fix needs to be 'averaged' at least two times: a) when the point is originally marked, and b) a second 'averaged' fix later in the day (after at least 90 mins).

    Use the following priority order for 'averaging' of points (time permitting):
    a) Bird stations (e.g. while completing bird RECCEs)
    b) Possum line ends and pellet line ends
    c) Possum line starts and pellet line starts
5. Use the labelling protocol for every waypoint (i.e. sampling location, survey, transect identifier and START, e.g. 'ABC123POSDDSTART').

Laying out transect lines and establishing PMD sites

1. Set the first PMD 20 m away from the start point along the transect bearing (Figure 7) on the nearest acceptable site. Walk as closely as possible along the transect bearing; use a hip-chain to measure distance between PMDs and use flagging tape to mark your track. All hip-

chain cotton must be removed at completion of measurement to prevent entanglement of birds.

2. All subsequent PMDs should be set at 20 m intervals (Figure 6) at the nearest suitable site.
3. When barriers (e.g. bluffs or rivers) that **can be safely crossed** are encountered, proceed with the transect along the same bearing, after crossing the barrier at the earliest practical opportunity (Figure 9c).

Transect line length and bearing

1. The underlying principle is that the possum transect line MUST NOT exceed 200 m in length.
2. Transect variation will occur due to equipment calibration (hip chain variation etc.), therefore lines are required to be within 10% of their overall design length. For instance, a 5 PMD line should be 100 m ± 10 m long; a 10 PMD line must be 200 m ± 20 m long (i.e. from 180 to 220 m. long).

Acceptable sites for setting PMDs

1. For chewcards, sites require sufficient height for the device to be nailed on. This can be a tree or fence post.
2. A steel peg should be used when no suitable site is available.
3. If there are no suitable trees or fence posts at the planned site on the transect line, either;
    a. Search for a suitable tree or fence post within a 10 m radius from the planned site on the transect line or,
    b. If no suitable tree or fence post is found use a steel peg to set the PMD at the planned site on the transect line or the nearest suitable site within a 10m radius.
    c. If neither option above is available, refer to ‘Encountering barriers on transect lines’ Pages 17-20).
4. If the nearest suitable site is found off the line of the compass bearing, you must return onto the line before proceeding to the next PMD site.
5. PMD sites can be established in dry riverbeds or similar habitats using steel pegs. The need for steel pegs can be assessed by looking at maps, photographs (e.g. DOCgis) and the data record sheets from the previous measurement of the sampling location (if available).
6. Teams must plan for all sites and carry enough steel pegs to complete the site.

Minimum distances between PMDs on the different transect lines

1. The minimum distance between two PMDs on separate lines is 20 m.
1. It is important to check this minimum distance when a deviation is made from original direction of a transect line.

Encountering barriers on transect lines

Can be safely crossed

1. When barriers (e.g. bluffs, roads or rivers) are encountered that can be safely crossed but there is no suitable site to establish a PMD, continue along the same bearing but halt establishing any PMD sites (i.e. break in the line) until the barrier has been crossed or skirted (Figure 9).
2. In this case the principle to apply is a **PMD can be moved ± 10 m from its 'planned' location along the transect line**. When applied this principle results in the following;
   - The maximum permitted distance between two PMDs on the same transect line is 40 m.
   - The minimum permitted distance between two PMDs on the same transect line is 10 m.
   - The possum transect line cannot exceed 200 m in length.

     For example, when 12 m after the previous PMD and encountering a river, staff can establish a PMD site at this location (< 10 m from 'planned' location) and 'break' the line for a maximum distance of 38 m before a new PMD site needs to be established (8 m to 'planned' site + 20 m to next + 10 m movement allowed for next chewcard = 38 m).

     On the other hand, when encountering a barrier at 8 m after the previous PMD site, staff cannot establish a PMD site at this location (> 10 m from 'planned' location) and can break the transect line up to a maximum of 22 m (12 m to 'planned' site + 10 m movement allowed = 22 m).
3. If a PMD cannot be set within ± 10 m from its **'**planned' location, go back to the previous PMD site and treat the barrier as impassable.
4. Where the PMD is not at its 'planned' location, record the hip-chain length in the 'Device Notes' field of the data record sheet.

Cannot be safely crossed

1. When barriers (e.g. bluffs or rivers) that cannot be safely crossed are encountered, add or subtract 90° from the original compass bearing such that the transect turns away from the barrier. If a deviation from the original bearing is required, it must be made at the last PMD before the barrier. Follow the transect along the new bearing. If the barrier ends, return to the original bearing at the next PMD site and proceed (Figure 9a).
   a) Note that transect lines cannot be turned back towards the vegetation plot.
   b) Staff cannot set a PMD and then double-back along the line (e.g. if a PMD has become a 'dead-end', then this is the end of the line).
   c) Thick or prickly vegetation is not an acceptable barrier to turn the line.
2. Create waypoints for all turning-points (T) and label following the labelling protocol (Refer to Section 3). For example, AB123POSAAT1 for turn 1, or AB123POSAAT2 for turn 2 (See Figure 9). Record all turn points grid reference coordinates, bearings and associated data in the transect deviations table of the Field Data Record Sheets.

3. It is permitted to turn a line directly from a corner of the vegetation plot provided the transect line returns to original bearing at the first PMD site. After that the 20m rule is applied as per normal. If turning from corner of plot:
    - Record new bearing in transect notes e.g. “T0 = 180”.
    - Record initial planned bearing in “Transect Bearing”.
    - Record Turn point ID as T0 in in the transect deviations table of the Field Data Record Sheets.
    - Do not mark a waypoint for T0, record the transect start coordinates in the transect deviations table.
4. If a transect line runs into private land, where permission **is granted**, continue setting PMDs along the original bearing. If permission **is not granted**, then treat it as an impassable barrier and turn 90°.

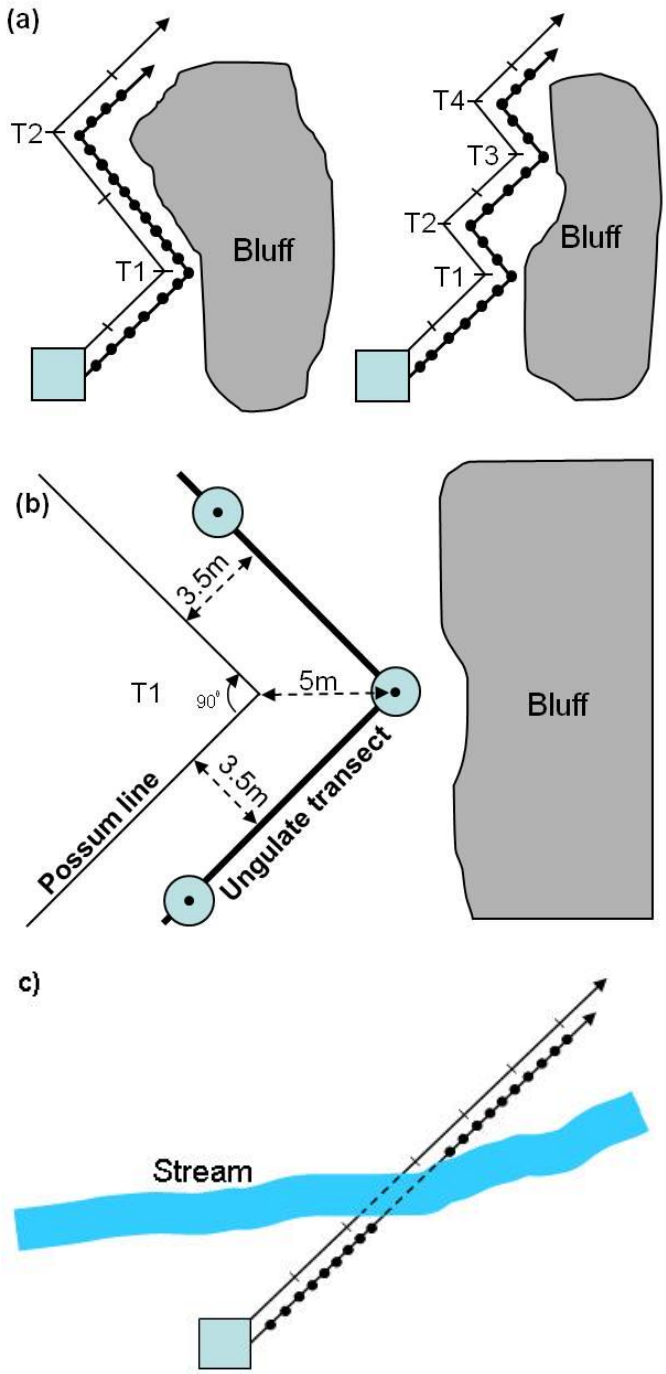


Figure 9. Example of barriers and scenarios; (a) turn in a possum line due to a barrier with example of possum line turning-point a sufficient distance from the barrier to allow for the ungulate transect (b) turn in possum line due to a barrier (c) break in a possum line due to a barrier

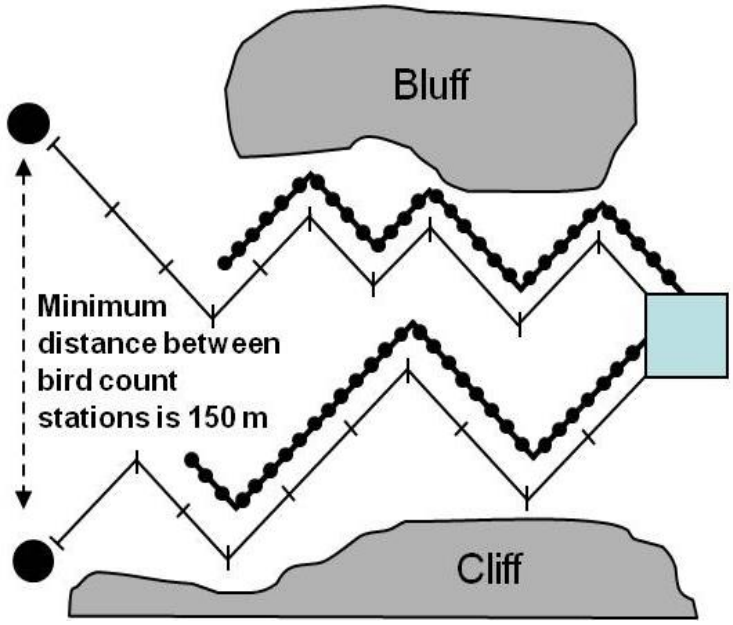


Figure 10. Required minimum distance between bird count stations.

5. There may be instances when several barriers (e.g. bluff and/or cliff) affect the possum transects in a sampling location such that they are converging.
    a) In such a situation, consider the positions of the end-points of the possum transects line to ensure that, in all practicality, a 150 m minimum horizontal distance requirement between bird count stations is achieved (Figure 10).
    a) If a transect line cannot be completed (e.g. safety concerns **or** the transect line changes course and comes within 20 m of another transect line), **as many PMDs as possible** should be set whilst staying within these guidelines. It is acceptable that a transect line has less than 10 PMDs set.
    b) Since the minimum distance between two PMDs on separate lines is 20 m, a possum or ungulate transect line must be discontinued if it is unavoidable to come within 20 m of another transect line of the same method.
6. Save the transect end point in the GPS unit using the labelling protocol and record the coordinates in the GPS Data Record Sheet at the back of the Field Data Record Sheets for Mammal Surveys.

Weather, timing and habitat types when setting possum monitoring devices

Weather considerations

PMDs are to be set for 1 fine night i.e. there has been no rain within 4 hours after darkness. Definitions of rain overnight for determining a fine night are described in Table 2.

You MUST NOT set chewcards in heavy rain or snow. However, circumstances may arise where the chewcards are set but the weather changed (e.g. cards were set in fine weather, but contrary to forecast, heavy rain falls) and the night is no longer valid. Record these results and contact your Supervisor immediately and while at the site to advise them of this. You MUST repeat the chewcard measurement at this site (i.e. layout a new set of cards for one fine night). Refer to Key methods: Priority order for postponing section.

NOTE, this is to be avoided as much possible as multi-night sets are known to influence possum behaviour and affect detection rates.

Once chewcards are retrieved, record the weather at the site (as defined in Table 2) in the 'Rain Overnight' field on the Possum Monitoring Data Record Sheet.

Table 2. Definitions of rain overnight (including snow) for determining a fine night and when valid to set chewcards.

Rain overnight	**NONE**	**0 mm of rain in first 4 hours after darkness**	FINE NIGHT – VALID TO SET PMD
Rain overnight	**LIGHT SHOWERS**	0–1 mm of rain in first 4 hours after darkness.	FINE NIGHT – VALID TO SET PMD
Rain overnight	**HEAVY RAIN**	Greater than 1 mm of rain in first 4 hours after darkness	NOT FINE NIGHT - INVALID
Rain overnight	**SNOW**	Greater than 1 cm of snow in first 4 hours after darkness	NOT FINE NIGHT - INVALID

Darkness

Darkness is defined as per the Land Transport (Road User) Rule 2004 definition: hours of darkness are 'any period of time between half an hour after sunset on one day, and half an hour before sunrise on the next day'. You can use Metservice website or your GPS to determine sunset.

Habitat

For both possum and ungulate transects, record the dominant habitat at each PMD/plot location. Habitat types are described in Table 3. The dominant habitat is defined as the one habitat type with the highest proportion of cover. For possum transects, it is assessed within a 10 m radius of the

PMD. Habitat is assessed on overall cover to the maximum height of vegetation, not simply ground cover (e.g. a patch of bare ground in a closed canopy forest is classed as forest, not bare ground).

Table 3. Description of habitat types.

Bare ground	BG	Bare ground, snow, scree and rock
Grassland	G	Tussock or unenclosed grassland
Shrubland	S	Woody vegetation consisting of shrubs (e.g. mānuka, kānuka, matagouri, gorse, broom, hawthorn)
Forest	F	Forest cover dominated by indigenous tall forest canopy species.

6. Protocol for setting possum monitoring devices

Chewcard standards

Only use approved chewcards http://www.traps.co.nz/chew-card-loaded-with-possum-dough-100. These are 9 x 18-cm rectangle card made of 3-mm white plastic coreflute. Cards are baited with an aniseed-flavoured pre-feed paste for possums (an attractant called possum dough), which is applied to the internal channels at either end of the card (Figure 11).

Important notes about chewcards

1. Only new chewcards are to be used. Do not re-use previously set cards.
2. All chewcards should be labelled with Plot (AB123), Transect ID (AA), and Chewcard Number (1–10) (e.g. AB123 AA1).
3. Chewcards can be labelled either with permanent marker or pre-printed labels provided.
4. Ensure all chewcards can be relocated. To assist with this, use flagging tape as a marker. If markers are used, DO NOT place these directly above the chewcards, where they may act as an additional attractant.
5. DO NOT use luminescent strip or flour and icing sugar lure when setting chewcards.
6. It is essential that chewcards are handled with care to avoid handling damage and false markings. DO NOT carry sharp or hard, angular item such as nails and hammers in the same bag as the new chewcards being deployed.

Setting Chewcards

Forest

1. Cards are applied to tree trunks or posts, so that the bottom of the chewcard is 30 cm ± 5 cm above the ground.
2. Use 50 or 75 mm galvanised flathead nail to attach chewcards to trees. For tree ferns, use a 75 mm nail to ensure the nail penetrates into the hard core of the tree fern.
3. Fold the card in half then push the nail through the top half of the card, about 10 mm down from the fold. Then push the nail through the bottom half about 5 mm down from the fold.
4. This offset nail placement helps hold the card in a **right-angled position when placed on the tree** (Figure 11 A) and ensures that the bottom half of the card is not flush against the tree.
5. Finally nail to the tree with the nail angled up at about 30 degrees.

Non-forest

1. Cards set using steel pegs or spikes must be 30 cm ± 5 cm above the ground.
2. Use 50 cm steel pegs or spikes with a bend or washer at the top to prevent chewcard sliding off.

3. Fold the card in half then push the spike through the top and bottom half of the card, about 10 mm down from the fold. Secure on a spike so that the bottom of the chewcard is 30 ± 5 cm above the ground.
4. Ensure the card is in a right-angled position when the spike is placed in the ground (Figure 11 B).

Figure 11. Setting Chewcards on trees or steel pegs.

Recording Results - Chewcards

Important notes about recording chewcard results

1. Before recording bite marks, ensure you are confident of the identification (especially possum).
2. If you are unsure of the identity of any bite marks present on a chewcard, write a © symbol after the bite mark result you are unsure of (e.g. 'P©' or NT© or P, NT©). If this is a Non-target species, also record the © symbol in the notes beside the Non Target species name. This © symbol indicates that the chewcard requires further identification. Record your best estimate of the bite mark identity unless you are completely uncertain, in which case record as unknown (U©).
3. Note, when collecting any mark on a chewcard, for practical reasons, all the bite marks on the card will be identified.

Recording chewcard results—bite marks

There are seven possible results for each chewcard:

1. Includes possum bite marks (P).
2. No possum bite marks, but identifiable non-target bite mark (NT and record the species names(s) in the notes).

3. No possum bite marks, but unknown bite marks (U). These should be collected and labelled with the collection symbol (U ©).
4. No bite marks (record as 0 (zero)).
5. Chewcard is beyond interpretation (BI) These should be collected and labelled with collection symbol (BI ©).
6. Chewcard is lost (L).
7. Chewcard not set (NOT SET).

NOTE: Multiple chewcard results need to be recorded by separating results with a comma; for example: P, NT.

Retrieving, bagging, and assembling chewcards

1. It is essential that staff handle cards with care. DO NOT carry sharp or hard, angular item such as nails and hammers in the same container or near collected chewcards.
2. After collecting a line ensure the result of each chewcard is recorded in the data record sheets, then:
    a) Check that the labelling on the chewcard is still present and complete. If it has been chewed, then rewrite clearly.
    b) Check all the chewcards for one line (e.g. AA) have been retrieved, then open the chewcards flat and bundle together.
    c) Use a loose rubber band to hold all the chewcards together. Best practice is to use one rubber band, placed in the centre fold of the chewcard and wrapped around one time. It is essential that the rubber band is loose to avoid damaging the card.
3. Complete the same step above for each line.
4. When all lines have been retrieved, place all four sets of chewcards (lines AA, DD, MM and PP) into a plastic or paper bag.
5. Label the outside of the bag with plot name, collected by and collected date.
6. Place the labelled bag of chewcards into a separate rigid container. This is required to protect cards from handling damage and marking that may lead to misinterpretation of results.
7. Double check chewcard results at the end of plot. Check all cards collected in dry conditions with good light and use a hand lens where required.
8. Follow the Information Management Protocol (doccm-1508274) for information regarding processing at base and sending to Christchurch.

7. Protocol for ungulate faecal pellet counts

Overview

Pellet counts will be conducted along four 150 m transects. Each ungulate transect starts at a designated sub-plot intersect from the edge of the vegetation plot (Figure 12), parallel to the possum line maintaining 3.5 m distance from each other. Ungulate Pellets will be counted at 5 m intervals along each transect within 1 m radius circular plots (Figure 12 and Figure 13). Rabbit and hare pellet plots are conducted concurrently within 0.18 m radius circular plots (Figure 17) located inside the ungulate plots (refer to Section 8).

Surveys **should not be conducted in poor light or in rain as this will impair visibility** and lead to some pellets being missed **and** makes the assessment of intactness difficult.

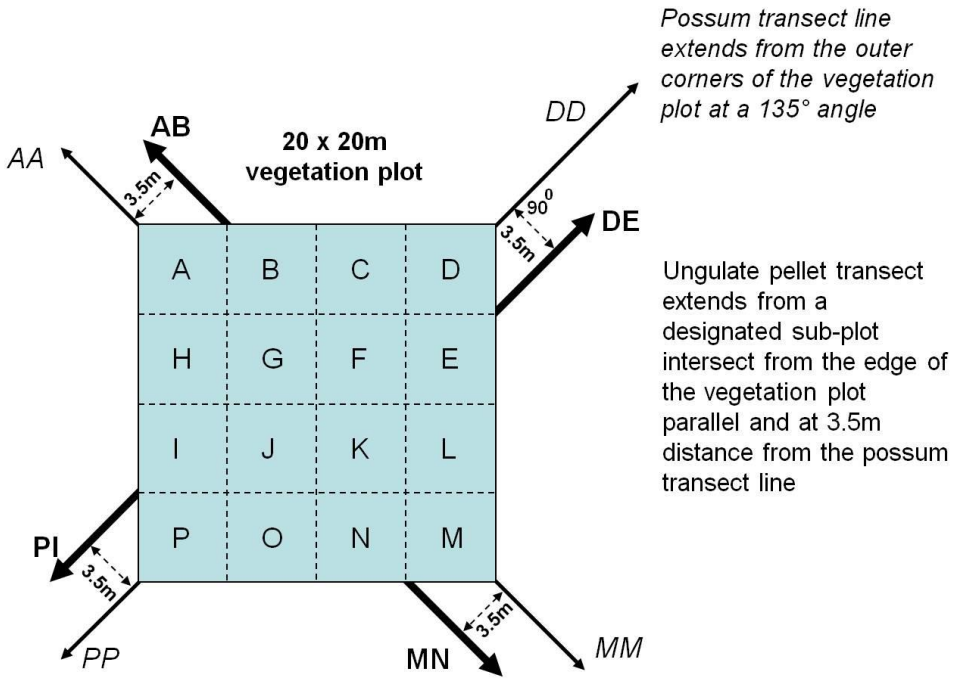


Figure 12. Locations of pellet transects in relation to the possum transect lines and the vegetation plot layout.

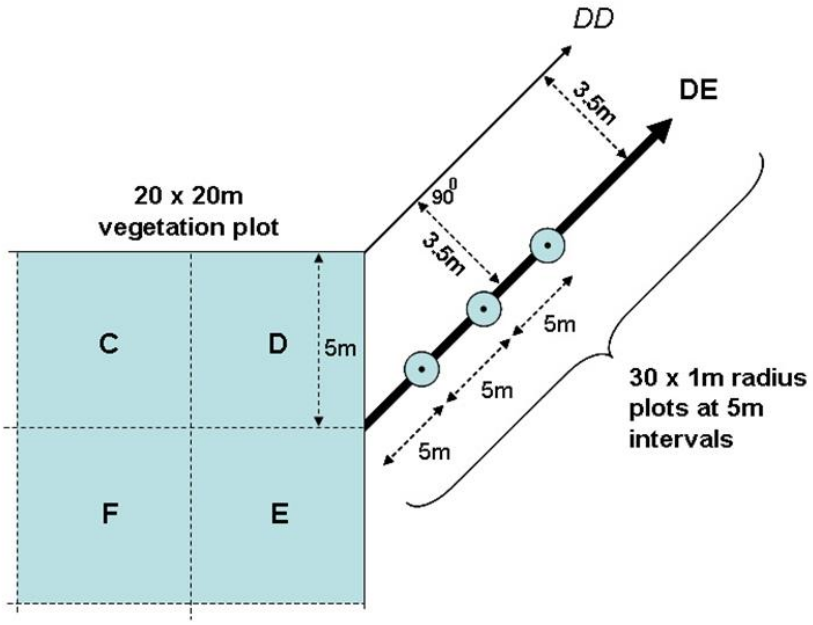


Figure 13. Location of 1 m radius plots along 150 m pellet transect.

For each of the four ungulate transects:

1. Navigate to the start point of the transect line. To do this locate the required corner of the 20x20 vegetation plot (also the start of possum transects), if looking out the possum transect, move 5 m to the right along plot axis to intersect of next subplot. If the plot is not established, then use a running line to measure the required distance
2. Fill in the top of the Faecal Pellet Count Data Record Sheet, including:
    a) **Sampling location identifier** (e.g. **ABC123**)
    b) **Transect identifier** (e.g. **AB, DE, MN, PI**)
    c) **Observer**
    d) **Date** (day/month/year)
    e) **Transect bearing** (the same as the adjacent PMD transect bearing).
3. Save the transect start point in the GPS unit using the labelling protocol (i.e. sampling location, survey, transect identifier and START, e.g. ABC123UNGABSTART).
4. Record the GPS coordinates (and associated data) of the start point in the GPS Data Record Sheet at the back of the Field Data Record Sheets for Mammal Surveys.

Laying out transect lines and establishing pellet count plots

1. Use a running line to complete the layout of the transect line and measurement of the pellet count plots (Forsyth 2005). A running-line consists of two pegs (e.g. tent pegs or bicycle spokes, approximate length 15–25 cm) connected by a 5 m non-stretch cord (Figure 14). On the 5-m cord there are two knots, each 1 m from either peg (Figure 14c): this knot defines the radius of the circular plot to be searched. The running line should be checked prior to

starting the first transect on each day to ensure that the string between the pegs is 5-m long and that the plot markers are exactly 1 m from the pegs.

2. At the transect start point, place one of the running-line's pegs into the ground. Move along the transect bearing. When the running-line is taut at 5 m, place the second peg into the ground and gently pull on the string so that the other peg pulls out of the ground. The first ungulate pellet count plot is 5 m from the transect start point.
3. A knot on the running line is then used to delineate the ungulate pellet count plot, a circular plot of 1 m radius. In this area faecal pellets are counted (see Figure 12 and Figure 13).
4. All subsequent pellet count plots should be set at 5 m intervals (Figure 13). Continue on the compass bearing and at every 5 m (when the running line is taut) insert the peg to establish the pellet count station.
5. Repeat this procedure on the same compass bearing until 30 plots have been completed (i.e. each transect is 150 m).
6. Continue the transect along the bearing whilst maintaining at least 3.5 m distance from the parallel possum transect line. A possum or ungulate transect must not cross any other possum or ungulate transect.

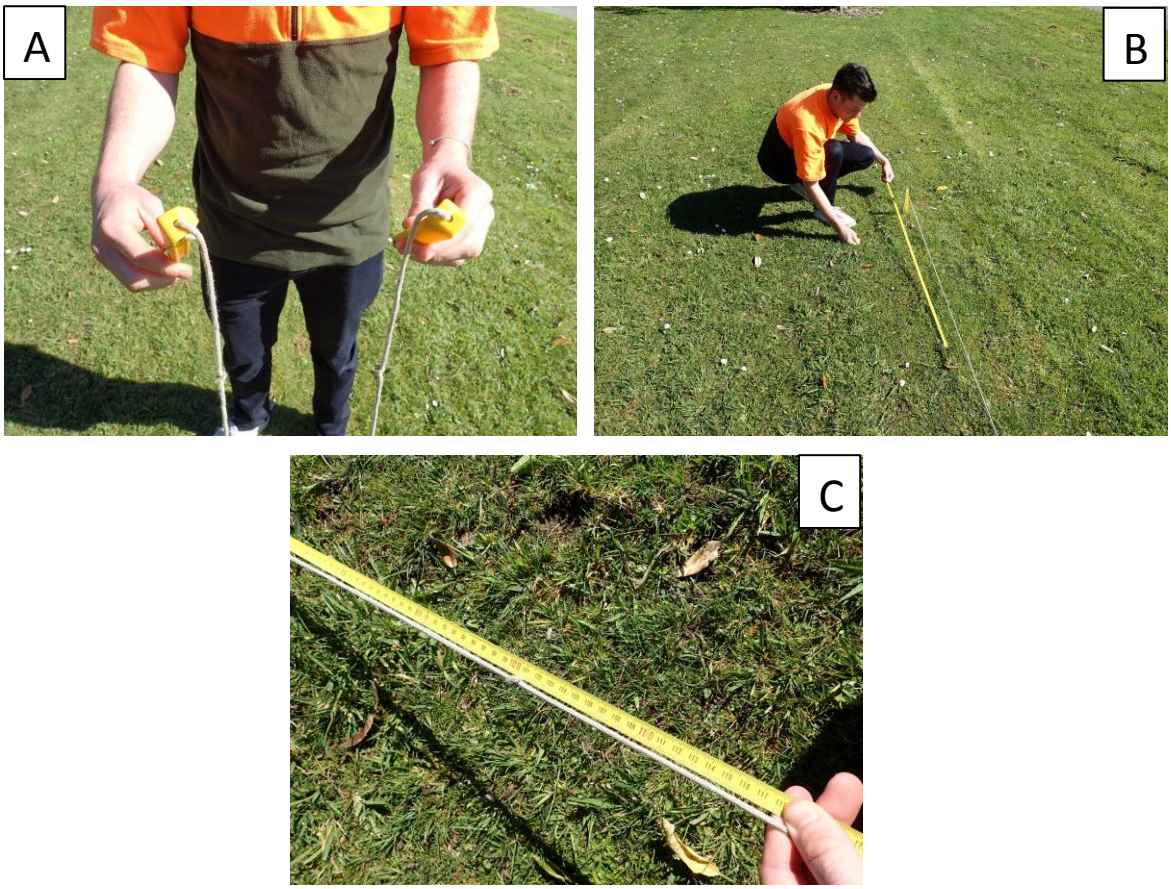


Figure 14. Making a running line - Two tent pegs or spokes are connected by a 5 m cord (a, b), with a knot 1 m from each peg or spoke (c).

Transect line in reverse

1. It is acceptable to complete pellet lines in reverse, i.e. walking back down the line and start at PMD 8 and work back towards plot. This can only be done when the pellet line is not broken (turns are acceptable) The following rules must be followed to ensure the data are recorded against the correct pellet plot number:
    a) You can only do this on lines where the PMDs are already established.
    c) Pellet line and pellet count plots positions must be correct and in planned position (e.g. in a normal or a reverse ungulate line implementation pellet count plot 30 is in the same place).
    d) As you complete the possum transect lines flag each PMD with its number. This will enable accurate location of PMD 8 as a reference for where to start the reversed ungulate line.
    e) Record the results of each plot in the Faecal Pellet Count Data Record Sheet in the **planned order**, i.e. pellet plot 1 is closest to the vegetation plot.
    f) Label the GPS points as normal, i.e. the GPS point taken at PMD 8 will be labelled as the Ungulate line end point (eg ABC123UNGABEND) and the GPS point taken at the vegetation plot will be labelled the Ungulate line start point UNGSTART (eg ABC123UNGABSTART)
    g) Tick “Transect completed in reverse” on the Metadata Record Sheets.

Minimum distances between ungulate pellet count plots on the different transect lines

1. The minimum distance between two ungulate plots on separate lines is 20 m,
2. An ungulate transect must be discontinued if it will come to within 20 m of another transect of the same method.
3. It is important to check this minimum distance when a deviation is made from original direction of a transect line.

Habitat

For both possum and ungulate transects, record the dominant habitat at each PMD/plot location. Habitat types are described in Table 4. The dominant habitat is defined as the one habitat type with the highest proportion of cover. For ungulate pellet plots, habitat is assessed within a 1 m radius from the peg. Habitat is assessed on overall cover to the maximum height of vegetation, not simply ground cover (e.g. a patch of bare ground in a closed canopy forest is classed as forest, not bare ground).

Table 4. Description of habitat types.

Bare ground	BG	Bare ground, snow, scree and rock
Grassland	G	Tussock or unenclosed grassland

Shrubland	S	Woody vegetation consisting of shrubs (e.g. mānuka, kānuka, matagouri, gorse, broom, hawthorn)
Forest	F	Forest cover dominated by indigenous tall forest canopy species.

Encountering barriers on transect lines

Can be safely crossed

1. When barriers (e.g. bluffs or rivers) that **can** be safely crossed are encountered, continue the transect along the same bearing after crossing the barrier, at the earliest practical opportunity (Figure 9c). It is permitted to break the ungulate line to a maximum combined distance of 50 m.
2. Breaks in the ungulate transect may eventuate as singular or multiple breaks, e.g. one 50 m break, or ten 5 m breaks. These breaks can be independent of the possum transect. Record these breaks in the transect notes as code; [LB]-[plot number], [xxM] (e.g. if a line is broken at pellet plot 5 for 17 m, code as:LB-5, 17M).
4. In this case, an Ungulate pellet count plot can be moved up to 50 m from its 'planned' location along the line, so the maximum permitted distance between two Ungulate pellet count plot is 50 m.
5. The ungulate transect should not exceed the length of the possum transect line.

Cannot be safely crossed

1. Where the PMD transect has been turned due to an impassable barrier, the pellet line transect must also be turned to follow the same bearing
2. Create waypoints for all turning-points (T) and label following the labelling protocol (Refer to Section 3). For example, AB123UNGABT1 for turn 1 or AB123 UNGABT2 for turn 2 (See Figure 9). Record all turn points grid reference coordinates, bearings and associated data in the in the transect deviations table of the Field Data Record Sheets.
3. If the possum transect has been established **without sufficient space for the ungulate line** to run at 3.5 m away, **'jump' the ungulate transect to the other side of the possum transect**, i.e. treat the possum transect as a passable barrier and restart the line in parallel direction at the other side. Do not record GPS waypoints for line jumps, unless the transect is also turned at the same point, in which case it should be recorded as per usual for a turning point. Note: **This is the only time where 'jump' protocols can be applied**. Record in the transect notes as code; [LJ]-[plot number], i.e. the plot number at which the transect changed sides (e.g. if the possum transect line jumped at plot 5, code as: LJ-5). The next count should be completed 5 m along from the previous count, but on the other side of the line, i.e. jump at the last count and measure 5 m along from there. As soon as possible, return to the original side and record in the transect notes the plot number at which the transect (again) changed sides (e.g. if it jumped at plot 15, code as: LJ-15).
4. If a transect cannot be fully implemented (e.g. due to safety concerns **or** the transect comes within 20 m of another transect of the same method), establish as many plots as possible

whilst staying within these guidelines. It is acceptable that a transect has less than 30 plots sampled.

5. Save transect end point in the GPS unit using the labelling protocol and record the GPS coordinates in the GPS Data Record Sheet at the back of the Field Data Record Sheets for Mammal Surveys.

Measuring transect lines that fall in standing or running water

1. When measuring ungulate pellet plots, they must be completed exactly where they fall, and on all substrates where it is safe to do so. This includes when they fall in standing or running water.
2. If ungulate transect lines and pellet plots are in **standing water and it is safe to measure**;
    a. If the plot falls in shallow (<20cm) standing water (e.g. shallow flooded clearings), establish and measure the ungulate pellet plot at the planned location. Search the entire plot area **including the area underwater**, as there may be pellets present. Record the area of the pellet plot covered by shallow standing water “XX% Standing water” (e.g. 50% Standing water) in the “other” column.
    b. If the plot falls in deep standing water (e.g. deeper wetland area), establish and measure the ungulate pellet plot at the planned location. Search the plot area **excluding the area underwater**. Record the area covered by deep standing water “XX% deep standing water” (e.g. 100% deep standing water) in the “other” column.
3. If ungulate transect lines and pellet plots are in **deep standing water and it is NOT safe to measure**; apply the method described in the Encountering barriers on transect lines (page 31).
4. If ungulate transect lines and pellet plots are in **running water and it is safe to measure**;
    a. If the plot falls in shallow (<20cm) running water (shallow stream caused by heavy rain) establish and measure the ungulate pellet plot at the planned location. As best you can search the area underwater as there may be pellets present. Search the entire plot as some of the area may be out of water. Record “XX% running water” (e.g. 50% running water) in the “other” column.
5. If ungulate transect lines and pellet plots are in **deep running water and it is NOT safe to measure**; apply the method described in the Encountering barriers on transect lines (page 31).

Counting ungulate pellets and pellet groups

1. Ungulates are defined as all hoofed animals. For the Tier 1 monitoring programme these are broken into two types;
    a. **Deer, goat, chamois, tahr and sheep**. These are counted if pellets are present in the ungulate pellet count plot.
    b. **Pigs, cattle and horses**. These are not counted but are recorded if pellets are present in the ungulate pellet count plot.

2. When searching each ungulate pellet count plot, vegetation (including fern fronds/small branches/standing tussock blades) is pushed aside to ensure that the entire plot surface is searched, but the leaf litter/horizontal dead tussock layer is not disturbed.
3. Ensure the plot is searched in a systematic way so that no section is missed. In dense vegetation, subdivide the plot into manageable sections using natural features or tape to ensure no part of the plot is missed or double counted.
4. Get close enough to the ground to see the pellets clearly, i.e. getting on hands and knees is usually necessary.
5. **Do not search outside the 1 m radius plot.**

Pellet groups, intact and non-intact pellets defined

1. An intact pellet (following Baddeley 1985) is defined as having no recognisable loss of material, regardless of whether the pellet is cracked, partly broken or deformed (e.g. by trampling). The presence of moss or fungus does not affect whether a pellet is considered intact or not. See the pellet reference sheet (Figure 16).
2. Pellets with insect holes but no other recognisable loss of material are classed as intact.
3. A pellet group is defined as ‘intact pellets voided in the same defecation’, and is determined by appearance (i.e. size, shape and colour) (Figure 15). A pellet group may consist of one or more intact pellets (i.e. a single pellet is the minimum number of intact pellets required to constitute a pellet group within the plot).
4. All intact pellets inside the plot are recorded, irrelevant of whether these are part of a pellet group which extends out of the plot. For example, if only 10 of 100 pellets in a single group are in the plot, count the 10 pellets of that group and record this as one group.
5. Note that a major change from previous New Zealand Forest Service protocols is that a group in this method is defined as ‘one or more intact pellets. Hence, a group size of 1 is possible.
6. The number of intact pellets in each pellet group is counted and recorded (Figure 15). Pellets of the same group may adhere together; this is called a **clump**. The number of pellets in clumps should be counted by teasing apart the clump.

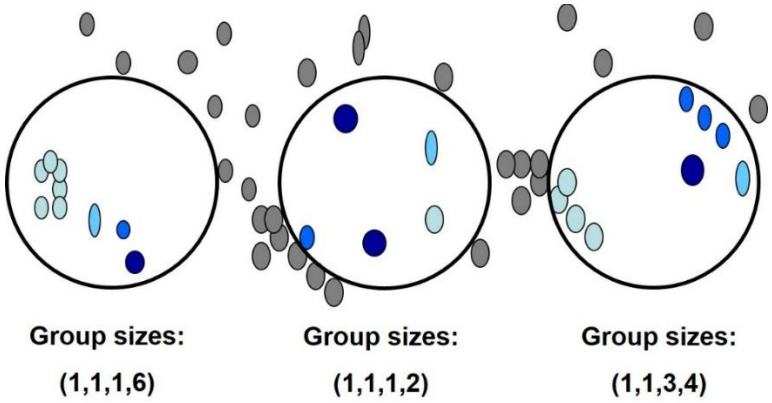


Figure 15. Examples of intact pellet counts within 1 m radius of the ungulate pellet count plot. Each colour represents a different group and there are three scenarios providing examples of how these are to be counted.

Deer, goat, chamois, tahr and sheep

1. It is not necessary to differentiate pellets by species; they are all classed as ungulate.
2. The ungulate pellet count plot is searched systematically and the **number of intact pellets** is counted and recorded ‘Intact ungulate pellets by group’ on the Faecal Pellet Count Data Record Sheet.
3. If ‘Non-intact ungulate pellets’ are present, record these by ticking the Non -intact ungulate pellets column on the Faecal Pellet Count Data Record Sheet.
4. Where a defecation contains both intact and non-intact pellets; count the intact pellets and record these the ‘Intact ungulate pellets by group’ field **and** record presence in the ‘Non-intact ungulate pellets’ field on the Faecal Pellet Count Data Record Sheet.
5. If the pellets of sheep are intact but are clumped and cannot be clearly distinguished and counted, record presence in the “Other” column on the Faecal Pellet Count Data Record Sheet.

Cattle, horses and pigs

1. If there are signs of **cattle or horses** (e.g. cattle dung) in the ungulate pellet count plot, record these as a note in the ‘Other’ column on the Faecal Pellet Count Data Record Sheet. Specify the species and the type of sign.
2. If there are signs of **pig rooting** or there is **pig dung** present in the ungulate pellet count plot, record these by ticking the appropriate field in the ‘Pig dung/rooting’ column on the Faecal Pellet Count Data Record Sheet.
3. Do not count cattle, horse or pig pellets.

Possums, rabbits, hares and wallabies

1. If there are signs of **possums, rabbits, hares** and **wallabies** in the ungulate pellet count plot, record these as present by ticking the appropriate species columns in the Faecal Pellet Count Data Record Sheet.
2. Do not count pellets of other species such as possums, rabbits, hares and wallabies.

Other species

1. If there are signs of any other introduced mammals in the ungulate pellet count plot, record these as a note in the ‘Other’ column on the Faecal Pellet Count Data Record Sheet. Specify the species and the type of sign.

Important notes about recording ungulate pellet count results

1. Data are recorded in the Faecal Pellet Count Data Record Sheet.
3. Ungulate pellet count plots are recorded as separated rows.
4. Pellet group is an important element for analysis and reporting. Effort must be made to determine different grouping of pellets.

5. Intact pellets are recorded as the number within each pellet group. Counts of intact pellets are separated by a comma (e.g. 48, 1, 17).
6. Presence is recorded as a tick in the appropriate field or as a note in the “Other” column.
7. If lines are not fully implemented (i.e. less than 30 plots established) or abandoned, record the last counted plot number in the Transect Notes (e.g. Line ends at plot 26) and record NOT MEASURED in the data fields for the uncounted pellet plots.

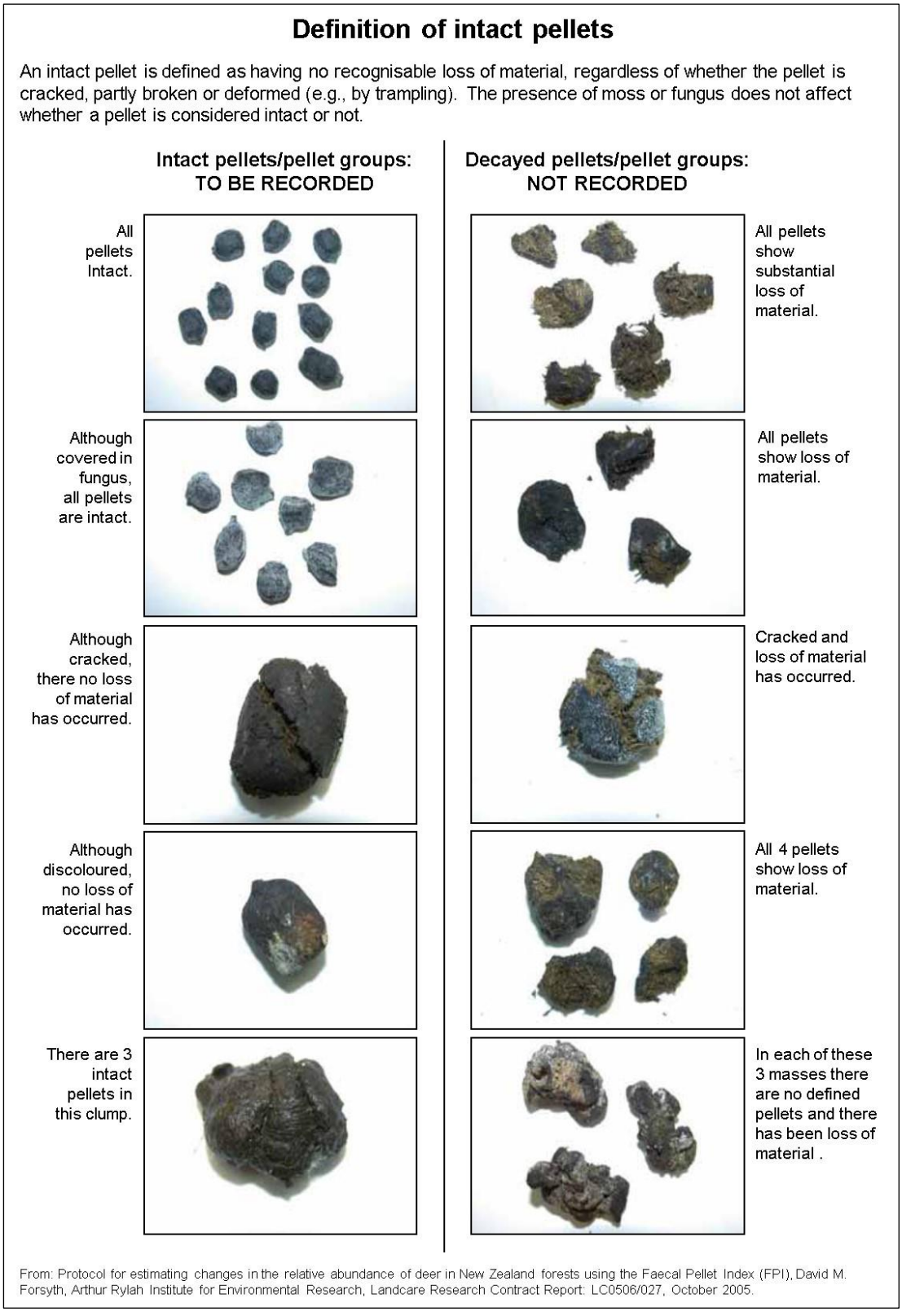


Figure 16. Definition of intact pellets.

8. Protocol for rabbit and hare faecal pellet counts

Overview

Rabbit and hare pellet counts will be conducted along four 150 m transects in 0.18 m (i.e.18 cm) diameter plots in the centre of each ungulate plot (Figure 17).

Surveys **should not be conducted in poor light or in rain** because poor visibility leads to some pellets being missed **and** makes the assessment of species difficult.

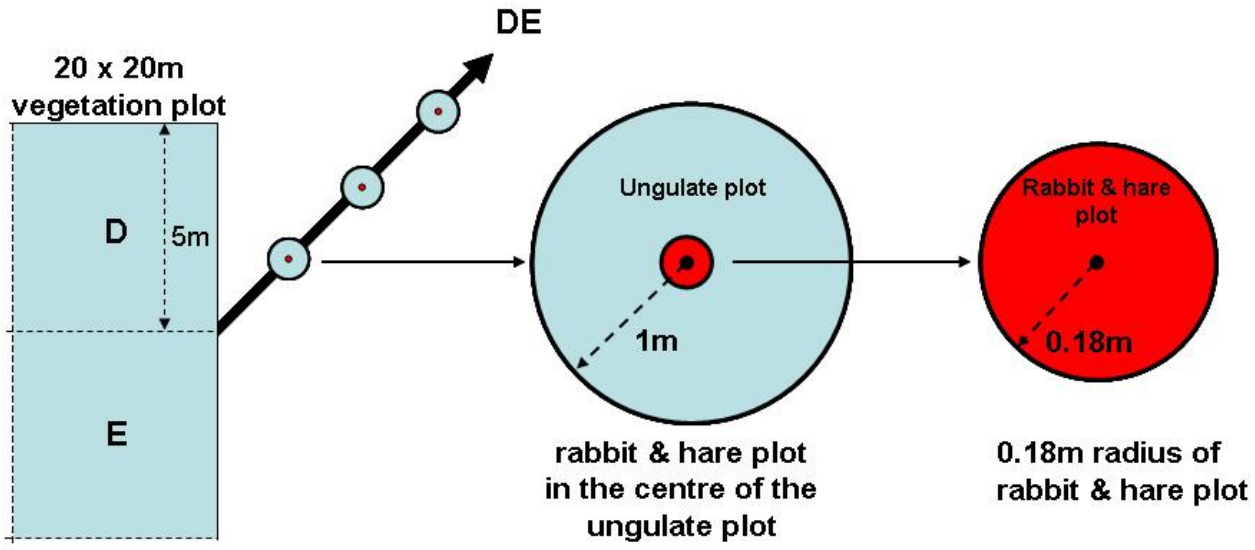


Figure 17. Location of rabbit and hare faecal pellet plot in relation to the ungulate plot.

For each rabbit and hare plot:

1. Fill in the top of the Faecal Pellet Count Data Record Sheet, including:
    a) **Sampling location identifier** (e.g. **ABC123**)
    b) **Transect identifier** (e.g. **AB, DE, MN, PI**)
    c) **Observer**
    d) **Date** (day/month/year)
2. A knot on the running line is used to delineate a circular plot (of 0.18 m radius) in which faecal pellets are counted (see Figure 17).
3. All pellets that are recognisable as hare or rabbit are included in the count. Pellets do not need to be intact to be counted.
4. When the plot has been thoroughly searched, continue on the compass bearing for 5 m until the running line is taut and insert the peg: this is the centre of next plot. Repeat this procedure until 30 plots have been completed (i.e. each transect measures 150 m).

Counting rabbit and hare pellets:

1. Rabbit and hare pellets are only counted in the 0.18 m plots.
2. Within the bounded 0.18 m radius plot, complete a systematic search and count and record recognisable rabbit and hare faecal pellets.
3. Pellet groups do not apply to rabbit and hare pellet count.

Distinguishing rabbit and hare faecal pellets

Faecal pellets of the two species can usually be distinguished, but there is overlap in their morphology. The descriptions in Table 5 and photos in Figure 18 and Figure 19 are to assist staff with distinguishing rabbit and hare faecal pellets and sign.

Table 5. Characteristics of typical rabbit and hare faecal pellets.

Character	Rabbit	Hare
Size	Generally, about 0.5 cm; adult males up to 1 cm	Generally, about 1 cm in adults
Shape	Variable but usually **oval with more pointed ends**, often with uneven surface	Consistently **spherical** (slightly flattened), usually smooth surface
Colour	Darker to grey depending on diet and age	Brown to grey depending on diet and age
Texture (see Figure 18)	Less fibrous and more compacted	Fibrous and looser

Figure 18. Texture of a hare and rabbit pellet. Note the more fibrous nature of the hare pellet compared with the more compacted rabbit pellet.

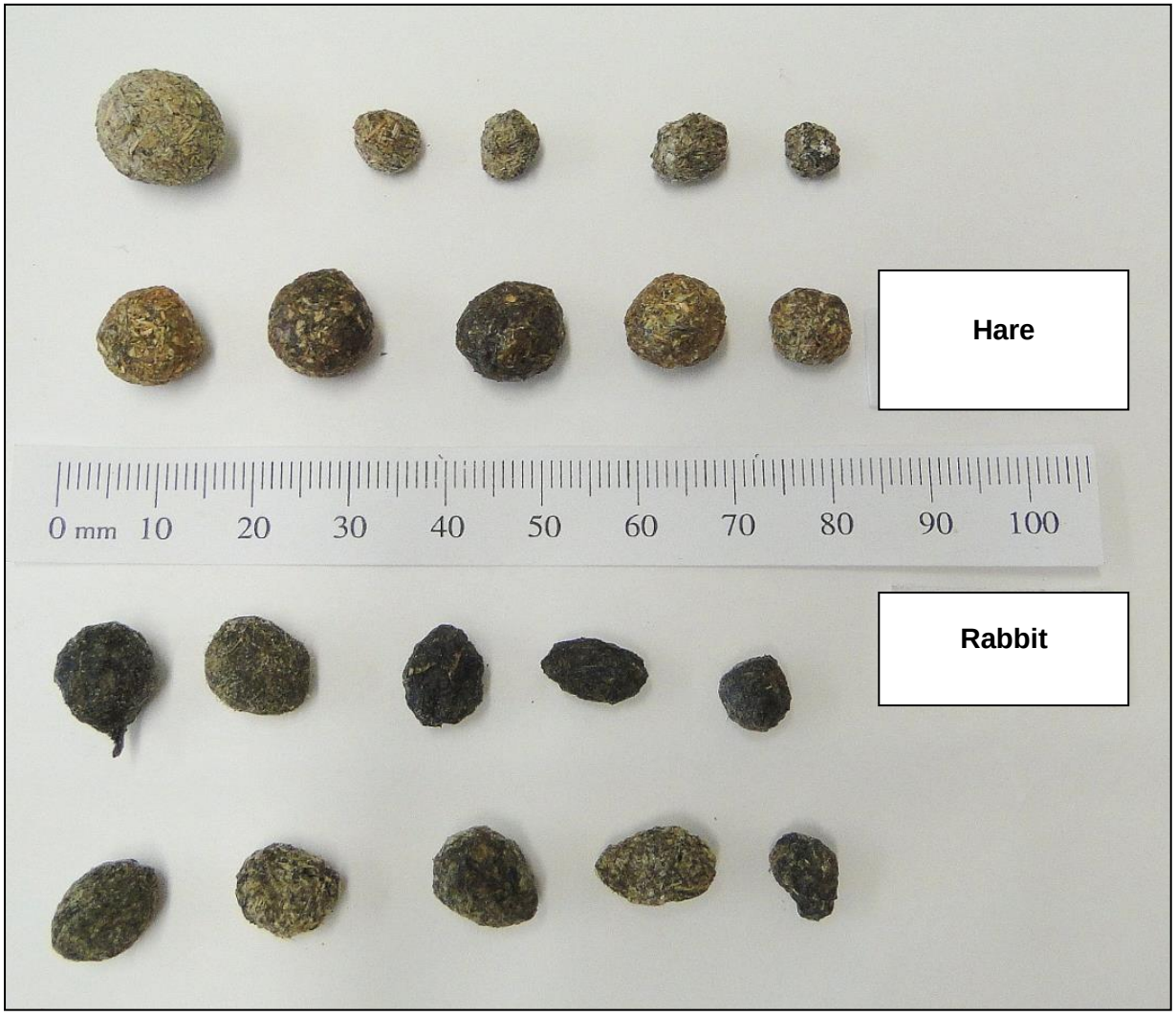


Figure 19: Rabbit and hare pellets.
Top row: Older hare pellets from those that have retained their shape and size but faded to a grey colour, through to very old.
Second row: Typical fresh adult hare pellets.
Third row: Typical fresh rabbit pellets—note the range of sizes but similar shape and dark colour.
Fourth row: Larger pellets from a 'buck heap'.

Additional information

Rabbits and hares both produce a large number of faecal pellets each day: 820 for rabbits (Taylor 1956) and between 300 and 700 with an average of 434 for hares (Flux 1967). The pellets can last for many months and sometimes years (Flux 1990; Parkes 1999) so even modest densities of animals can result in a very large standing crop of pellets from fresh to very old and degraded.

Both species use pellets as social markers. Adult male rabbits in particular deposit pellets in 'buck heaps' (Figure 20), and hares will often deposit pellets around prominent structures in their range, although rarely in the large accumulations typical of a rabbit 'buck heap'. These sites are usually on raised ground and may contain thousands of accumulated pellets.

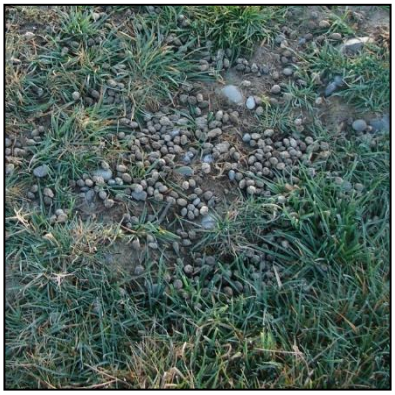


Figure 20. Buck heap of rabbit pellets.

Figure 21. Typical rabbit scratching in sandy river bed soil.

Figure 22. Typical hare form.

Rabbit and hare sign

Associated sign

Rabbits dig burrows, which may have multiple entrances and harbour many rabbits (a warren) or just a single entrance with few residents. Rabbits also dig small scratchings in the soil (Figure 21).

Hares do not dig burrows but do make depressions in the vegetation or soil (called forms) in which they sit during the daytime. They rarely scratch in the soil although may do so to dig up food such as thistle roots.

Inferences from location

Habitat can be used to interpret the identity of some pellets if there is doubt.

- Pellets in alpine grasslands are almost always those of hares. Rabbits rarely inhabit these areas.
- Hares are rare in the semi-arid grasslands of the Mackenzie Basin and central Otago, at least when rabbit numbers are high, hares being restricted to the taller tussock grasslands on the adjacent hills which are less-favoured by rabbits.
- Both hares and rabbits are found in many improved pastures. (Note: When rabbit haemorrhagic disease reduced rabbit numbers, hares became more abundant than rabbits for several years).

Caveats

- Leverets (baby hares) produce smaller pellets than adult hares so the size range overlaps with that of most rabbits.
- Male rabbits produce larger pellets whose size ranges overlap that of hares. However, they retain the slightly elongated shape characteristic of rabbit pellets, so they can be distinguished from those of hares.

- In drier areas the pellets, especially of hares, tend to slowly abrade by loss of surface material so they tend to retain their shape but become smaller and can resemble older rabbit pellets.
- Rabbits and hares eating the same food tend to produce pellets with a similar texture and colour, although the typical shape and size differences remain.

9. Protocol for swabbing ungulate faecal pellets for DNA

Overview

Up to 10 suitable ungulate groups within a 234 m radius of the 20 × 20 m plot centre (Figure 4) are to be swabbed for DNA, both inside and outside ungulate pellet plots.

Selecting suitable ungulate faecal pellets for DNA:

- Swabbing for DNA can be undertaken in any weather conditions if pellets can be accurately identified, and the swapping procedure is followed to avoid contamination (i.e. gloves are used).
- Only ungulate pellets (excluding pigs, horses, cattle or sheep pellets) of fresh appearance (i.e. moist, soft and usually a black or dark green colour) are considered suitable and should be swabbed.
- Ungulate pellets that have lost these colours and have dried out, or are starting to disintegrate, should not be swabbed as they do not contain useful DNA.

Sampling suitable ungulate faecal pellets for DNA:

- A swab sample consists of **wiping three different pellets from the same group**
- Only **one swab sample** should be taken from **one pellet group**.
- Collect a **maximum of 10 swab samples per sampling location**.
- Collect no more than **one swab sample per pellet plot** (Figure 13).
- **Do not** swab possum, pigs, horses, cattle or sheet pellets.

Swabbing procedure:

1. Before handling a sample, remember to wear a fresh pair of gloves and use new forceps, swab and tube.
2. Remove a sterile swab from its protective case and submerge the **clean** swab into preservation buffer[1] **once**, before swabbing.
3. Use forceps to hold the selected pellet and gently wipe the entire surface of **three** different pellets from the **same pellet group** for each swab sample.
4. Insert swab head into its 1.5 ml tube and split the handle so only the head is submerged in buffer.
5. Label each tube as follows:

[1] Preservation buffer is Longmire buffer (Longmire et al. 1997). This is a non-toxic solution (although it should not be ingested) that preserves the DNA at room temperature for long periods of time and meets requirements for air transport.

a) For a swab **collected inside an ungulate pellet plot**, use a permanent fine-tipped marker and label the lid of the 1.5 ml tube with the plot ID, sampling location 'AB' and the unique number specifying the transect ID and pellet plot number '01' (e.g. AB01). Record the unique number of the collected sample in the Ungulate DNA Data Record Sheet.

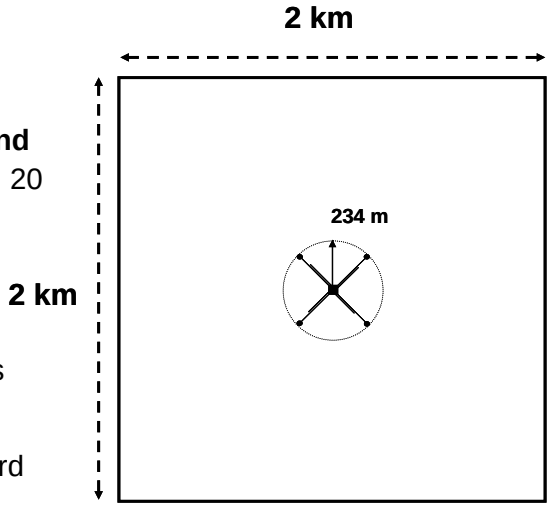
b) For a swab **collected outside an ungulate pellet plot**, use a permanent fine-tipped marker and label the lid of the 1.5 ml tube with plot ID, sampling location, 'ZZ' and the sequential number of the swab (i.e. the first sample collected outside an ungulate pellet plot should be labelled 'ZZ01' and so forth). Record 'ZZ' and sequential number of the collected sample in the Ungulate DNA Data Record Sheet.

6. Place gloves, forceps and the swab's protective case in a zip lock bag for disposal when you return to base.
7. Place all the DNA samples from one sampling location in a zip lock bag and insert a waterproof label, follow the labelling instructions recorded in the Information Management Protocol (doccm-1508274).
8. Keep the samples out of direct sunlight at all times.
9. Follow the Information Management Protocol (doccm-1508274) for information regarding processing at base and sending to Christchurch.

10. Ground survey for introduced mammal pests

This survey records incidental sightings and signs observed while walking to-and-from, and around, the sampling location.

234-m radius of the 20 × 20 m plot:



Sighting

1. Record sightings **possums, ungulates, rabbits and hares**, anywhere within a 234-m radius of the 20 × 20 m plot centre (234m from BIRX):
   - Record the animal name (Table 6), observer and number of animals.
   - For **ungulates** also record the age-sex classes (Table 7), and the GPS location.
   - For **possums, rabbits and hares**, do not record age-sex class or GPS locations.
   - Record sighing's on the Ground Survey Mammal Pest Sighting Data Record Sheet

Sign

2. Record sign of **possums, rabbits and hares**, anywhere within a 234-m radius of the 20 × 20 m plot centre (234m from BIRX):
   - Tick boxes for the type of sign (Tracks, pellets / dung, browse, bark-biting or digging) or record other sign in the 'Other' sign field.
   - **Do not record ungulate sign within the 234-m radius** of the 20 × 20 m plot.
   - Record sign on the Ground Survey Mammal Pest Sign Data Record Sheet.

2 × 2km area around the 20 × 20 m plot

Sighting

3. Record sightings of **ungulates and wallabies** anywhere within the 2 × 2 km area:
   - Record the animal name (Table 6), observer and number of animals.
   - For sightings of **ungulates and wallabies**, either:
     a. Record GPS locations (if you walk close to where you observed the animal(s)), or
     b. Estimate GPS locations from the map of the 2 × 2 km area (if you did not walk close to where the animals were observed).
   - For **ungulates** also record the age-sex classes (Table 7).

- Record sighing's on the Ground Survey Mammal Pest Sighting Data Record Sheet

Sign

4. Record sign of **ungulates and wallabies** anywhere within the 2 × 2 km area:
   - Tick boxes for the type of sign (Tracks, pellets / dung, browse, wallow, antler rubbings or record other sign in the 'Other' sign field.
   - Record sign on the Ground Survey Mammal Pest Sign Data Record Sheet.

Caveats

5. When crossing private land to get to a sampling location and domestic stock are present which have access to the vegetation plot and pellet lines, include these species as part of the ground survey. If a fence or other feature prevents access to the sampling location, do not include them.
6. Do **not** include recorded sightings from the possum transect line or ungulate and rabbit/hare transects.

Table 6. Ground Mammal Survey ungulates age/sex classes.

Ungulates Age/sex classes	
AM: Adult male (>2 yrs.)	**YF**: Yearling female (1-2 yrs.; not usually with young at foot)
AF: Adult female (>2 yrs., may have young at foot)	**J**: Juvenile (<1 yr.; usually seen with an AF)
YM: Yearling male (1-2 yrs.; 'spiker' for deer)	**U**:Unidentified

Table 7. Ground Mammal Survey Animal Species.

Animal species	
Deer (list species if confident),	Unknown ungulate
Tahr	Feral pig
Chamois	Feral cattle
Goat	Feral horse
Wallaby (list species if confident).	Feral sheep

11. Protocol for bird counts

Bird monitoring will consist of four methods:

1. Distance sampling over a 5-minute count period (Distance)
2. Standard manual 5-minute bird count (5MBC)
3. Deployment of acoustic recording devices (ARDs)
4. Incidental bird sightings.

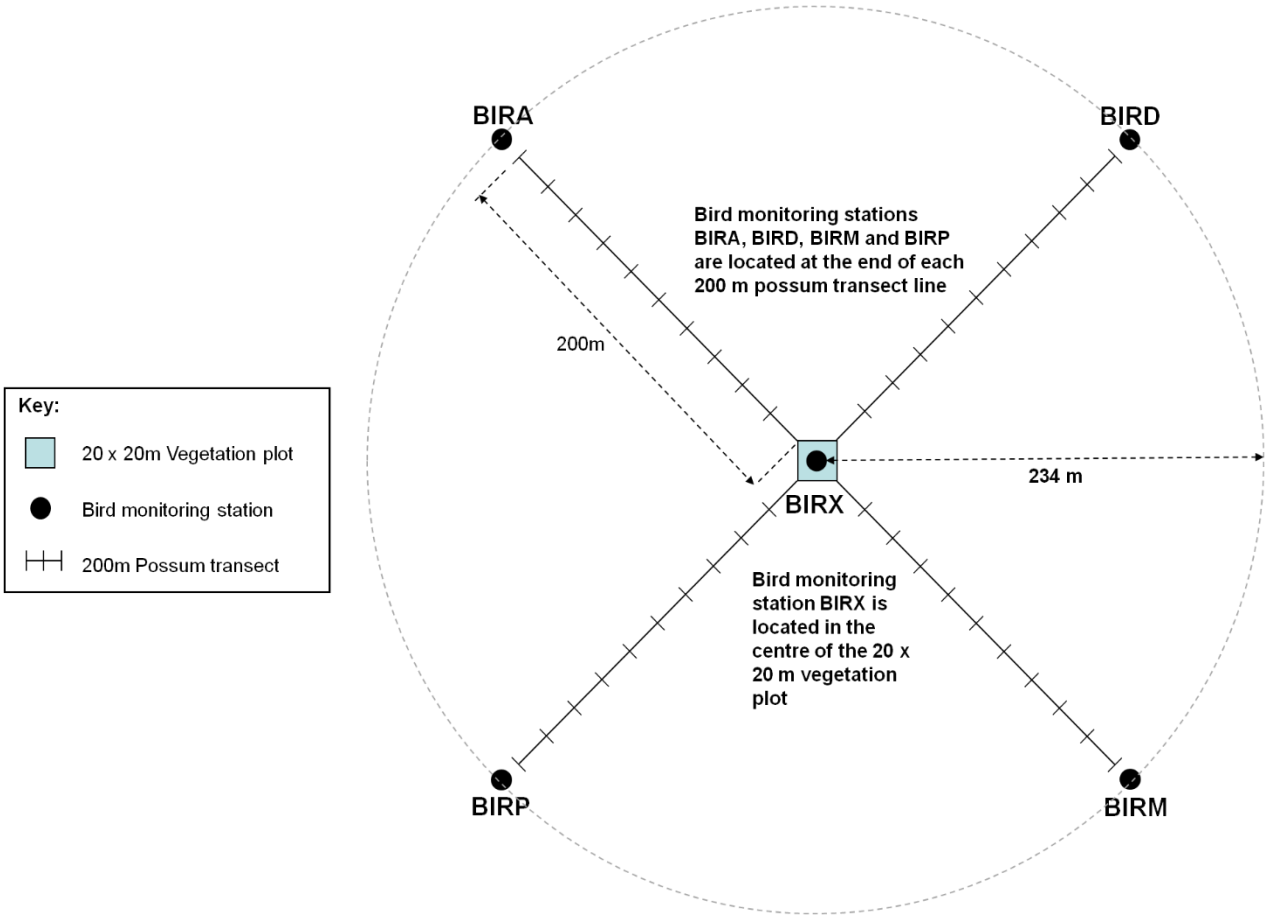


Figure 23. Locations of the bird count stations at each plot.

Overview

Bird counts and acoustic recordings will be carried out at five count stations (Figure 23).

- The first count station is located in the centre of the 20 × 20 m vegetation plot (BIRX), with four remaining stations (BIRA, BIRD, BIRM & BIRP) located at the end of each of the 200-m possum transect lines which extend from each corner of the vegetation plot (Figure 23).
- Count stations and ARDs will be established on Day 1.

- On Day 2, all bird counts will be carried out in fair weather conditions between 1 hour after official sunrise and 1300 hours.
- Record **TIME TAKEN** for your tasks in the Field Diary Data Record Sheet.

Day 1: Establishing and permanently marking the bird count stations

1. Count station **BIRX** will be in the centre of the boundaries of a 20 × 20 m vegetation plot.
2. All other count stations (**BIRA**, **BIRD**, **BIRM** & **BIRP**) will be established at the completion of each possum transect line. The possum lines will provide a marked route to each bird count station. The station is to be established 20 m beyond the last device on a possum transect (i.e. 20 m along the bearing). If geographic barriers impact on the ideal layout of possum transect lines (bluffs, rivers, etc.), any necessary deviations will need to ensure bird count stations remain a **minimum** of 150 m apart (horizontal distance).
3. Once determined, each bird station is to be permanently marked.
4. **Forested Habitat:** At or near the station, select a tree on which to nail a cross of permolat. Label the permolat with the sampling location, bird station name and year (e.g. 'AB123 BIRA 2015'). Nails should remain protruding by at least 2 cm to allow for tree growth.
5. **Non-forested habitat**: At or near the station, mark the bird station with a 500mm (16 × 2.5 mm) aluminium pipe where it is clearly visible. Ensure the pipe is driven into the ground c. 300 mm deep. This same pole can be used for attaching the ARD (refer to Deploying the recorder on page 55). Take a photo of the pole (with the ARD attached) with obvious prominent features in the image (e.g. a rock or a bush).
6. For some non-forested habitat aluminium pipe cannot be used. For shrubland, mark the bird station using permolat wired to shrubs. For bedrock or a rocky substrate, mark these with a coach bolt (see Alternate methods for permanent marking of plot corners on page 75).
7. If pipe is not established at the bird station, record the distance and bearing of the aluminium pipe, wired permolat or coach bolt from the bird count station in the Bird Station Notes field on the 5MBC Record Sheet.
8. The ARD must be established as close as possible to the bird count station, and not outside of the boundaries of the bird RECCE. Although the aluminium pipe may be used for attachment, if a suitable alternative structure (e.g. shrub) exists closer to the bird count station, this should be used instead.
9. Adequate permolat marking is invaluable when plots are to be remeasured.
10. **Move a station if:**
    a) Environmental noise at stations BIRA, BIRD, BIRM or BIRP (i.e. consistently loud noise, e.g. wind or water noise) is **likely to mask most bird calls** and is able to be reduced by moving the station.
        i) Stations can be moved up to 20 m from their current location along the same bearing, or if necessary, back along the current line as far as PMD (also ensuring the stations remain a minimum of 150 m apart).

ii) Bird stations should be moved only as far as necessary to avoid environmental noise.

iii) As unbiased sampling design is critical, sites should be objectively located. A bird count station must NOT be moved simply because a higher number of birds is likely to be counted at the new location.

iv) Note: At present, there is no objective means of assessing noise—the bird person must decide based on his/her experience. Rule of thumb: 'If in doubt, complete the count', and record that there were noise issues.

11. **Abandon a station if**:

b) Possum transect line is **not implemented to at least 140 m of its length** (154 m from the 20 × 20 m plot centre**—**i.e. at least seven PMDs are set).

c) Bird count station is **not suitable** for 5MBC or ARD measurement, i.e. minimum proximity criteria cannot be achieved (150 m horizontal distance from other bird count stations). Abandon the station from the least 'regular' transect line. 'Regular' is defined as the line that most closely follows the ideal plot layout (Figure 2). For an example of an irregular line, see Figure 10.

d) Environmental noise at stations BIRA, BIRD, BIRM or BIRP (i.e. consistently loud noise, e.g. wind or water noise) is **likely to mask most bird calls** and is unable to be reduced by moving the station.

e) Environmental noise at station BIRX is **likely to mask most of bird calls**. This station can be measured at another time (between 1 hour after sunrise and 1300 hours) to avoid noise, or if consistently loud the station can be moved but must stay within the 20 × 20 m vegetation plot. If noise is unavoidable, the observer may either:

i) Measure BIRX and record that there were noise issues; or

ii) Abandon BIRX when confident that conditions will render the bird counts useless.

12. Once the location of each bird count station is identified and **permanently marked** and labelled:

a) Record the GPS coordinates (and associated data) in the GPS Data Record Sheet at the back of the Field Data Record Sheets for Bird Surveys for each count station. Note: This is important as a vegetation RECCE survey will be carried out at each bird count station—the GPS coordinates need to be made available to the person conducting the RECCE survey).

b) **Save the station point in the GPS unit using the labelling protocol** (i.e. sampling location, survey **and** transect identifier, e.g. ABC123BIRX).

c) Deploy an appropriately programmed ARD at each station (see section 12 'Protocol for acoustic recording').

Day 2: Conduct bird monitoring

13. **Timing of counts**: At each sampling location, all counts must begin **at least 1 hour after official sunrise**, but not before 0700, **and must be completed no later than 1300**. Each

count station will be visited at least once on **Day 2** during this time (preferably twice if the overall sampling schedule permits, providing the interval between repeat visits to points is a minimum of 1 hour).

14. **Weather conditions**: Counts must not be carried out in heavy rain, strong winds or poor visibility (e.g. mist or fog).
15. **Order of count stations**: Count station '**BIRX**' (i.e. the one centred on the vegetation plot) is the most important and should usually be completed first (this rule applies to both coupled and de-coupled scenarios). Observers can then work systematically through the rest of the stations in the order which is most efficient. If there are significant constraints that make this challenging, the order may be changed provided:
    a) The possum lines are established and you know the exact location of bird stations.
    b) The team is de-coupled, therefore noise from other team members at station BIRX will not be a potential issue (as with coupled teams).
    c) You are confident that there will be no factors to prevent measurement at station BIRX (e.g. deteriorating weather, time constraints).
16. **Approaching count stations**: Do this as quietly as possible. This will minimise disturbance to birds and increase likelihood of detecting birds departing the plot—particularly those close to the count station itself (important for distance sampling—see the Bird movement in response to observers in Distance sampling on Page 51). For this reason, avoid checking PMDs and approaching count stations at the same time as much as possible.
17. **10-minute recording period**: Recording of birds is to be initiated as soon as observer(s) arrive at the count station and continues for a total sample of 10 minutes divided into two 5-minute blocks (leaving several minutes between these count periods to complete data entry is fine) as follows:
    a) **Distance sampling (5MDist—first 5-minute block)**: This is an unbounded index count of all birds that can be seen or heard within six specified distance intervals This method requires that distances between the count station and a bird (using visual and/or aural cues) are accurately estimated and recorded on the appropriate side of the data record sheet in the correct distance category.
        i) The use of laser rangefinders makes distance estimation much easier;
        ii) Distance sampling counts are unbounded;
        iii) Be organised: Finish paperwork of 5MDist before starting 5MBC.
    b) **Five-minute bird counts (5MBC—second 5-minute block)**: This is a simple unbounded index count of all birds that can be seen or heard within broad distance intervals.
18. **Same observer for a round of counts**: A single round of bird counts (A-P and X) must be completed by the same observer. If a second round of counts is completed in the same period, another observer can complete these but again, they will need to complete all of the counts for that round.

Recording data in data record sheet

Distance sampling (5MDist)

During the first 5-minute count period, a distance sampling 5MBC is to be conducted. For each bird (or group of birds) seen or heard within a 5-minute period, the horizontal distance is measured (using a range-finder) and recorded in one of six distance classes: 0–8 m, 9–16 m, 17–25 m, 26–45 m, 46–100 m and >100 m. The aim is to create a 'snap-shot' of bird positions for each species, which can then be used to calculate densities. It is therefore essential that birds are recorded at their initial locations (i.e. prior to them moving away or towards the observer). Failure to do this may result in biased density estimates (see 'distance sampling rules, page 51).

Distance Sampling Data Record Sheet

- **Start time:** Record start time (hh:mm) for each 5-minute count period.
- **Species name:** Record the species seen or heard on a unique row in the data record sheet (even if this species has already been recorded). Refer toTable 8. Bird species codes. If the observer is uncertain about the identity of the species, record as '**UNID**'.
- **Distance to bird:** During the first 5-minute count period, estimate the horizontal distance using a laser rangefinder to the point at which each bird (or group of birds) was initially located as accurately as possible and record in the relevant distance class. This will not be possible on all occasions if there are large numbers of rapidly moving birds in the area or birds can only be detected a long way off. **It is important to concentrate search effort on the area directly above and immediately adjacent to the count station (particularly within radius of 0–25 m)**. Distance measurements of birds further than 60 m from the observer are notoriously inaccurate and may be discarded during analysis. A small number of accurate measurements will be far more useful than large numbers of inaccurate and distant measurements.
- **Cluster size**: Record as accurately as possible the 'cluster size' (number of individuals) detected. Individual birds for which a distance measurement can be obtained should be recorded as a cluster size of '1'. Only one measurement of distance to the approximate geometric centre of 'non-independent' pairs, flocks or other groups of birds (i.e. birds whose presence is probably dependent on the proximity of others) should be recorded and the number of birds in this group estimated (e.g. distance = 23 m and cluster size = 4). The observer must use his/her experience to judge whether or not birds are dependent on presence of others, and record clusters appropriately.
- **Precision of your cluster size**: Please note the precision of your cluster size estimates as either '**A**' (accurate) or the more rudimentary '**E**' (estimate).
  - Use *'Accurate*' when precise counts of the entire cluster can be made (e.g. a pair (2) or small family group (5) of rifleman; a small flock of relatively slow-moving whiteheads or brown creepers etc.). 'Accurate' also applies to single birds heard calling but not seen.
  - Use '*Estimate*' where cluster size is less certain and under-estimates are likely to result from rapid movements of cluster, difficulties resolving numbers from many/few

calls, distance from observer or density of vegetation (e.g. flocks of finches and silvereyes) etc.

- **Comments**: Field for recording notes.

Distance sampling rules

- **Bird movement in response to observers**: Where birds in close proximity to the count station were obviously disturbed by the approach of an observer, care must be taken to note the identity and original location of those birds as soon as you arrive at the station and make a distance measurement to this point. Some species (e.g. robins) may also move towards the observer. If you do not know the point from which a bird departed or moved towards the observer, and therefore cannot record a distance, do not record this bird on the distance sampling form. If, however, it is a species that is not recorded in any of the other counts, it should be added to the incidental bird sightings.
- **Flying birds**: **Do not** record flying birds unless you saw their point of origin - doing so will bias density estimates. These birds should instead be recorded in incidental bird sightings, with a note that they were seen flying. Note that this does not include hovering birds such as skylark, as the horizontal distance to a hovering bird does not change. For these birds, record the horizontal distance and add a comment that it was hovering.
- **'Missed' distance measurements**: If birds are thought to have escaped detection close to the point and/or immediately above it during the initial 5-minute distance sampling period but are subsequently noted during the 5MBC period, these birds and the distances to them should also be recorded on the distance sampling form (providing the observer is confident that the birds are at their initial location and have not moved). This situation is most likely to occur for species that tend to sit quietly for long periods (e.g. kākā, kererū, etc.) or where the canopy height is very high and/or complex making observation difficult.

Bird count diagram

- This is an optional tool to assist with bird counts. It is designed to keep track of locations of individual or clusters of birds and helps avoid missing or double-counting birds. There is one diagram for each station. The centre of the diagram represents the position of the count station, whilst the circles represent distances from the count station. It may be helpful to mark landscape features on the diagram (such as large trees, rivers, cliffs, etc.) before starting the count.
- It is important to remember that use of this tool is **optional**, and if used **all data must be transferred to the Distance Sampling Data Record Sheet** before moving to the next station.

Five-minute bird counts (5MBC)

During the second 5-minute block (record start time) a modified 5MBC is to be conducted. This is a simple tally of **all** bird species seen or heard and recorded in three distance 'bins' (near, far or very far), within a 5-minute period over an unbounded (> 100 m) distance. A rangefinder may be useful for these observations.

5MBC Data Record Sheet

- **Species name:** Record the species seen or heard on a unique row in the data record sheet. Refer to Table 8. Bird species codes. If the observer is uncertain about the identity of the species, record as '**UNID**'.
- **Distance to bird:** Tally **all** bird species seen or heard within a 5-minute period and record as either '**Near**' (0–25 m), '**Far**' (26–100 m) or '**> Far**' (> 100 m) over an unbounded (> 100 m) distance. A rangefinder may be useful for these observations.
- All observations should be recorded and assigned a distance. However, if for some reason the distance is not known (e.g. birds flying into, out of (where departure point is not known), or over the plot area), the number of individuals can be recorded without the distance, using the following procedure:
  - Record the species name on a unique row in the data record sheet (even if this species has already been recorded).
  - Leave the distance categories BLANK.
  - Record in the COMMENTS field 'Distance Unknown' and a tally of birds observed (e.g. 'DU, III').
- **Comments**: Field for recording useful notes (e.g. DU, III).

Five-minute bird count notes

- The observer must clearly state (toward the microphone) the **start** and **finish** of the count. For example, '**5-minute bird count station X start**' and '**5-minute bird count station X finish**' or something similar.
- No bird should be knowingly counted twice within a single count. However, if an individual bird was included in a count from a previous station (or from the previous 5 minutes of distance sampling) it should be counted again as an independent observation.
- If a bird calls in one place and later an individual of the same species calls some distance away, they are assumed to be two individuals unless there is evidence that the first bird moved to the second place.
- No birds should be assumed to be present without some visual or auditory clue to their presence (e.g. the number of silvereyes seen or heard is noted rather than a guess based on the frequency of calling).

Bird count diagram

- This is an optional tool to assist with bird counts: it is designed to keep track of locations of individual or clusters of birds and helps avoid missing or double-counting birds. There is one diagram for each station. The centre of the diagram represents the position of the count station, whilst the circles represent distances from the count station. It may be helpful to mark landscape features on the diagram (such as large trees, rivers, cliffs, etc.) before starting the count.
- It is important to remember that use of this tool is **optional**, and if used, **all data must be transferred to the 5MBC Data Record Sheet** before moving to the next station.

Once the 10-minute bird counting period is complete:

- Ensure that if bird count diagrams have been used, all data are transferred accurately to the relevant bird count data record sheets.
- Ensure that all relevant information about the count station identifier, dates, times and observer(s) are completed.
- Fill in weather information and noise conditions that occurred during the count, including the source of any noise.
- Use the '**Notes**' section (on 5MBC Data Record Sheet) to make any additional notes that may be useful about the methods, conditions, site or logistics associated with this count.

Incidental bird sightings:

- Record any additional bird species detected while **within the sampling area (defined as the circular area of 234 m radius**, with the 20 × 20 m vegetation plot at its centre—see Figure 23).
- Record these on the Incidental Bird Sightings Data Record Sheet. Refer to Table 8. Bird species codes.

Other bird sightings:

- Record threatened and /or other noteworthy species (e.g. NZ falcon, kiwi, or species not within normal ranges or habitats), outside the 234m radius sampling area but **within the 2 × 2 km grid square**, on the Other Bird Sightings Data Record Sheet. Refer to Table 8. Bird species codes.
- There is no formal requirement to record observations made **outside of the 2 × 2 km grid** square; however, the 'Plot notes' (Field Data Record Sheets for Bird Surveys, page 3) field can be used for this. Any such observations must be accompanied by a note to say they are outside of the 2 × 2 km grid square and must be forwarded to your Supervisor.

Retrieve field equipment

After the last set of bird counts on Day 2, retrieve ARDs from all count stations (see section 12 'Protocol for acoustic recording').

Table 8. Bird species codes.

Native birds				**Introduced birds**	
BBG	Black-billed Gull	PIG	Pigeon (NZ)/ Kereru	BLK	Blackbird
B-C	Brown Creeper	PIP	Pipit (NZ)	CAL	Californian Quail
BEL	Bellbird	PST	Pied Stilt	C-B	Cirl Bunting
BFT	Black-fronted Tern	PUK	Pukeko	C-G	Canada Goose
B-S	Black Swan	RBG	Red-billed Gull	CHA	Chaffinch
CAS	Caspian Tern	RIF	Rifleman	CHU	Chukor / Chukar
DOT	Dotterel (Banded)	ROB	Robin (NZ)	DUN	Dunnock
FAL	Falcon (NZ)	R-W	Rock Wren	GOL	Goldfinch
FAN	Fantail	SAD	Saddleback	GRE	Greenfinch
FER	Fernbird	SBG	Southern Black-backed Gull	HOU	House Sparrow
G-W	Grey Warbler	S-C	Shining Cuckoo	MAG	Magpie (Australian)
HAR	Harrier (Australasian)	S-E	Silvereye	MAL	Mallard
KAK	Kaka	SWP	Spur-winged Plover	MYN	Myna (Indian)
KEA	Kea	TIT	Tomtit	PHE	Pheasant (Ring-necked)
K-F	Kingfisher (NZ)	TUI	Tui	RED	Redpoll
KIW	Kiwi (* specify)	WEK	Weka	ROC	Rock Pigeon (Feral)
LTC	Long-tailed Cuckoo	WFT	White-fronted Tern	ROS	Rosella (Eastern)
MOR	Morepork	W-H	Whitehead	SKY	Skylark
O-C	Oystercatcher (* specify)	W-S	Welcome Swallow	STA	Starling
PAR	Parakeet (* specify)	Y-H	Yellowhead	THR	Song Thrush
P-D	Paradise Shelduck			YEL	Yellowhammer
PIG	Pigeon (NZ)/ Kereru				

12. Protocol for acoustic recording of birds

Acoustic monitoring operating schedule

One acoustic recording device (ARD) will be deployed (on a suitable stake or sapling) at each of the five bird count stations (**BIRX, BIRA**, **BIRD**, **BIRM** & **BIRP**) on Day 1 and retrieved following the conclusion of bird counts on Day 2. ARDs must be deployed at all established bird count stations.

The ARD will be set to turn on (internal clocks will be synchronised) and record (using the HIGH quality setting) at a pre-determined time schedule for Day 1 and Day 2 as per below:

Calls are recorded for two sessions[2]

1. **commencing 2000 hours until 0600 hours**
2. **commencing 0700 hours until 1300 hours**

Deploying the recorder

Before mounting the recorder, carefully open it and check that the batteries and SD card are correctly in position and that the Plot ID and Station ID are correct.

The recorders can be mounted to trees, posts or stakes using brackets, cable ties or tape. Attach recorder to the post or tree (the smaller the tree the better—large trees can cause unwanted blocking of the sound). The recorder then sits in the bracket and is held in place by a cable tie (see Figure 24). In non-forested plots, use thin fibreglass rods of 1 cm diameter and 1.2 m length. Position the rod into the soil until stable (approx. 30 cm) and attach the bird recorder using electrical tape. When using fibreglass poles, set into aluminium cylinders in scree and secure the poles to prevent them rattling around in the wind.

Figure 24. Mounted acoustic recording device (ARD).

Voice indexing for bird counts (5MBC)

During each 5MBC (second 5-minute period), recordings need to be indexed to observer-based 5MBC. This is achieved by clearly stating (toward the microphone) the **start** and **finish** of the count. For example, '**5MBC station X start**' and '**5MBC station X finish**' or something similar.

[2] **NOTE: The ARD will start recording when the batteries are inserted.** The skip menu allows you to skip the current recording session; e.g. you arrive on Day 1 within the recording period (0700–1300 hours) and intend to deploy the ARD during this time period but do not wish to activate recording until 2000 hours.

Retrieval of recorders

On completion of the bird counts all ARDs will be retrieved, recorders turned off, opened as per instructions below, batteries removed, and the SD cards extracted and placed into an appropriately labelled bag or envelope that clearly identifies sampling location, count station and date. Note that batteries must not be removed until at least 30 minutes after the end of the last bird count to prevent loss of data.

Although it is preferable for the ARDs to be left in position until the end of the recording period (1300 hours), they can be collected as early as 11:00am. Record deviations to this standard (i.e. collected before 11:00am) by recording the time of retrieval and providing a reason for the deviation in the 'Acoustic Record Notes' field in the Field Data Record Sheets for Bird Surveys.

As soon as possible, the data files on each card should be copied onto the appropriate hard drive (the files are automatically named for easy identification and processing). Note that the data files are automatically broken into 15-minute segments.

- To record this amount of data, 8 GB SD cards will be required.
- In the event of lasting heavy rain, it is advised that recording is abandoned (device turned off).

Operating instructions for ARD

Be very careful pushing together and pulling apart these recorders (check for grit and/or burrs on aluminium surfaces) to avoid jamming the two halves together. **Avoid getting moisture or debris inside the recorder**.

Figure 25. Opening an ARD.

Depending on the model ARD, open the recorder, remove the aluminium tube cover by gently screwing off the cover or twisting until the locators disengage and then pulling on the cover. Try to ease the tube off rather than it pulling away and knocking the recorder electronics inside. It is easiest to use your hands to lever the cover off as shown in Figure 25.

Once the recorder is open you can see the display screen, control buttons and SD card slot on one side; the battery holders are on the other (Figure 26).

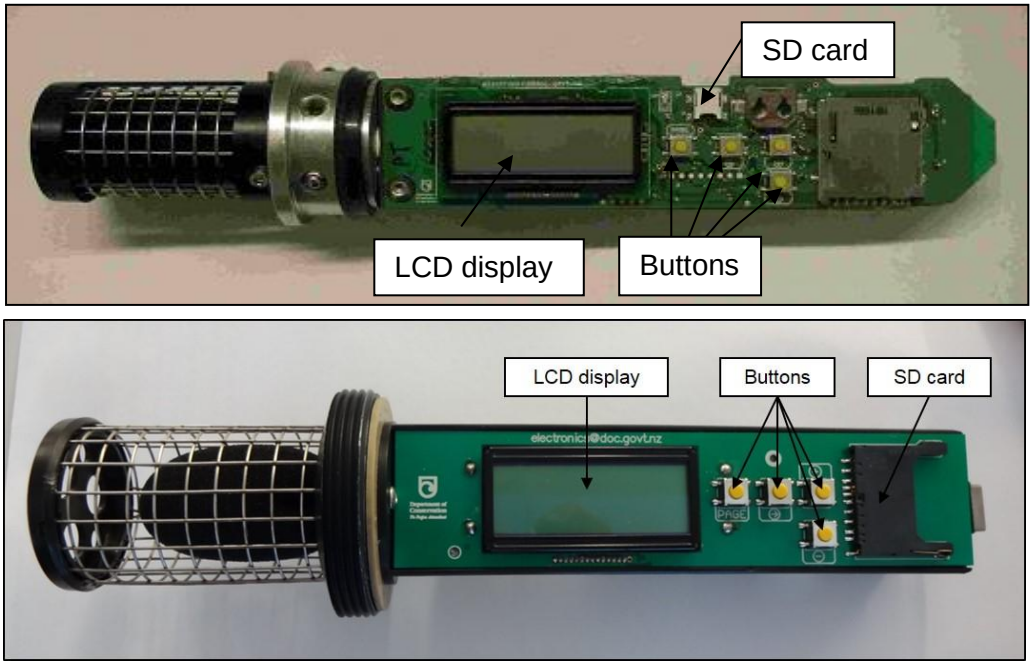


Figure 26. ARDs with the covers removed.

Buttons for settings

There are four keys on the recorder to navigate through the menu:

- The **On/Page** key wakes up the recorder and allows you to cycle through the pages in the menu.
- The **Plus & Minus** keys (+/−) modify the settings in the page.
- The **Shift** key (→) selects which value to modify.

Settings:

Press the ‘On/Page’ key to start the display. After a few seconds the ‘Time’ page will appear. Using the On/Page key you can scroll through the various settings pages as below.

Time =	Current time, in 24-hour format.
Date =	Current date including the year, in DD/MM/YY format.
Protocol =	Depending on the ARD model, a standard Tier 1 protocol is loaded onto the ARD. Newer models allow the user to choose a Tier 1 Day and/or Tier 1 Night protocol.
Location ID or	
Survey name=	Note this can vary in length between 4 and 7 characters. The interface allows for an underscore character which is not included in the filename. Only the last four characters of the ID can be set to underscore.
Station =	Tier 1 station ID. The value can be scrolled between BIRA, BIRD, BIRM, BIRP and BIRX.

Card = Either check the card (function and free space) or reformat the card. Use the +/− keys to toggle between the card check and card format options. The Shift key starts the check or format.

Skip1stRec = Skips the current recording period. If you are setting up the recorder during a preset recording period (this is indicated by an asterisk (*) on the time display) then setting this menu to ‘yes’ will prevent the recorder from starting recording when the display powers down. The menu setting resets to ‘no’ every time the recorder display shuts down.

Note: On each page the **Shift** key (→) button (middle button) can be used to **select** a value (*the value flashes*) and the **Plus/Minus** keys are used to **modify** it. After about 20 seconds of no activity from the user the display will power down.

13. Protocol for vegetation reconnaissance (RECCE) surveys at bird count stations

Overview

1. Vegetation reconnaissance (RECCE) surveys will be carried out in four 'out-lying' bird count stations **BIRA, BIRD, BIRM** & **BIRP** to characterise the topography and vegetation at each station.
2. Note that the RECCE survey in bird count station **BIRX** will be carried out as part of the 20 × 20 m vegetation measurement (including sub-plot and stem diameter measurements). However, the vegetation classification is not completed at BIRX by the vegetation team, therefore this must be completed.
3. The bird count stations **BIRA, BIRD, BIRM** & **BIRP** are located at the end of each of the 200-m possum transect lines which extend from each corner of the vegetation plot. The possum transect line will provide a marked track route to each permanently marked bird count station. *Note: GPS locations of all bird count stations are available from the bird expert who has recorded these in the GPS Data Record Sheet. If a different person is completing the Bird Recce, It is recommended these are saved in your GPS (use the labelling protocol) in order to relocate the bird count stations.*
4. The bird RECCE plot boundaries are **not permanently marked**, but the use of a range finder and flagging tape to temporarily determine the boundaries of a 20 × 20 m plot (Figure 1) centred on the bird count station is recommended.
5. On sloping ground, establish the P–M boundary along the predominant contour and the P-A boundary up the slope (Figure 1). On flat terrain, establish the plot so that the M–P boundary lies in a north–south direction (i.e. corner M is north of corner P).
6. Use the Field data Record sheets for RECCE survey at bird count stations to record findings.

Data record sheets

- **Limit data to constrained categories** (where these are supplied). For example, do not record drainage as 'okay'; always record it as 'good', 'moderate', or 'poor'. Use the 'Vegetation Description and Notes' section where justification or further detail is required.
- **Do not leave any field on the data record sheet blank.** Where data are intentionally not recorded in a data field, record a dash ('–') or 'none' to ensure that the data are not interpreted as missing. Record '**not measured'** where data were not measured for whatever reason.

RECCE metadata

Plot metadata provide essential information for each plot that will assist with future planning and plot remeasurement. Record the metadata information at the top of each page in your Field Data Record Sheets for RECCE Surveys at Bird Count Stations:

- **Record the sampling location**. This is the unique letter/number code (e.g. R149) that identifies the position of the plot on the 8 km^2 sampling grid.
- **Select/circle** the bird count station you are measuring.
- **Observer**: Record the full name of the person(s) completing the description of the plot (e.g. Larry Burrows).
- **Date:** Record day/month/year of the first day on plot in full, using the format day/month/year (DD/MM/YYYY).
- **If the bird count station was not measured**, tick the 'Station not measured' box. If ticked, you must also briefly describe why the RECCE plot was not measured, in the 'Reason' box.

RECCE site description

Site data collected provide important information on abiotic factors that may influence vegetation structure and composition. As a minimum, a set of basic, readily obtainable measures is required, as outlined below. Record data on the RECCE Site Description Record Sheet:

- **Altitude:** Record altitude to the nearest 10 m and record on the RECCE Site Description Record Sheet. Using the GPS coordinates, determine the plot position on a topographical map (or the map loaded onto the GPS) and then use the map contour lines to determine the altitude.
- **Physiography:** Circle the applicable option from: ridge (including spurs), face, gully, or terrace. When more than one category could apply, circle the predominant physiography and record any major change in physiography within a plot in the Notes section.
- **Aspect:** Determine the physiography of the plot before measuring the aspect. Use a compass to measure the predominant aspect at right angles to the general lie of the plot, to the nearest 5° (magnetic). An aspect measurement is taken at right angles to the general lie of the plot. Where there is a major change in aspect across the plot (e.g. a plot lies across a ridge), record the predominant aspect. Aspect cannot be determined on flat or almost flat plots (slope < 5°) and should be recorded as 'X'. Do not use zero to record aspect on flat plots, as this will be misinterpreted as a northerly aspect.
- **Slope:** Use a clinometer (or equivalent instrument) to measure the average slope of the plot along the predominant aspect, to the nearest degree. From the middle of the plot, sight the clinometer on an object at eye level near the upslope and downslope boundaries of the plot, and average the two readings. Select the applicable slope type option from 'convex', 'concave', or 'linear' to describe the shape of the slope along the predominant aspect.
- **Parent material:** Parent material can often be determined prior to fieldwork from geological survey maps; copies are available in libraries and can be obtained from GNS Science (http://www.gns.cri.nz/). Where available, the QMAP geological map series at 1:250 000 scale should be used. DOC Tier 1 survey Parent Material layer polygon type is 'Main Rock'. Where the field party contains staff with expertise in the identification of rock types, any observed differences with the map classifications provided on the DOC Tier 1 Metaforms can be noted in the field, particularly when there are extrusive/intrusive rocks. Circle the

relevant option to record whether parent material was derived from the mapped classification or was observed in the field. If unaware of the parent material while in the field, record 'Unknown'.

- **Drainage:** Select one applicable option from good (fast runoff and little accumulation of water after rain), moderate (slow runoff, water accumulation in hollows for several days following rain), or poor (water stands for extended periods).
- **Cultural:** Record direct evidence of human interference within the plot boundary using the categories provided (e.g. logged, burnt, tracked, cleared, mined, grazed (by domestic stock), none). Use the Notes section to justify your choice(s) where necessary, or to record indirect evidence of human activity (e.g. plant species characteristic of post-fire communities as evidence of a past fire).
- **Mesoscale topographic index:** Use a clinometer (or equivalent instrument) to measure the angle from the centre of the plot to the horizon at eight equidistant (45°) magnetic compass bearings. Record whether each angle is above (+) or below (−) the horizontal. When the horizon angle is obscured (e.g. by low cloud or dense vegetation), estimate the location of the horizon as accurately as possible, measure this angle, and make a note that the recorded value is an estimate (e.g. −8° (est.)). When all eight values are averaged, the resulting value provides an indication of the relative protection (e.g. high values) or exposure (e.g. low values) of the site (McNab 1993).
- **Surface characteristics:** Record the following for the plot:
  - **Bedrock %, broken rock %**: Estimate the percentage of the plot ground surface composed of bedrock and broken rock (> 2 mm), to the nearest 5%. Include all rock that is evident, even if covered by vegetation, moss, or a thin layer of litter.
  - **Size of broken rock (> 2 mm)**: Record whether rocks are < 30 cm and/or > 30 cm by circling the relevant option. If there is no broken rock, cross out both options.
  - **Mode of transport of broken rock:** Classify (if possible) whether broken rock was mostly deposited as a result of alluvial (river deposits), colluvial (erosion debris), moraine (glacial deposits), or volcanic activity.
- **Ground cover %:** Record the following for the plot. Estimate the percentage of the plot area (to the nearest 5%), below 1.35 m, that is covered by:
  - **Vegetation:** Live vascular vegetation including foliage, tree trunks and exposed roots. Note that tree trunks and exposed roots normally make up only a very small portion (usually < 1%) of vegetative cover.
  - **Non-vascular**: All non-vascular vegetation: mosses, liverworts, hornworts, lichens (including crustose species) growing on soil, litter, coarse woody debris, and rock, and include non-vascular plants growing as epiphytes on other living plants, stems and roots, and dead-standing stems.
  - **Litter:** Litter including leaves, dead logs, and branches (and inclusive of litter among low-growing vegetation).
  - **Bare ground:** Exposed soil not covered by litter, vegetation, moss, or rocks.
  - **Rock:** Exposed rock, either broken rock (> 2 mm) or bedrock, not covered by vegetation, moss or litter.

The above five values must sum to at least 100%, but because of multiple layers of overlapping cover, they will normally sum to more than 100%. As plots are not flat (there are hollows, cliffs, and general topographic features), it is best to imagine flattening these features and estimating ground cover as a proportion of this total flattened surface.

Where cover is absent (0%) for a ground cover type, record a dash ("-").

- **Average top height (m)**: Estimate the average top height of the dominant vegetation on the plot, to the nearest metre. Here, the dominant vegetation is defined as all vegetation in the tallest tier with an overall cover of > 25% (i.e. overall cover class of ≥ 4). Where none of the tiers have cover > 25%, average top height should be averaged across the entire plot. Height estimates should be calibrated regularly with heights measured using a tape (e.g. 8 m builders tape), height pole, or a Vertex or equivalent instrument, and recorded to the nearest metre. Low-statured communities, where average top height is less than 1 m, are recorded to the nearest 0.1 m.
- **Canopy cover (%):** Visually estimate the total canopy cover of the plot above 1.35 m, to the nearest 10%. Canopy cover is based upon the vertical projection of all vascular and non-vascular live or dead material (leaves, trunks and branches) over the plot area. This is a measure of the cover of the canopy and reflects how much light is being blocked. Use the canopy cover scale (Figure 27) to help arrive at the estimate. Include all vegetation > 1.35 m above the ground. In plots with a dense sub-canopy, several estimates may need to be made from different positions around the plot (e.g. the centre and four other points, halfway between the centre and each of the plot corners) and then averaged.

RECCE vegetation description

On the RECCE Vegetation Description Record Sheet, vegetation structure and composition is described in height tiers (strata) using cover classes.

A. Cover Class for each height tier

Cover Classes

Assign an OVERALL cover class to each tier (tiers 1–6). For each height tier, these represent the total canopy cover of all species collectively in the tier.

- Use the standard cover-abundance scale (Table 9) to assign a cover class to each species in each tier (see 'Height tiers' below). Do not include tree trunks in cover class estimates.
- Use the canopy cover scale (Figure 27) to help determine the canopy cover percentage and assign cover classes.

Table 9. Cover class applied to the species present in each height tier on the RECCE vegetation description, for a 20 × 20 m plot area. Cover classes are modified from the Braun-Blanquet cover-abundance scale (see Mueller-Dombois & Ellenberg 1974). Equivalent areas of a 20 × 20 m plot are also given.

Cover class	% canopy cover	Equivalent area of a 20 × 20 m plot	
1	<1	<2 × 2 m	(i.e. <4 m^2)
2	1–5	>2 × 2 m and < 4 × 5 m	(i.e. 5–20 m^2)
3	6–25	c. 1–4 (5 × 5 m) subplots	(i.e. 21–100 m^2)
4	26–50	4–8 (5 × 5 m) subplots	(i.e. 100–200 m^2)
5	51–75	8–12 (5 × 5 m)	(i.e. 200–300 m^2)
6	76–100	12–16 (5 × 5 m) subplots	(i.e. 300–400 m^2)

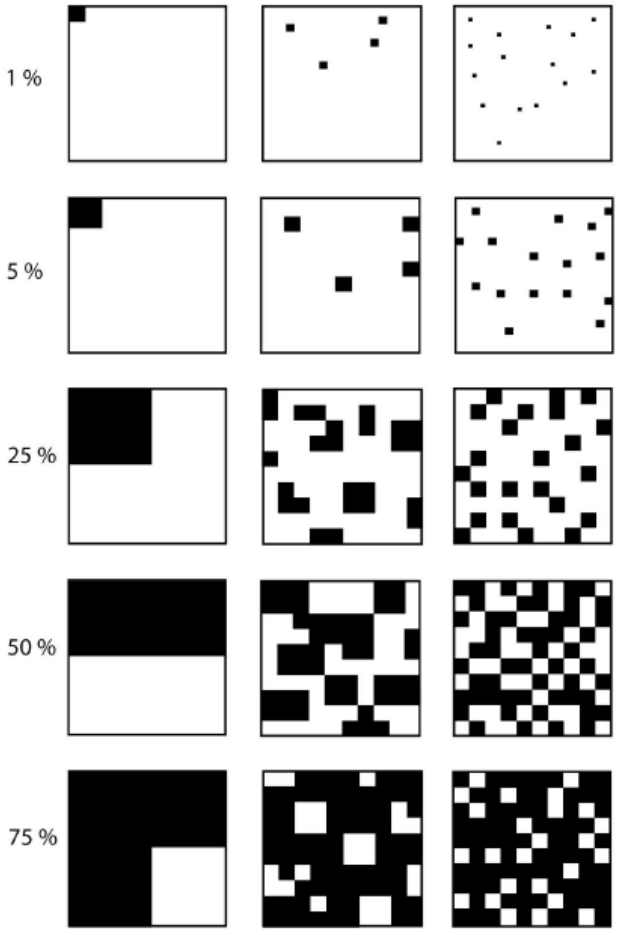


Figure 27. Canopy cover scale

- The cover class assigned to each tier represents the percentage of canopy cover within that tier, which is the ‘percentage of the plot area covered by a vertical projection downwards of the outermost perimeter of the natural spread of the crown of each plant’ (Daubenmire 1968; Jennings et al. 1999), for every plant within that tier. Unlike the Foliar Browse Index

methodology, the density of the foliage does not matter. Small openings within the crown of each plant are included in canopy-cover estimates, so canopy cover differs distinctly from foliar cover. Care should be taken not to bias the estimate because of high or low foliage density. For instance, the tree in Figure 28 would have a cover score that encompasses the perimeter, regardless that within this the foliage is dense in patches.

Figure 28. Cover class method for the RECCE vegetation description. The out margin of a tree is marked and represent the outermost perimeter of the natural spread of the crown. The cover within is considered continuous.

- Develop straightforward approaches to arrive at cover estimates. For example:
  - **When the cover** of a species within a tier is very high, it may be easier to estimate the proportion of the plot area not covered by the species.
  - **Visualise the canopy** of each tier squashed into a flat plane, and then estimate the proportion of the plot area covered by the species (i.e. avoid biasing cover estimates because of high or low foliage density).
  - **Plant species are deemed to be present** in a height tier only when they have living foliage within that tier. For example, if the canopy of *Rubus cissoides* (bush lawyer) all occurred c. 10 m above the ground, it would be included in tier 3 (5–12 m); and if a *Weinmannia racemosa* (kāmahi) had foliage in each of tiers 1 to 6, then it would be included in all of these tiers.
- Record the cover score for each Tier in the Cover Class field on RECCE Vegetation Description Record Sheet.

Height tiers

Use the following standard fixed-height tiers (Figure 29). Fixed-height tiers provide standardised and repeatable data that are readily comparable between plots on a survey and among surveys.

- **Tier 1:** Record all canopy trees taller than 25 m. Estimate and record the total foliage cover in the horizontal plane for all species in the tier using the cover-abundance scale outlined in Table 7.
- **Tier 2:** Record the overall cover of all vascular plant species 12–25 m tall.
- **Tier 3:** Record the overall cover of all vascular plant species 5–12 m tall.
- **Tier 4:** Record the overall cover of all vascular plant species 2–5 m tall.
- **Tier 5:** Record the overall cover of all vascular plant species between 30 cm and 2 m tall.
- **Tier 6:** Record the overall cover of all vascular plant species up to 30 cm tall.

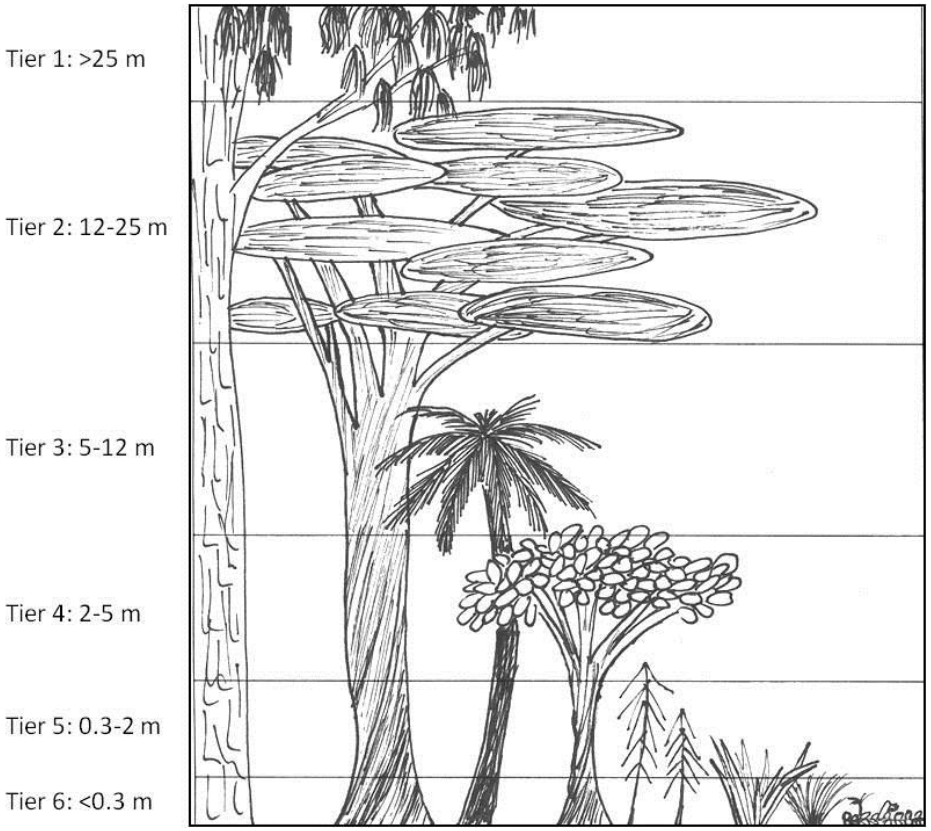


Figure 29. Height tiers used for RECCE vegetation descriptions on 20 × 20 m plots.

B. Classification of the dominant vegetation type

Select a dominant vegetation type from the list (Table 10) that best describes the vegetation cover at the bird count station. The dominant type is the vegetation type that covers the majority of the 20 × 20 m plot area.

- This is a quick assessment of the vegetation type at the bird count station. It should take about 5 minutes (maximum) for you to make this assessment.

- In places with mixed vegetation types (e.g. forest edges or shrub-grassland areas) you need to decide which type is most representative of the 20 × 20 m plot and best describes bird habitat.
- Record dominant vegetation type by circling ONE option in the Vegetation Type on RECCE Vegetation Description Record Sheet.

Table 10. Vegetation types and definitions for the bird RECCE vegetation description.

VEGETATION TYPE	DEFINITION
FOREST	
Beech Forest	Forest canopy dominated by *Fuscospora* and/or *Lophozonia* (both previously *Nothofagus*) species.
Broadleaf Forest	Forest canopy dominated by broadleaf tree species (e.g. broadleaf, *Coprosma*, nīkau palm, cabbage tree, māhoe, pigeonwood)
Conifer Forest	Forest canopy dominated by conifer species other than kauri (e.g. matai, miro, rimu, kahikatea, kaikawaka).
Exotic Forest	Forest canopy dominated by exotic tree species (e.g. pine trees, elder, willow, gum trees).
Kauri Forest	Forest canopy dominated by kauri trees.
Tree fern	Forest canopy dominated by tree fern species (*Cyathea* or *Dicksonia*).
SHRUB	
Exotic Shrub	Low-statured (usually < 5 m) exotic trees and shrubs (e.g. gorse, broom, briar rose). AND plants growing like shrubs (e.g. blackberry).
Mānuka/Kānuka	Mānuka, kānuka or a mix of both species.
Other Native Shrub	Low-statured (usually < 5 m) native trees and shrubs (e.g. matagouri, *Dracophyllum*, tree daisies, *Coprosma*) AND plants growing like shrubs (e.g. bracken fern).
GRASSLAND	
Exotic Grassland	Grasslands dominated by introduced grass species (e.g. browntop, sweet vernal, rye grass). May be grazed or ungrazed pasture.
Short-Tussock Grassland	Native grasslands dominated by short (< 50 cm) grass species (e.g. carpet grass, blue tussock).
Tall-Tussock Grassland	Native grasslands dominated by tall (> 50 cm) grass species (e.g. snow tussocks, silver tussock, hard tussock).
AQUATIC	
Braided River	Wide riverbeds containing multiple braided river channels. Vegetation often sparse, but could also be thick with invasive species (e.g. broom, Russell lupins).
River (other)	River edge/bed areas other than braided rivers. These could include areas such as turf communities, boulder streams.
Saline	Saturated or bordering saturated areas with salt or brackish water present (e.g. estuarine areas, mangroves).
Wetland	Highly saturated fertile areas with still freshwater present (e.g. pākihi, swamps, alpine bogs/tarns/seepages, flaxlands).

ALPINE	
Herbfield	Low-statured vegetation (often < 30 cm), dominated by non-woody species (e.g. mountain daisies, speargrass, buttercups, gentians).
Nival—Permanent Snow/Ice	Areas with year round snow/ice. Limited or no vegetation.
Scree/Fellfield	Rocky (fellfield) or rocky, mobile (scree) areas with limited vegetation, often high alpine.
OTHER	
Bare Ground	Area devoid or almost entirely devoid of vegetation (e.g. recent landslides).
Dunes	Coastal sandy environments with sparse or low diversity vegetation.
Geothermal	Areas of hydrothermally altered ground. Often associated with stunted vegetation.
Horticultural	Primary production areas (e.g. orchards, vineyards, short-rotation crops or other crops).
Ultramafic	Heavily mineralised, rocky areas with low fertility.
Urban	Built up areas (including sports fields/parks within), surface mines, dumps, or areas of transport infrastructure.

14. Photos

Transect photos

Photographs of the plot are to be taken from each corner (A, D, M and P) looking outwards down the direction of the transect. If the transect turns from the corner of the plot, take the photo in the 'planned' transect direction 45° from the plot corner. Photos need to be checked to make sure they are in focus and that there are no obstructions in the way. If images are not clear and in focus, take them again, take them at another time of the day with better light, or move slightly to remove any obstruction from a photo. The file should be c. 700 KB per image. The date and time the photos were taken should be recorded on the Field Data Record Sheets for Mammal Surveys ('Photo out').

Relocation photos for newly established plots in non-forest habitats

- Accurate approach notes and GPS coordinates are vital for establishing and relocating newly established non-forest plots.
- Photos of a plot itself and of the plot in relation to distinct landscape features can provide essential information for vegetation teams relocating plots in the future.
- The number of photos required to adequately capture a plot's key features (for successful relocation) will depend on the vegetation and terrain and will differ between plots.

Procedure

- Step a few metres back from the plot and find the best location to take one photo with a view of the entire plot (external tapes should be visible in the photo as best as possible to indicate the directions of the corners and show noticeable features inside the plot (e.g. rock, distinct plant) in relation to the tapes. *If you cannot get a full plot view, take extra photos towards the plot centre that will provide a view of the missing plot section).*
- Take additional photos looking uphill and downhill from locations outside the plot and, where possible, include characteristic landscape features that can be readily identified in the field. Such features can be located nearby (e.g. large distinctive rocks or bluffs, watercourses, noticeable vegetation) and/or in the distance (e.g. distinctive ridge or skyline, slopes with large slips, waterfalls).
- After each photo is taken, check that the photo quality is adequate and retake if needed.
- Use the additional photo table sheet to record the metadata for each photo as you go along.

Bird station photos (non-forest only)

In open areas with no woody vegetation, photos are to be taken at bird stations (once the ARD pole is established) with a distinguishable feature in the foreground or background. One photo is sufficient if a clearly distinguishable feature is present (e.g. rock formation). Photos are not a requirement in forest.

Photos for each station should be recorded in the Field Data Record Sheets for Bird Surveys Bird station photos table. Once photos are uploaded, convert the image numbers given by the camera to a unique name code that identifies photos associated with each bird station.

This code should contain the following information in the given order: **Sampling Location ID** (e.g. L158), **Bird station** (e.g. BIRM), the **Date** the photo was taken (DDMMYYYY), and **photo number** (when more than one photo is taken at a bird station). Separate each piece of information with an underscore.

For example, photo IMG123 could be converted to: **L158_BIRM_24012013_1.jpg**

15. Locating new plots at systematic or random sample points

Where new plots are to be established at points determined prior to fieldwork, **enter the grid reference for each plot into a GPS receiver prior to fieldwork**. Check the coordinate system of the coordinates before entering. If they were collected in New Zealand Map Grid (NZMG) they will need to be converted to New Zealand Transverse Mercator (NZTM). When GPS reception can be obtained, use it to navigate to within c. 30 m of each plot location. Ensure the direction function of the GPS receiver is set to magnetic and use the GPS waypoint function to obtain a bearing and distance to the plot. Follow the bearing and measure the distance to the plot using a hip-chain or tape. Establish corner P at this point (Figure 1). This procedure is recommended because the accuracy with which a GPS receiver can locate any specified point decreases as the point is reached (Burrows 2000). Use the GPS unit to re-fix the position at corner P. Averaged, 3D and 100% GPS are required to provide more accuracy. Waypoint and plot coordinates should be recorded on the RECCE Site Description Record Sheet in NZTM and retained electronically for subsequent downloading.

When GPS reception cannot be obtained, follow a bearing and measured distance using a hip-chain to locate the plot from a significant nearby landscape feature that can be accurately identified on a topographical map (e.g. stream confluence, high point, bush edge, ridge). Similarly, if there is no GPS reception at corner P, re-fix the position of an identifiable point (e.g. a prominent landscape feature).

For all new forest plots, you must use permolat (i.e. painted aluminium strip) **to mark a line to each plot position** from a significant landscape feature (e.g. stream confluence, high point, bush edge, ridge) to ensure plots will be easily re-located by future field parties. Fix the line start and key landmarks on the way to each plot with the GPS receiver and record the coordinates on the RECCE Site Description Record Sheet. Mark the position of the plot on the appropriate topographic map (Topo50 map series) and aerial photo (where available).

Where the field team is unable to establish a plot at the specified grid coordinate because it is either unsafe to do so (e.g. steep terrain prevents access to all or part of the area) or the surrounding terrain means that it is impossible to get to the exact location, they should proceed as follows.

DOC Tier 1 plots

It may not be possible to establish a plot for the following reasons:

a) Access to the plot is constrained (e.g. bluffs on all sides making the plot impossible to access).

b) It is possible to access the site but not possible to establish the entire plot (e.g. the bottom edge of the plot is a bluff). You must be able to establish the entire plot area.

c) It is possible to access and establish the entire plot but there is a high risk of accident or injury for a team when working on the site.

When it is not possible to establish a plot, the following protocols are to be followed.

Locating an alternative plot location

Where it is not possible to establish a plot because there is a high risk of accident or injury for a team working on the plot, or it cannot be established due to barriers and safety (b and c above), you will be provided with 30 alternative locations to be tested. The priority-ordered list of 30 alternative points consists of 10 random bearings originating from the original grid point for the plot. On each bearing a possible relocation point occurs at 200 m, 400 m, and 600 m.

Working systematically through random bearing options in order of 1 to 30, navigate towards the alternative sites on the Relocation Record Sheet (Appendix 1) and at the first possible location, establish the plot.

Option 1. When terrain permits easy travel, start with the first random bearing supplied on the relocation table provided (these will be available to the field teams via their Supervisor), and from the original corner P, walk along this bearing for 200 m to first site. At this point, if it is possible to establish a plot, then do so. If not, continue to 400 m. At exactly 400 m, if it is now possible to establish a plot, then do so. If that fails, walk to 600 m and repeat. If a plot cannot be established, return to the original corner P, choose the next random bearing on the list and repeat the process. Up to 10 random bearings are provided per plot.

Option 2. When terrain does not permit easy travel along the lines (e.g. unsafe terrain), the alternative method can be used. Starting with the first relocation point and testing these in the exact order as provided on the Relocation Record Sheet, use a GPS to navigate to within c. 30 m of each location. Ensure the direction function of the GPS receiver is set to magnetic and use the GPS waypoint function to obtain a bearing and distance to the plot. Follow the bearing and measure the distance to the plot using a hip-chain or tape. Establish corner P at this point (Figure 1) if possible. If a 20×20-m plot cannot be established, move on to the next relocation point following the same method until a plot is established.

If all 30 relocation points are tested and a 20×20-m plot was not able to be established, the plot is abandoned. In addition to completing the ‘Original Plot Information’ on the Relocation Record Sheet, if time permits also record as many of the fields as possible on the RECCE Site Description Record Sheet and the RECCE Vegetation Description Record Sheet (presence, dominance and abundance where possible of any woody vegetation). This original plot location will be classed for carbon accounting purposes as either a nil value (no woody vegetation present) or a missing value (woody vegetation present but unable to be measured).

What to record for original and alternative plot locations

Complete a Relocation Record Sheet for the original plot and any subsequent relocation points detailing why each point could not be established. Record the following:

- Could the plot relocation point be accessed?
- Can the plot relocation point be established?
- Was the plot relocation point safe to work on?
- How the plot relocation point was assessed, either from helicopter, on the ground directly surrounding the plot (< 20 m), or on the ground directly but from a greater distance (> 20 m—record the distance in metres).

Also record the hazards or impediments that prevented establishment of the plot relocation point and any other notes. These are defined as:

- Private land
- Open water
- Unsafe due to permanent snow and ice
- Unsafe as too steep and the Slope (estimated if this cannot be measured)

Complete the 'Original Plot Information' on the Relocation Record Sheet. This information is used to ground truth the original plot location, for mapping layers, and to update the sample universe and design metadata that is essential for analysis.

You must record the actual land cover class and land use class of the original plot location. This can be ascertained from a distance, including by helicopter. Using maps or metadata provided, record the catchment and sub-catchment.

If you are able to get within 50 m of the plot, also assess and record the following site description characteristics: altitude, physiography, aspect, slope. Record notes on the plot vegetation and any additional observations such as evidence of erosion, disturbance, pest impacts or notable features of topography. If possible, take photos of the original plot location that give an understanding of the vegetation and physical characteristics.

If you are unable to get within 50 m of the plot (or close enough) to assess the altitude, physiography, aspect and slope, leave these fields blank and record '**Not measured**' in the notes and the reason. If you were unable to take photos, record as 'None'.

Laying out tapes when establishing new plots

When newly established plots are located, and once corner P has been established, identify the bearing that runs along the predominant contour of the slope. Stand on corner P of the plot and determine the bearing by using a sighting compass to sight on somebody standing 10–15 m away along the contour of the slope. Establish the P–M boundary along this contour by laying a 20 m tape along this bearing to form the lower boundary of the plot (P–M in Figure 1). Take 90° off the compass bearing of the P–M boundary to determine the compass bearing of the P–A and M–D boundaries and lay out two boundary tapes at right angles to the first. Join the open end along the A–D boundary with a fourth boundary tape to form a square plot.

When a newly established plot is located on **flat terrain** (slope of < 5°), establish the plot so that the M–P boundary lies in a north–south direction (i.e. corner M is north of corner P).

Use a sighting compass to lay out plot boundary tapes to the correct magnetic bearings.

Check that boundary tapes meet at right angles at each plot corner. Do this by:

- Checking that compass bearings of plot boundary tapes are correct using a sighting compass.
- Using a 3–4–5 triangle. Measure 3 m along one tape from a corner and 4 m along the adjacent tape and mark these points. The distance between the two points should be 5 m.
- Checking (where practical, i.e. on very open plots with even ground) that the length of a tape placed between diagonally opposite corners (i.e. A–M and D–P) is 28.3 m.
- Checking that each boundary tape is 20 m. Note that due to topographic variation across the plot area, it will not always be possible to make each boundary tape exactly 20 m, even when the corners are at right angles.

Protocol for permanent marking of new non-forested plots

- It is vital that plots are adequately marked when established in order to relocate plots for remeasurement.
- For new non-forested plots in which an animal measurement team visits before a vegetation team, corner P must be marked as per protocol.
- The other corners (A, D, M) can be temporarily marked (flagging tape, cairns, etc.) and will be permanently established by the vegetation team.

Office-based preparation

- Review other nearby plots and local information about the site to plan and prepare the alternative plot marking equipment.
- Check if the relocation points are located in forest or scrub. If this is the case, then forest marking equipment will be required. This is best done using office-based analysis of the sites with Google Earth, wams.org.nz, docGIS, and terraview.

Plot location

- For the plot location, orientation and layout, refer to the Field Protocols for DOC Tier 1 Inventory & Monitoring and LUCAS Plots (section 2 ‘Plot location and layout of DOC Tier 1 I & M and LUCAS permanent plots’).
- Accurate approach notes and GPS coordinates are vital for establishing and relocating non-forest plots.

Figure 30. Corner P marker. Waratah with 8 mm stainless cup head bolt with Nylock nut used to attach a 50 × 50 mm square washer.

Figure 31. Other corners. 500 mm aluminium angle (25 × 3 mm).

Permanent marking of plot corners

Corner P must be permanently marked with a short length **waratah** (680 mm) driven halfway into the ground (Figure 30). An 8 mm stainless steel or galvanised cup head bolt with Nylock nut should be used to attach a 50 × 50 mm square washer with plot identifier (e.g. AB123). These should be pre-engraved in the office with a rotary engraving tool (recommended and preferred) or may be scratched on in the field (only if required).

All other corners (A, D, M) must be permanently marked with 500 mm aluminium angle (25 × 3 mm) with corner details engraved (recommended and preferred) or scratched on in the field (only if required). The angle must be driven into the ground 200–300 mm (Figure 31).

The centre of the plot must also be permanently marked with the aluminium pipe used to mark bird station X. In cases where the animal team have visited the plot before the vegetation team, the pipe should be relocated to the true centre (C) of the plot by the vegetation team. The aluminium pipe should be placed as near to the centre as possible.

When the pipe cannot be placed in the exact centre (due to bedrock), a coach bolt and washer must be used to mark the plot centre (see below for method).

In some situations, it is not possible to permanently mark the plot as described above. Alternative methods for some specific situations are described below: In all cases the methods of permanent plot marking should be recorded on to the Plot Layout Record Sheet.

It is essential for relocating the plot, and for the integrity of the plot network, that as much of the plot is permanently marked as is possible, as failure to do so could significantly impact on future teams locating the plot for remeasurement.

Alternate methods for permanent marking of plot corners

1. If the plot is located in a highly mobile or exposed site (e.g. avalanche chutes):

Drive corner and centre marking waratahs/angles to ground level (if possible) or, in the case of scree, bury below the surface rock to minimise movement down the slope. These will be relocated with the aid of a metal detector on future visits.

Note that these methods have been applied in alpine and mobile areas for other programmes and these plots have been relocated. Do not assume they won't remain in place.

2. When waratah cannot be placed at corner P (e.g. bedrock or solid rock at corner):

Use the next most suitable plot corner (consider visibility for relocation and a location where the waratah will remain in place for at least 5 years). Record location of the waratah and reason for variance on the diagram on the Plot Layout Record Sheet and describe this in the approach notes on the RECCE Site Description Record Sheet.

If placement of a waratah in any of the four corners is not possible, try the plot centre. When all these positions fail, choose the next best location within the plot for permanent placement (consider visibility for relocation and a location where the waratah will remain in place for at least 5 years). Record the location of the waratah and the reason for variance on the diagram on the Plot Layout Record Sheet and describe this in the approach notes on the RECCE Site Description Record Sheet. The bearing and distance from the waratah to corner P should also be recorded and appropriately marked on the Plot Layout Record Sheet.

3. On sites with bedrock or large rocks on the surface that prevent pegs being driven into the ground:

Mark corners by drilling a 7 mm hole into a rock and driving an 8 mm galvanised coach bolt with a 50 × 50 × 3 mm, 10 mm flat head washer on it. Plot and corner details are to be engraved or scratched onto the washer (Figure 32).

Figure 32. Corner markers. 10 mm flat head washer bolted to a rock with 8 mm galvanised coach and with plot identifier engraved.

4. No permanent markers are possible:

Very occasionally permanent marking of corners or the plot centre are not possible. See below for how to install corner permolat in non-forest environments.

Permanent plots and the use of permolat

Permolat is used to mark permanent corners for relocation (i.e. aid the location of corner and centre waratahs/angles/coach bolts) and can at times be used in place of waratah/angles/coach bolts.

1. Corner marking

As with forest plots, corner permolat is required in addition to corner waratahs/angles/coach bolts to provide greater visibility of corners, and more importantly, to aid in the re-establishment of corners when these are not found.

When no large woody vegetation is available to nail permolat to, stainless steel wire should be used to attach permolat to the base of a shrub near the centre of the plot, and at each corner. The permolat should have the name of the corner (A, D, M, P or C) and the distance and bearing from the base of the shrub to the corner of the plot scratched into it. Label each permolat strip with the measured distance (using a builder's tape) along the ground, the *magnetic* bearing FROM the base of the shrub TO the corner peg, and the appropriate corner letter (e.g. 'Corner A 1.6 m @ 205°'), and use an arrow to indicate the direction of the peg.

When there is no vegetation whatsoever to attach corner permolat to, a coach screw and washer can be used to attach the permolat to a boulder or exposed bedrock. After drilling a hole in the rock, the permolat should be placed between the washer and the rock, and then the coach screw can be driven through the permolat into the hole. **Note: In this scenario, the distance and bearing scratched onto the permolat should be from the coach screw to the corner of the plot, as determining where to measure from the base of a rock is not always straightforward.**

2. Corner permolat where corners are not permanently marked

On the rare occasion when a corner or centre waratah/angle/coach bolt cannot be established at all, then corner permolat will have to be used to relocate the plot. Follow the same guidelines as above but record the lack of waratah/angle/coach bolt permanent markers on the Plot Layout Record Sheet and take care that the distance and bearings recorded on the permolat are correct and double checked.

3. Rock cairns

Rock cairns may be built to assist relocation. These must be built before any photos are taken so they are visible in the photos.

Cairns should only be built if it is likely they will survive until next measurement.

Marking the line to plot

In addition to GPS points and lines, the line to the plot must also be permanently marked with permolat, especially when a plot may be difficult to find (e.g. scrub plots). For information on marking lines refer to *Field Protocols for DOC Tier 1 Inventory & Monitoring and LUCAS Plots*.

When vegetation along the route is not large enough to hold nails and permolat, stainless steel wire can be used to attach permolat to any available shrubs/bushes. Alternatively, rock cairns can be used to mark the line, but only if they are likely to remain until the next measurement.

16. Plot metadata and site description

Plot metadata, RECCE site description data and additional relocation information provide essential information for the vegetation team planning and aid in relocation for future surveys. Metadata Record Sheet is required for each site visited by an animal team.

Metadata

Metadata are described and captured on the Animal Team Metadata Record Sheet. The Metadata Record Sheet is required for each site visited by an animal team. Record the following information about the current measure.

- **Plot identifier:** Record the unique plot identifier. This is the unique letter/number code (e.g. R149) that identifies the position of the plot on the 8 km^2 sampling grid.
- **Date:** Record day/month/year in full, with month recorded in non-numeric form (e.g. 10 February 2015). For multiday plots ensure the date on the Metadata Record Sheet is the first day of plot measurement.
- **GPS reference:** This is taken at corner P of the plot. Record the GPS make and model (e.g. Garmin 62S). Easting and Northing are recorded using the seven-figure NZTM coordinates (e.g. (Easting) 1498070, (Northing) 5299433).
- Record the **GPS fix type**:
  - For Garmin GPS units that are the 60 series and older, average a waypoint, allowing 30 measurements. Record that it was averaged, 2D or 3D, and the accuracy in metres (e.g. ± 9 m).
  - For Garmin 62 units or newer, use the multi-sampling averaging function. The unit will display 100% once the averaging process is complete. Wait at least 90 minutes and then average the point again. Then scroll through to the satellite page where there is accuracy displayed in metres and record this. Record that it was 100% and averaged, 3D, and the record the accuracy in metres (e.g. ± 8 m).
- **Team information:** Record the name of the **team leader** and the names of the **team members** in full for this measure.
- **Hazards: Record any potential hazards on the plot for the benefit of the next team.**
- **Land tenure of plot:** Record the ownership of the land the plot is located on (e.g. ‘public conservation land’ or ‘private land’.
- **Permission contacts:** For access to the plot, or for access across land to the plot, record the name of the appropriate DOC staff member and/or private landowner/manager (when private land is crossed), including contact details (e.g. address, phone number, fax number, email). Record the preferred method of contact by the monitoring team, and the name of the monitoring team contact person. Record the planned access date and yes or no to ‘gate keys necessary’.
- **Notes:** Record any additional notes relating to plot access that may aid teams with remeasurements in future or illustrate difficulties with access to location.
- **Time allocation:** For access, record:

  - Town/area the field team used as a base for the plot. (If members are travelling from different points, record the location where the whole team assembled and began travel to the plot.)
  - Time taken to drive to the plot/line start.
  - Time taken to drive to the aircraft loading site.
  - Fly time to the plot.
  - Boat time to the plot.
  - Walk time to the plot.
  - Search time taken to relocate the plot (do not record for new plots) and whether or not an alternative route was used. Record as 'N/A' for newly established plots.
- **Transect and bird station difficulty and description**: For each possum transect record the difficulty of the transect by circling the appropriate option (Easy, Moderate or Hard) and record a short description including hazards. For each Bird station record the marker type, and a brief description of its location including obvious landmarks.
- **Operational information**: Tick whether or not **mobile phone coverage** is available at camp or on plot and specify the service provider. Tick whether or not **VHF coverage** is available at camp or on plot and specify the channel. Tick whether or not **satellite phone coverage** is available at camp or on plot and specify the quality of reception. Record the name and contact details of the **helicopter/boat contractor** used.
- **Record if water is available** at the camp or plot by circling the appropriate option or adding a note if required.
- **Type of Helicopter Landing**: Tick the type of heli landing used at the time of measurement. Record general comments on the helicopter landing and any hazards to aid future visits to the site. If helicopters were not used out a line though the fields.
- Record the **weather** by circling the appropriate option or adding a description in OTHER.
- Record any and all **deviations from standard protocols**.

Additional Relocation Information

Additional information and photos are captured for non-forest sites to aid relocation are recorded in the Additional Relocation Information section. Refer to Section 8 of the Tier 1 Non-forested plot marking protocol - DOCDM-1482267 for photo guidelines.

Take Photos of a plot itself (Corner P) and additional plot in relation to distinct landscape features. The number of photos required to adequately capture a plot's key features (to aid successful relocation) will depend on the vegetation and terrain and will differ between plots.

Record the following information.

- **Forest plot:** Circle whether the plot is a forest plot.
- **Non-forest habitat photos:** If the plot is non-forest, photos of the plot itself (Corner P) and in relation to distinct landscape features are required.

- **Corner P photo:** Confirm Corner P photos is taken and record the image number, data and time from the camera.
- **Additional location photos for non-forest habitat:** Take up to 5 photos that will help relocation of the plot. Record the image number, nearest plot corner from your location, the distance and bearing to the corner.

Site description

Site description data are captured on the RECCE Site Description Record Sheet. Only record the Site Description when the animal team visits before the vegetation team.

Record the following information.

- **Approach:** When remeasuring plots, record **new** location notes. Provide detailed instructions on how to get to the plot. Include information on the location of the plot in relation to prominent features of the landscape or vegetation. Record any significant GPS waypoints along the approach route. Where plots are located on existing NVS lines, take a GPS reading and record the line start, the compass bearing, and the distance to the plot from this point. Also record if you found the line start, how this was permolated, if you followed a permolated line to the plot, and what colour this permolat was. Accurate and detailed approach notes are essential for future relocation of plots. DO NOT ASSUME that GPS references will be completely adequate for relocation purposes. The description should be sufficiently detailed to enable people who have not previously been to the plot to locate it without extensive searching. **Do not** copy previous approach notes but ensure that any points of confusion or misleading notes from the previous measurement are clearly explained.
- **Location diagram:** Sketch the route to the plot emphasising prominent landscape or vegetation features (e.g. ridges, gullies, streams, slips, bluffs, roads, large tree-fall gaps). Indicate all features for which GPS grid references are provided in the ‘Approach’ notes.

  Centre the sketch on the plot location. Use arrows to indicate North (magnetic), and the flow direction of any streams or rivers. Include transects and distinguishing vegetation features. Wherever possible, supplement the location diagram with a photographic record to assist future teams to locate the plot. When remeasuring plots, draw a new location diagram and identify any changes from previous measurements that might be a source of confusion for future field teams.

  Be aware that considerable time can be spent navigating un-mapped roads or farm tracks when driving to plots. You must provide clear and accurate information about the best route to drive to a plot and the best vehicle type to use (e.g. 4WD, ATV).
- **Altitude:** Record altitude to the nearest 10 m and record on the RECCE Site Description Record Sheet. Read altitude **directly** from the GPS and cross out ‘Map’ to indicate the method used**.**
- **Physiography:** Circle the applicable option from: ridge (including spurs), face, gully, or terrace. When more than one category could apply, circle the predominant physiography

and record any major change in physiography within a plot in the ‘Vegetation Description and Notes’ section.

- **Aspect:** Determine the physiography of the plot before measuring the aspect. Use a compass to measure the predominant aspect at right angles to the general lie of the plot, to the nearest 5° (magnetic). An aspect measurement is taken at right angles to the general lie of the plot. Where there is a major change in aspect across the plot (e.g. a plot lies across a ridge), record the predominant aspect. Aspect cannot be determined on flat or almost flat plots (slope < 5°) and should be recorded as ‘X’. Do not use zero to record aspect on flat plots, as this will be misinterpreted as a northerly aspect.
- **Slope:** Assign slope to one of the following categories: Flat (0–10°), Moderate (11–20°), Steep (21–40°), Very Steep (40+°). This does not need to be measured and can be estimated as it will only be used as a guide for relocation.

17. Bat monitoring using a bat recording device

To provide data on presence of bat populations, at each plot one or more bat recording devices will be deployed. Bat recording devices will automatically detect and record both short-tailed and long-tailed bat ultrasonic sounds (genus *Mystacina* and *Chalinolobus*). Long-tailed and short-tailed bats prefer different habitats:

> **Long-tailed bats** prefer small clearings in the forest or forest edges, calm waterways and ponds. In non-forested sites, long-tailed bats may fly over and forage in open spaces. Long-tailed bats are considered less likely to be detected above 500 m a.s.l., however bats do travel through this type of habitat**.**
>
> **Short-tailed** bats prefer habitat within the forest but can make use of forest edges, calm waterways and ponds.

Two types of bat recording devices are in use: 1) non-directional bat recorder (tube) and 2) directional bat recorder (box):

> **Non-directional bat recorders (tube)** record a bat at a maximum distance of 30–50 m away but can detect bats far better (7×) if the flight path of bats is unknown.
>
> **Directional bat recorders (box)** record a bat at a maximum distance of 50 m away.

Deploying a bat recorder

1. At least one bat recording device should be deployed **at every Tier 1 site** and **within the 200-m radius of the central plot** (Figure 33).
2. As a rule, if both device types are available, **use Non-directional bat recorders (tube),** especially in non-forested sites (e.g. grassland habitat).
3. Deploy these on Day 1 and collect on Day 2.
4. For practical reasons, it will be easier if the device is placed in a highly visible, easily retrievable site.
5. GPS coordinates of the deployment location are to be recorded in the GPS Data Record Sheet table in the Field Data Record Sheet for Bird Surveys.
6. Place a recorder at least 1 m off the ground making sure that the microphones are not obstructed and are pointing into air space.
    - In forest habitats, attach the recorder to a tree using bungee cords or cable ties making sure that the microphones are not obstructed and are pointing into air space.
    - In non-forest habitats, place the recorder on a stake or small tree/shrub (tube) or on a rock, log or a mound (box).

7. Place bat recording devices in suitable places for detection of short-tailed bats or long-tailed bats (e.g. potential bat flyways).
8. If using **directional** (box) bat recorders, **YOU MUST carefully select your placement**;
    - Directional bat recorders are designed to sit flat, parallel to the ground they can be angled slightly upwards if necessary, but they should not be pointing downwards.
    - To increase the likelihood of detecting a bat. Identify potential bat flyways and place the directional bat recorder in line with this potential flight path.

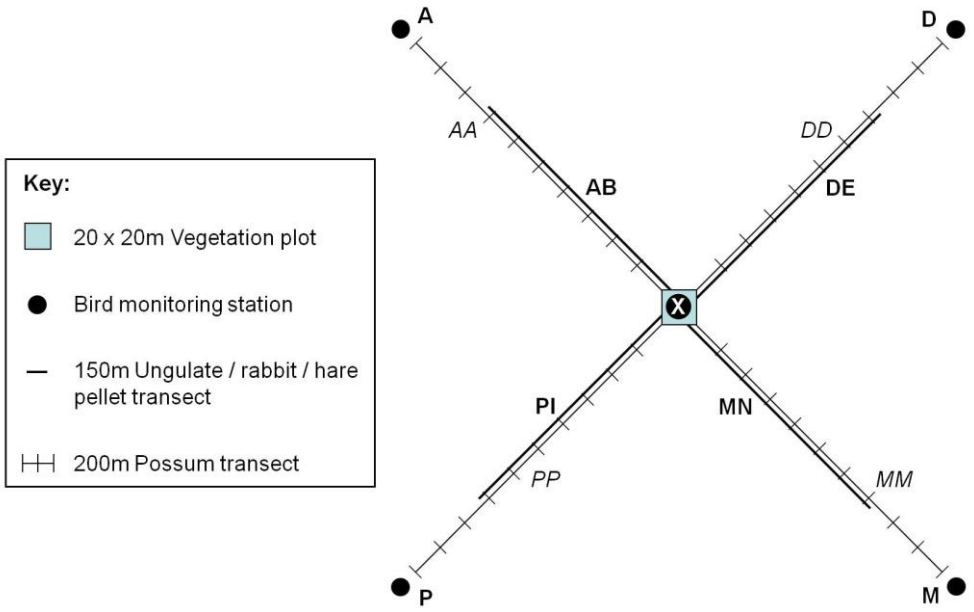


Figure 33. Layout of the Tier 1 animal survey sampling units in relation to the vegetation plot at each sampling location. The sampling area is referred to as the area within the bird count stations.

Operating schedule for all devices

- The bat recording device is to be set to record each day from **2000 hours** until **0600 hours** on the **FAST** setting (this allows for the variation in daylight hours around the country).
    - The recorder automatically starts recording when it detects ultrasonic sounds, but only during a preset time of the night. The rest of the time the recorder is asleep and draws very little power.
    - A basic noise switch turns the recorder off if it decides there is ‘too much’ noise.
    - If the battery voltages drop below 1.1 V, the recorder will shut down to protect it from damage.

On completion of the bat recording on the second day the recording device will be retrieved, turned off, opened as per instructions below, batteries removed, and the SD card extracted and placed into an appropriately labelled bag or envelope that clearly identifies the sampling location, monitoring type (i.e. BAT), count station and start date.

As soon as possible, the data files on the SD card should be copied onto an appropriate hard drive following the instructions provided in the Information Management Protocol (doccm-1508274).

Operating instructions for the directional bat recorder

The directional bat recorder (Figure 34) detects ultrasonic sounds, converts them to audible frequencies and records them onto an SD card as WAV files. The recorder has two channels: one at 28 KHz and one at 40 KHz. Both channels are recorded onto the card at the same time. These files can be played back on a computer or analysed using sound analysis software, including the BatSearch software.

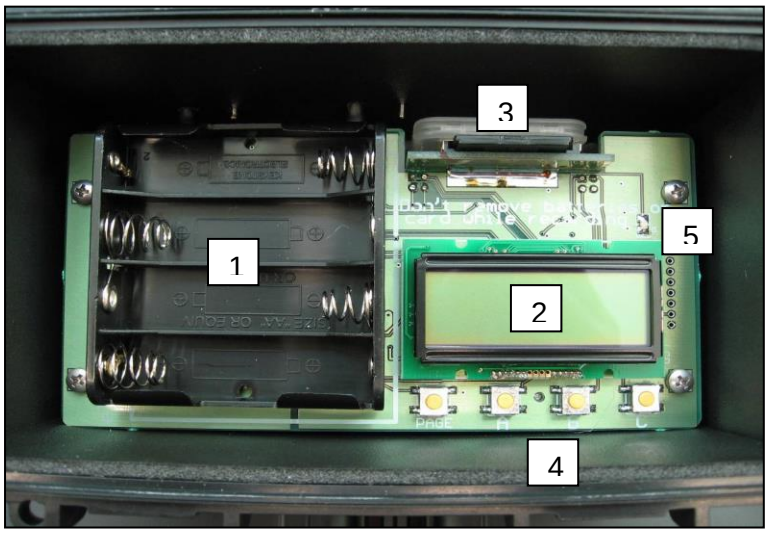


Figure 34. Inside view of directional bat recording device.
1: Battery holder (4× AA NiMH or Alkaline)
2: LCD display
3: SD card (card is inserted with label away from you)
4: Buttons: ‘PAGE’ (to start the display), ‘A’, ‘B’ and ‘C’
5: Indicator LED (flickers during recording and flashes every 15 seconds while the noise switch has been activated)

Batteries for the directional recorder

The recorder uses four AA batteries, either standard alkaline or rechargeable NiMH (recommend using NiMH). The batteries should last for several weeks of recording depending on how much is recorded each night. Note: The only way to stop the recorder from running each night is to remove the batteries.

Setting up the directional recorder for deployment in the field

1. Insert fresh batteries and wake the recorder up by touching the ‘page/wake’ pad.
2. Insert an SD card before the display powers off again (i.e. within 20 seconds). The card must never be inserted or removed while it is active; always wake up the recorder first to be sure.

3. Test and/or format the card.
4. Check the time, date and settings are correct.
5. Close the lid, checking the seal is in place and clear of debris.

IMPORTANT:

- Always wake the recorder up after inserting the batteries; this ensures the recorder has set itself up correctly to wake up at the ‘start’ time.
- The SD card can be corrupted if it is removed from the slot while it is active; this can make the card unusable.
- Always wake the controller before removing the card. While the controller is awake (display on screen) the card will not be ‘active’.

Adjusting/checking the settings of the directional recorder

To check or change the settings of the directional bat recorder, the controller unit needs to be woken up. To do this you will need to hit the ‘page/wake’ button. The red LED will flash and the LCD display will start up. After a second or so the time will be displayed on screen. This is the time page; all of the settings in the recorder are displayed in pages. To change pages, tap the ‘page/wake’ pad, and the display will shift to the next page. The following list of settings shows all the possible pages (Figure 35).

(Note: After about 20 seconds of no activity from the user the display will power down.)

Buttons for directional recorder settings

There are four keys on the recorder to navigate through the menu:

- The **On/Page** key wakes up recorder and allows you to cycle through the pages in the menu.
- The **Plus & Minus** keys (+/−) modify the settings in the page.
- The **Shift** key (→) selects which value to modify.

Settings for the directional recorder

TIME =	Current time, in 24-hour format.
DATE =	Current date including the year. Note: This is the only page that uses the ‘C’ button, to increment the years.
START TIME =	Time of day that the recorder will power on and start waiting for bats. This is in 24-hour format.
STOP TIME =	Time of day the recorder will power down, also in 24-hour format.
NOISE SWITCH =	Setting for the noise shutdown. Set on ‘Fast’.
CARD =	Use the ‘A’ key to test the card—this will check the space used on the card. Use the ‘B’ key to format the card (erase all files)—the recorder will first ask for confirmation (tap the ‘A’ key for yes).

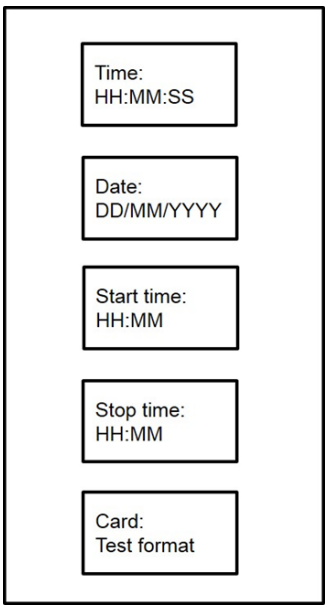


Figure 35. Diagram of the available settings.

The directional recorder noise switch

- The ‘Off’ setting disables the noise switch so that all events will be recorded. This could result in potentially hours of recordings of a rain event.
- The ‘Slow’ setting only turns the recorder off if conditions are very poor (i.e. there is a lot of rain or other noise) and turns it back on soon after conditions improve. Use this setting if you don’t want to risk missing bats and don’t mind more recordings of noise.
- The ‘Fast’ setting will disable the recorder soon after conditions become noisy and not turn on until it becomes quiet for a lengthy period. Use this setting if you don’t mind the risk of missing some bats and want less recordings of noise.

The noise switch is a basic way to prevent excessive recordings of noise events such as heavy rain or strong winds. The recorder monitors the number of files that have been recorded recently, especially very long or very short recordings that are unlikely to be bats. If ‘too many’ of these recordings occur in a short time frame, the recorder will suppress recording until conditions improve. While the noise switch is suppressing recording, the LED will flash every 15 seconds.

Operating instructions for the non-directional bat recorder (tube)

- The non-directional bat recorder (Figure 36 a-c) detects ultrasonic sounds, converts them to spectrograms and records them onto a SD card as bitmap image files. The recorder detects all frequencies from audible to high ultrasound and records these onto the image at the same time. These files can NOT be played back on a computer. They can be analysed using custom (BatSearch 3) analysis software (see DOC Electronics Team for more information).
- There are two types of non-directional bat recorder; (i) non-directional bat recorder Figure 36 a-c) and (ii) non-directional dual acoustic bird and bat recorder (Figure 36d).

- Note the non-directional bat recorder looks in appearance very like the digital bird recorder Figure 37c). Key differences are the short microphone protector cage and the black coloured rim and fastening screw.

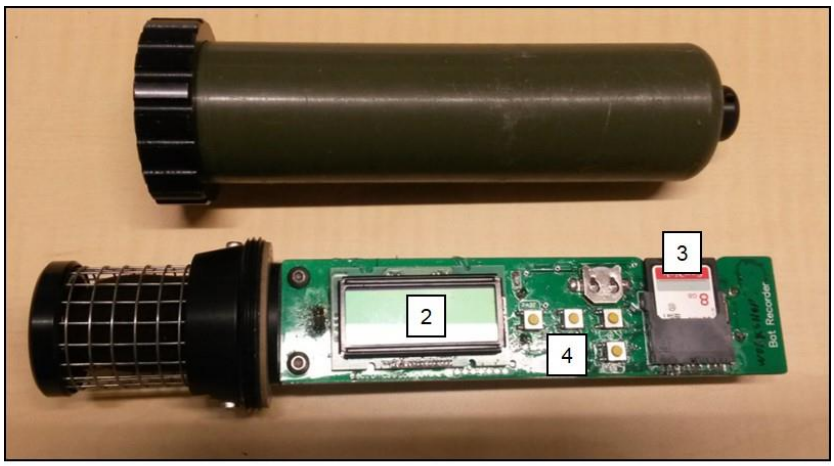


Figure 36.a Non-directional bat recorder (electronics view).

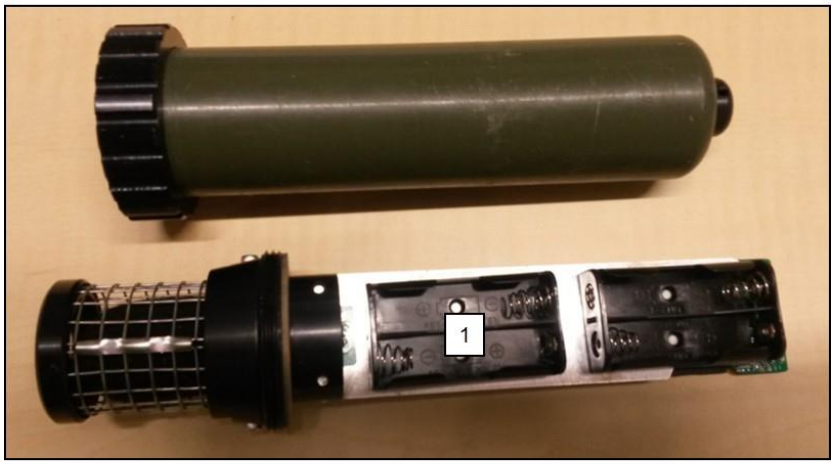


Figure 36.b Non-directional bat recorder (battery view).

1. Battery holder, 4× AA NiMH or Alkaline
2. LCD display
3. SD card (card is inserted with label away from you)
4. Buttons: ‘PAGE’ (to start the display), ‘A’, ‘B’ and ‘C’

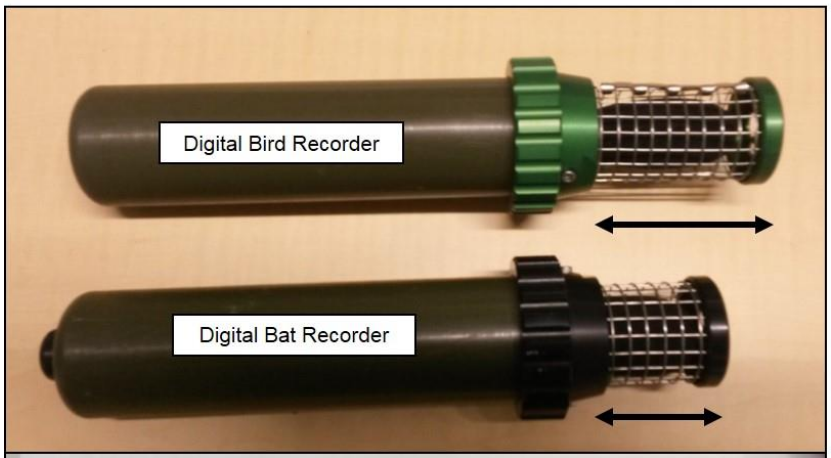


Figure 37.c Non-directional bat recorder and digital bird recorder comparison and the dual acoustic and bat recorder (non-directional).

Figure 36.d Non-directional the dual acoustic and bat recorder (electronics view).

Batteries for the non-directional recorder

The recorder uses four AA batteries, either standard alkaline or rechargeable NiMH (recommend using NiMH). The batteries should last for several weeks of recording depending on how much is recorded each night. Note: The only way to stop the recorder from running each night is to remove the batteries.

Setting up the non-directional recorder for deployment in the field

1. Insert fresh batteries and wake the recorder up by touching the ‘page/wake’ pad.
2. Insert an SD card before the display powers off again (i.e. within 20 seconds). The card must never be inserted or removed while it is active; always wake up the recorder first to be sure.
3. Test and/or format the card.
4. Check the time, date and settings are correct.
5. Close the lid, checking the seal is in place and clear of debris.

IMPORTANT:

- Always wake the recorder up after inserting the batteries; this ensures the recorder has set itself up correctly to wake up at the ‘start’ time.
- The SD card can be corrupted if it is removed from the slot while it is active; this can make the card unusable.
- Always wake the controller before removing the card. While the controller is awake (display on screen) the card will not be ‘active’.

Adjusting/checking the settings of the non-directional recorder

- To check or change the settings of the non-directional bat recorder, the controller unit needs to be woken up. To do this you will need to hit the ‘page/wake’ button. The LCD display will start up. After a second or so the time will be displayed on screen. This is the time page; all of the settings in the recorder are displayed in pages. To change pages, tap the ‘page/wake’ pad and the display will shift to the next page. The following list of settings shows all the possible pages (Figure 37).

- Note: After about 20 seconds of no activity from the user the display will power down.

Buttons for non-directional recorder settings

There are four keys on the recorder to navigate through the menu:

- The **On/Page** key wakes up recorder and allows you to cycle through the pages in the menu.
- The **Plus & Minus** keys (+/−) modify the settings in the page.
- The **Shift** key (→) selects which value to modify.

Settings for non-directional recorder (depending on the recorder):

Non-directional bat recorder

TIME = Current time, in 24-hour format.

DATE = Current date including the year. Note: This is the only page that uses the ‘C’ button, to increment the years.

START TIME = Time of day that the recorder will power on and start waiting for bats. This is in 24-hour format.

DURATION = Length of time the recorder will operate before powering down, in HH:MM format.

CARD = Use the ‘A’ key to test the card—this will check the space used on the card. Use the ‘B’ key to format the card (erase all files)—the recorder will first ask for confirmation (tap the ‘A’ key for yes).

Non-directional dual acoustic bird and bat recorder

Press the ‘On/Page’ key to start the display. After a few seconds, the ‘Time’ page will appear. Using the On/Page key you can scroll through the various settings pages or follow these settings for newer models:

Time = Current time, in 24-hour format.

Date = Current date including the year, in DD/MM/YY format.

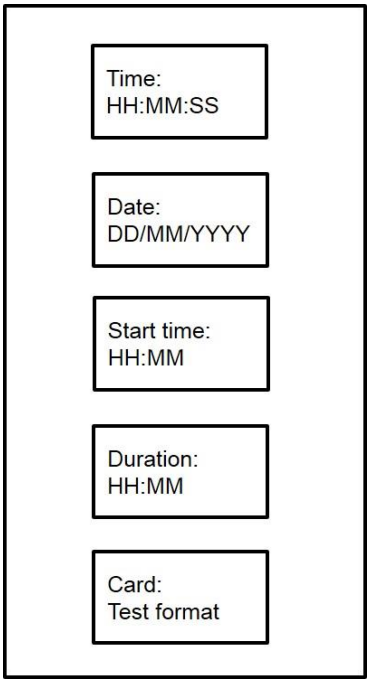
Protocol = Depending on the model bat recorder, a standard Tier 1 protocol is loaded onto the ARD. Newer models allow the user to choose a Tier 1 Day and/or Tier 1 Night protocol.

Location ID or

Survey name= Note this can vary in length between 4 and 7 characters. The interface allows for an underscore character which is not included in the filename. Only the last four characters of the ID can be set to underscore.

Card = Either check the card (function and free space) or reformat the card. Use the +/− keys to toggle between the card check and card format options. The Shift key starts the check or format.

Note: On each page, the **Shift** key (→) button (middle button) can be used to **select** a value (*the value flashes*) and the **Plus/Minus** keys are used to **modify** it. After about 20 seconds of no activity from the user the display will power down.



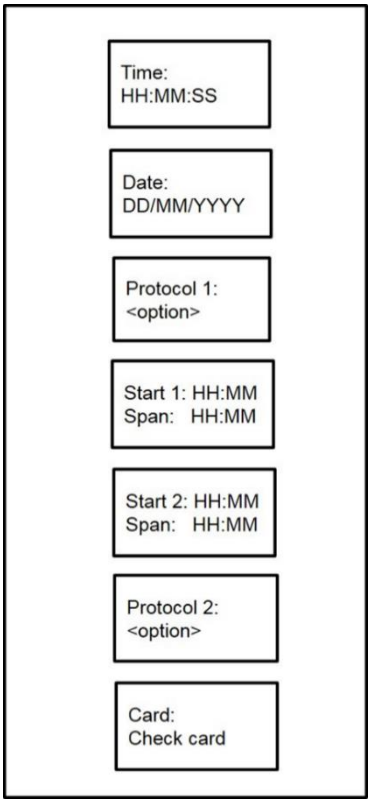


Figure 37. Diagrams of available settings depending on the recorder

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19. Register of major changes from Version 13

Section	Page No	Description of change	Reason
2. Operational Delivery	5	**Remeasuring plots: Mammal monitoring** Section restructure to clarify what information to take for existing versus new plots	Clarification of the requirements
2. Operational Delivery	8	**Remeasuring plots: Mammal monitoring** Updated to include instructions on how to define and record remeasurement status for animal transects and how to record	Clarification of the requirements
2. Operational Delivery	10	**Remeasuring plots: Bird count stations** Updated to refine terminology on how to define and record remeasurement status for bird stations and how to record	Clarification of the requirements
9. Protocol for swabbing ungulate faecal pellets for DNA	43	**Selecting suitable ungulate faecal pellets for DNA** Updated to clarify that swabbing for DNA can be undertaken in any weather conditions if pellets can be accurately identified, and the swapping procedure is followed to avoid contamination (i.e. gloves are used)	Clarification of the requirements
10. Ground survey for introduced mammal pests	44-45	**Ground survey for introduced mammal pests** Updated to clarify that teams should record this	Clarification of the requirements
12. Protocol for acoustic recording of birds	55	**Retrieval of bird recorder** Addition of requirement to record deviations to this standard deviations to this standard (i.e. collected before 11:00am) by recording the time of retrieval and providing a reason for the deviation in the 'Acoustic Record Notes' field in the Field Data Record Sheets for Bird Surveys	Clarification of the requirements
16.Plot metadata and site description	79	**Metadata: Transect and bird station difficulty and description** Updated to clarify what teams should record	Clarification of the requirements
16.Plot metadata and site description	79	**Metadata: Type of Helicopter Landing** New fields added to metadata to capture information on type of heli landing and hazards etc for future visits to the site	Change to method
16.Plot metadata and site description	79	**Metadata: Deviations from standard protocols**	Clarification of the requirements

Section	Page No	Description of change	Reason
		Updated to clarify that teams should record this	
16.Plot metadata and site description	79	**Metadata: Additional relocation information** Updated to clarify that teams should record this	Clarification of the requirements
16.Plot metadata and site description	70	**Metadata:** Site description Updated to clarify that teams only record the Site Description when the animal team visits before the vegetation team	Clarification of the requirements
Record Sheets			
Animal metadata Record Sheet	6	**Operational Information** Addition of Type of Helicopter Landing fields to aid future measurement at the site	Change to method
Field Data Record Sheets for Bird Surveys	4,7,10,13,16	**Acoustic Record Notes** Addition of 'Acoustic Record Notes' field to capture retrieval time deviations	Clarification of the requirements
Field Data Record Sheets for Bird Surveys	2	**Stage 1 check** Addition of new Stage 1 check in Acoustic recording devices (x5) section any deviations to retrieval times	Clarification of the requirements
Field Data Record Sheets for Bird Recce Surveys	4,5,7,9,11	**Bird Station Remeasurement** Removal of Bird Station Remeasurement status from these Record Sheets as not required for Bird Recce method	Clarification of the requirements