The Recce method

for describing New Zealand vegetation

– Field Protocols

J.M. Hurst and R.B. Allen

The Recce Method for Describing New Zealand Vegetation – Field Protocols

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1. Introduction

This manual outlines field protocols for the measurement of Reconnaissance (Recce) descriptions, which are used to describe the composition and structure of a diverse range of vegetation. This field manual expands upon, and updates, earlier versions of Recce description measurement protocols (Allen 1979, 1992; Allen & McLennan 1983). At each Recce description, plant species present are recorded within height tiers, with associated cover estimates. Site characteristics (e.g. altitude, aspect and slope) and additional characteristics of the vegetation (e.g. presence of animal browse) are recorded as these are often required to interpret vegetation patterns.

This version of the Recce description manual is designed for use in the field. An expanded version of this manual is also available (Hurst & Allen 2007a; see http://nvs.landcareresearch.co.nz/) that should be consulted before undertaking fieldwork. The expanded manual provides further detail on use of fixed-area vs variable-area Recce descriptions, principles of sampling, planning the survey, quality control procedures, and instructions for archiving data in the National Vegetation Survey (NVS) Databank.

2. Sampling

General guidelines on sampling are outlined in the expanded Recce manual (see http://nvs.landcareresearch.co.nz/). Key sampling decisions concern the arrangement, number, size and shape of Recce descriptions. Sampling decisions affect the statistical properties of the data (e.g. whether formal statistical tests will be valid), the representation of dominant versus rare species and communities, and have practical implications (such as influencing the number of Recce descriptions that may be undertaken within a given time frame). It is also important to decide from the outset whether the Recce descriptions in a survey will be temporary (i.e. used for one-off inventory only), or permanently marked (enabling remeasurement).

3. Pre-fieldwork Planning

Pre-fieldwork planning ensures that fieldwork proceeds as efficiently and smoothly as possible and the work is completed within budgeted time frames. Further details are outlined in the expanded Recce manual (see http://nvs.landcareresearch.co.nz/). The following planning must be undertaken as part of the overall management of the inventory or monitoring programme, and before undertaking fieldwork:

- Developing the sampling design
- Organising and purchasing of equipment (see Appendix 1)
- Selection of staff suitable to undertake the work
- Staff training
- Creating a detailed field-plan
- Allocating time for follow-up work after fieldwork is complete
- Obtaining lists of species likely to be encountered in survey area
- Obtaining permission to cross land and collect specimens

4. Recce Description Location

If implementing a representative sampling design (i.e. using random or systematic sampling), each Recce location is determined prior to undertaking fieldwork. In the field, the precise Recce locations must be determined in a truly objective (unbiased) way to ensure data collected are a representative sample of the study area. This can often be facilitated through the use of GPS to locate Recce positions; however, it must be noted that GPS transceivers cannot always be used to determine location, particularly in mountainous terrain or beneath tall or dense forest canopies. On such occasions alternative procedures to locate the Recce description must be followed, such as the use of a hip-chain and compass to locate the Recce from a nearby landscape feature that may be easily identified on a topographical map.

A predetermined Recce location may sometimes fall at a location where it is unsafe or unpractical to undertake a Recce description (e.g. bluffs, very steep terrain). Do not establish a Recce at the specified predetermined location where doing so would be likely to endanger the field party. For such Recces, use the Notes section of a Recce sheet to briefly describe the situation and vegetation, and archive this with the rest of the data from the survey.

4.1 Locating Recce descriptions at systematic or random sample points

- Where Recce descriptions are to be established at points determined prior to fieldwork, **enter each grid reference into a GPS receiver prior to fieldwork.** Where GPS reception can be obtained, use it to navigate to within c. 30 m of each Recce location. Set the direction function of the GPS receiver to magnetic, and use the GPS waypoint function to obtain a bearing and distance to the Recce. Follow the bearing and measure the distance using a hip-chain or tape. 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).

- **When GPS reception cannot be obtained**, follow a bearing and measured distance as above to locate the Recce from a significant nearby landscape feature that can be accurately identified on a topographical map (e.g. stream confluence, high point, bush edge, ridge).

- Where possible, fix each Recce position with the GPS receiver and record the coordinates on the Recce sheet (see section 5.2.1).

4.2 Locating Recce descriptions along transects

- If locating Recce descriptions along transects, navigate to the transect origin using GPS (where possible, as outlined above), map and compass. Record the transect bearing (magnetic) and the GPS reference (where possible) for the transect origin for all Recces along the transect (see section 5.2.1).

- When travelling along each transect **ensure that the compass bearing is accurately followed**. Measure the pre-specified distance to each Recce with a hip-chain or tape.

- Where possible, fix each Recce position with the GPS receiver and record the coordinates on the Recce sheet (see section 5.2.1).

4.3 Establishing permanent fixed-area Recce quadrats

- If establishing **permanent** fixed-area **Recce descriptions** (for further information see the expanded Recce manual) establish a square quadrat, labelling the corners ‘A’, ‘B’, ‘C’ and ‘D’ clockwise around the plot (e.g. Wiser & Rose 1997). One system of determining the quadrat orientation is

to establish corner D at the selected point, and the D–C boundary along the contour of the slope. Add 90 degrees to the compass bearing of the D–C boundary to determine the compass bearing of the D–A and B–C boundaries and lay out two boundary tapes at right angles to the first. Join the open end along the A–B boundary with a fourth boundary tape to form a square quadrat. Alternatively, if the quadrat is located on flat terrain, establish it so that the D–C boundary lies in a north–south direction (i.e. corner D is north of corner A).

4.4 Marking permanent fixed-area Recce quadrats

For any Recce descriptions that are to be remeasured, permanent marking of the location and boundaries is important to ensure that each Recce can be accurately re-established at a future date. DO NOT rely solely on GPS references for re-location purposes, as GPS fixes can be imprecise. It is important to adequately mark the route to each permanently marked Recce description so that they can be re-located easily by future field parties. Where possible, use a GPS to locate the Recce position and to record the location of significant landscape features along the route to the Recce (e.g. transect origins (where applicable), stream confluences, bluffs, high points, campsites, helicopter landing sites). All access route and Recce location markers should be robust enough to withstand disturbance from animals (e.g. stock) and natural elements. Suitable marking depends on the vegetation of the study area:

- **Forest:** Quadrat corners can be marked using Permolat (painted aluminium strip) attached to an aluminium peg (e.g. 7-mm diameter, 45 cm long) placed in the ground. Bend each aluminium peg at the top to reduce the likelihood of the Permolat strip falling off. Label the Permolat strips with the appropriate corner letter (e.g. ‘A’, ‘B’, ‘C’, ‘D’ clockwise around plot). Near each corner peg, select two trees outside the plot on which to nail a strip of Permolat and provide corner location information. Each Permolat strip should be labelled with the measured distance along the ground, the magnetic bearing FROM the base of the tree TO the corner peg, and the appropriate corner letter. Nails should remain protruding > 2 cm to allow for tree growth. Adequate Permolat marking near corners is invaluable if plots are to be remeasured, as corner pegs can be lost over time.

- **Grassland or wetland:** Quadrat corners may be marked using 50×50-mm wooden stakes, angled aluminium standards, or waratahs (steel standards) as appropriate. Such corner pegs should protrude from the ground by 0.8–1.0 m so they are easily visible to assist re-location. Aluminium pegs are lighter to carry and may be suitable, particularly where the interval between plot establishment and remeasurement will be short. Rock cairns and

photographic records can assist with plot re-location. The coloured Permolat strips usually used to mark study sites in forest vegetation are not recommended in South Island alpine zones as they attract kea.

- A combination of the above approaches may need to be taken in vegetation composed of scattered grassland and shrubs.

5. Recce Description Measurement Protocols

Equipment required to undertake Recce descriptions is detailed in Appendix 1. Each Recce description can generally be undertaken most efficiently by two people. Each Recce is recorded on a double sided Recce description sheet (see Appendix 2), which can be downloaded from the NVS Databank website (http://nvs.landcareresearch.co.nz/). Two alternative field-sheets are available with different sets of fixed-height tiers for the Recce vegetation description (see section 5.2.5).

Note that collecting data over extended periods in wet or cold weather is not advisable, as data quality generally suffers. In addition, when working on steep terrain significant damage to the vegetation on a Recce can occur when the ground is wet, which is of concern where permanently marked Recce plots are to be used to monitor vegetation change.

5.1 Plant species nomenclature and coding system

Plant species are recorded using a strict species-coding system to guarantee long-term data quality and integrity. Each taxon is recorded using a unique code that applies only to that taxon. Before beginning fieldwork all survey participants should be familiar with the species-coding system, be aware of potential non-intuitive species codes, and know how to check that species codes used are correct. For further details refer to the expanded Recce manual (see http://nvs.landcareresearch.co.nz/).

- **Before starting fieldwork**, obtain an **up-to-date** list of all species codes currently used in the NVS Databank from the NVS database administrator (email: nvs@landcareresearch.co.nz), or the NVS Databank website (http://nvs.landcareresearch.co.nz). The list is frequently updated. Use this list during fieldwork to check that each six-letter code used is correct.

- **Each vascular plant species is represented using a unique six-letter code** on field-sheets and in electronic data once the data are entered. The species

code usually, but not always, consists of the first three letters of the plant genus (upper case) followed by the first three letters of the species, subspecies or variety (lower case). For example, *Pseudopanax crassifolius* is recorded as PSEcra on all field-sheets.

- **Non-intuitive codes** are used for some species to ensure that every species receives a unique code (e.g. the code for *Pseudopanax colensoi* is NEOcol to avoid confusion with *Pseudowintera colorata*). A list of some common non-intuitive codes for vascular plants in the New Zealand flora is given in Appendix 3, but others will become possible as a result of ongoing taxonomic revisions.

- **Where only the genus is able to be determined** due to a lack of identifying features (e.g. *Parsonsia*), the first six letters of the generic name are used (written in upper case on field-sheets, e.g. PARSON).

- **DO NOT use ad hoc non-standard plant species codes**, as at a future date these are likely to be misinterpreted by persons unfamiliar with the dataset. Where there is any possibility of ambiguity or if in doubt of the correct six-letter species code, write out the plant name in full.

- **List of species recorded in the survey:** During the survey, maintain a list of the full taxonomic names of every species recorded, along with the six-letter codes used on field-sheets. An easy way to create and maintain this list during fieldwork (e.g. at field-base) is to mark species off on the master list of species codes currently used in NVS as they are recorded in the survey.

5.2 Recce description measurement

Recce identification information and descriptive data on the site and vegetation (sections 5.2.1–5.2.4) are recorded on the front side of the sheet. An example of a completed Recce description sheet is provided in Appendix 2. When measuring and recording the Recce identification and site data:

- **Define the boundaries of the area that will be described prior to undertaking any measurements**. Where ‘variable-area’ Recce descriptions are to be used, mentally take note of features forming the boundaries of the area that will be described. If using fixed-area Recce descriptions, tapes should be used to define the Recce area. Refer to the expanded Recce manual (see http://nvs.landcareresearch.co.nz/) for information on the use of fixed-area vs variable-area Recces.

- **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 Notes section where justification or further detail is required.
- Confer with other field-party members if at all unsure of the value for a data field. This applies especially where subjective visual assessments are required.
- **Ensure that data are legible.** Neatly record data to minimise any possibility they will be misread or be unable to be interpreted.
- **Do not leave any field on the data-sheet blank.** Where data are intentionally not recorded in a data field (e.g. the sub-catchment in which the Recce is located is unnamed), 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.

5.2.1 Recce identification information and location

Recce identifier:	Record the unique identifier for the Recce on the survey (including transect line number where appropriate). Ensure that the unique identifier is recorded on both sides of every Recce sheet used, in case they are photocopied onto separate sheets.
Survey:	Record the name of the survey (e.g. Hokitika).
Region:	Record the region or DOC Conservancy (e.g. Northland Conservancy). This will determine how the data will be archived in the NVS Databank (see section 8).
Catchment:	Record the name of the catchment in which the Recce is located (e.g. Whitcombe River).
Sub-catchment:	If the Recce is located in a named river or creek running into the main catchment, record as a sub-catchment (e.g. Vincent Creek).
Measured by:	Record the FULL name of person(s) doing the Recce measurement (e.g. Larry Burrows).

Recorded by:	Record the FULL name of person(s) recording the descriptive data.
Date:	Record the day, month, and year in FULL (e.g. 3 March 2005).
Aerial photo:	If aerial photographs are used, record on the Recce sheet the aerial photograph series and photo number on which the Recce location is marked. Aerial photographs (where used) should be archived with the data.
Topographical map:	Record the topographical map series, map sheet number, and name (e.g. NZMS260, L30, Reefton).
GPS reference:	Where possible the location of each Recce should be recorded using a GPS receiver, in order to provide accurate location information. **GPS make and model** – Record the make and model of the GPS receiver. **GPS reference** – Record the Easting and Northing in the space provided, preferably using seven-figure coordinates (e.g. Easting 2387885, Northing 5788535). Record whether the fix was 2D or 3D, whether the reading was a single or averaged position, and the precision obtained (e.g. ± 9 m). For guidelines on obtaining this information, refer to the instruction manual for the particular make or model of the GPS receiver. If the GPS receiver used cannot output a GPS reference in seven-figure coordinates, record the global latitude/longitude position coordinates in degrees, minutes, seconds, and decimals of seconds to two places (e.g. 172º28’36.34’ E, 43º38’25.87’ S). **Datum** – Record which geodetic datum was used to obtain the GPS reference (i.e. NZGD49 or NZGD2000). Ensure that the Recce location is correctly marked on the topographical map and the aerial photograph (where available). Note that GPS use in mountainous or forested terrain can be inherently difficult and there

will be times and places where it is very difficult to obtain a GPS fix at a Recce location. In these instances, try to obtain a reading from the nearest high point or canopy gap for which good reception can be achieved. Record this position in the approach notes and mark it on the location diagram. Measure the distance and direction to the Recce using compass and hip-chain or tapes, and record this information in the approach notes. More detailed information on using GPS receivers can be found in Burrows (2000).

Size of Recce: For 'variable-area' Recces, record the approximate (±10%) size of the area described (e.g. 100 m^2). If the Recce description is bounded to a fixed-area quadrat, record the quadrat dimensions (e.g. 20 × 20 m). For information on the use of fixed-area vs variable-area Recce descriptions refer to the expanded Recce manual (http://nvs.landcareresearch.co.nz/).

Approach: Record brief information on the location of the Recce in relation to prominent features of the landscape or vegetation.

Where the Recce is permanently marked, record detailed instructions on how to re-locate the Recce. Record any important GPS waypoints along the approach route. Where the Recce is located on a transect, record the compass bearing of the transect and GPS or map reference for the transect origin. Accurate and detailed approach notes are very important for future re-location of Recces. DO NOT assume that GPS references will be completely adequate for re-location purposes.

Location diagram: Where the Recce is permanently marked, sketch the route to the Recce emphasising prominent landscape or vegetation features (e.g. ridges, gullies, streams, slips, bluffs, roads, large tree-fall gaps).

Location diagrams should always have an arrow indicating North (magnetic), and the direction of flow of any streams or rivers should be indicated.

Notes: Provide a short description of the vegetation on the Recce and any additional observations or impressions such as evidence of erosion, disturbance, pest impacts or notable features of the topography. Information recorded here should provide a general impression of what the Recce looks like.

5.2.2 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.

Altitude: Determine the altitude using a barometric altimeter, or by estimation from a map (e.g. by using the GPS reference to determine the Recce location on the map). Record altitude to the nearest 10 m. If using a barometric altimeter it should be calibrated from a known spot-height on the topographical map each morning before work starts, and more frequently in changeable weather.

Altitude should not be directly read from GPS receivers as the reading can be inaccurate. Some models of GPS receiver contain in-built barometric altimeters; check the specifications of the GPS receiver used.

Physiography: Select the applicable option from: ridge (including spurs), face, gully, or terrace. When more than one category could apply, select the predominant physiography and record any major change in physiography within a Recce in the Notes section.

Aspect: Use a compass to measure the predominant aspect at right angles to the general lie of the Recce, to the nearest 5º (magnetic). Aspect cannot be determined on flat or almost flat sites (slope <5º) and should be recorded as ‘X’. Do not use zero to record aspect on flat Recces, as this will be misinterpreted as a northerly aspect. Where there is a major change in aspect across the Recce, record the predominant aspect.

Slope: Use a clinometer (or equivalent instrument) to measure the average slope of the Recce along the predominant aspect, to the nearest degree. From the middle of the Recce, sight the clinometer on an object at eye level near the upslope and downslope boundaries of the Recce, and average the two readings. Select the applicable 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.

Where the field party contains staff with expertise in the identification of rock types, any disagreement with the broad map classifications can be noted in the field, particularly when there are extrusive/intrusive rocks. Select the relevant option to record whether parent material was derived from the mapped classification or was observed in the field.

Drainage: Select the 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).

Mesoscale topographic index: Use a clinometer (or equivalent instrument) to measure the angle from the centre of the Recce to the horizon at eight equidistant (45º) magnetic compass bearings. Record whether each angle is above (+) or below (−) the horizontal. Move around the Recce description area if necessary. When the horizon angle is obscured (e.g. by low cloud or dense vegetation), estimate the horizon angle and make a note that the recorded value is an estimate. 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:

%bedrock, %broken rock – Estimate the percentage of the Recce ground surface comprised of bedrock and broken rock 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 – Record whether rocks greater than 30 cm (>30 cm) or less than 30 cm (<30 cm) form the predominant cover of broken rock, by selecting the relevant option. If there is no broken rock, deselect both options.

Mode of transport of broken rock – Classify (if possible) whether broken rock was mostly deposited as a result of alluvial (river deposits), moraine (glacial deposits), colluvial (erosion debris), or volcanic activity.

5.2.3 Vegetation parameters

The following vegetation parameters are estimated visually, and as such they are relatively subjective. They are included because of their use in demonstrating marked differences between sites, and provide a data-user with a better impression of what the Recce looks like. These variables have been used in studies of vegetation patterns (e.g. Harcombe et al. 1998; Wiser et al. 1998).

Ground cover: Estimate the percentage of the Recce 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 comprise only a very small portion (usually <1%) of vegetative cover.

Non-vascular – All non-vascular vegetation (i.e. mosses, liverworts, hornworts, lichen).

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 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%.

Average top height: Estimate the average top height of the dominant vegetation on the Recce, to the nearest metre. Here, the dominant vegetation is defined as all vegetation in the tallest tier (as recorded on the Recce vegetation description; see section 5.2.5) 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, hypsometer or equivalent instrument.

Canopy cover (%): Visually estimate the total canopy cover of the Recce area above 1.35 m, to the nearest 10%. Use the canopy cover scale (Appendix 4) to help arrive at this estimate.

Include all vegetation >1.35 m above the ground. On Recces with a dense subcanopy several estimates may need to be made from different positions around the Recce and then averaged.

Basal area: In forest vegetation, stand basal area (BA; m^2/ha) may be estimated where relevant to the survey objectives, and can be recorded in the Notes section. In relatively open forest, basal area can be determined using angle-gauge sampling. With angle-gauge sampling, a tree is included if the angle its diameter subtends at the Recce description centre is greater than the angle-gauge-specific critical angle. The contribution of each included tree is determined from a basal-area factor, that is specific to the instrument being used (Allen 1992). For detailed instructions on conducting angle-gauge sampling refer to Goulding & Lawrence (1992).

5.2.4 Additional biological information

Cultural: Record direct evidence of human interference 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.

Fauna: Record the presence of any mammalian, bird, reptile, or invertebrate species that can be positively identified by sight or sound.

Browse: Record conspicuous browsing damage to plant species on the Recce using the following categories:

Light (L) – Browse on 1 or 2 shoots only, on only a few of the plants of the species present.

Medium (M) – Browse on more than 1 or 2 shoots, but most plants of the species not browsed.

Heavy (H) – Browse on most accessible shoots on most plants of the species.

Record the animal(s) responsible where this can be reliably determined (e.g. ungulate, goat, deer, thar, chamois, possum, insect, rabbit, hare), or record 'unknown'. If necessary use binoculars to closely observe canopy foliage. Possum-browsed leaves often have torn edges and jagged leaf stubs, while insect damage typically consists of holes and wavy, clean-edged browse or straight, finely milled edges (Payton et al. 1999). Refer to Payton et al. (1999) for examples of typical insect and possum browse on some common tree species.

General observations on animal impacts can be recorded in the Notes section (e.g. bark stripping and the height of browsing).

5.2.5 Vegetation description

On the reverse side of the Recce sheet, vegetation structure and composition is described in height tiers (strata) using cover-classes. Observe the following guidelines when completing the Recce vegetation description:

- **High taxonomic standards must be applied.** Reporting changes in plant biodiversity over time and between areas requires consistent, accurate taxonomic standards. Follow the rules for assigning standard six-letter species codes when recording data (section 5.1) or record species names in full. When a species is not known, collect a specimen for later identification at the field-base or office (section 6).

- **Make a thorough attempt to record ALL vascular species present on the Recce.** On variable-area Recce descriptions, define the bounds of the homogenous area that will be described before beginning the vegetation description. Non-vascular species (i.e. mosses, liverwort and hornworts) can also be included on Recce vegetation descriptions as an addition to the standard method.

(a) Cover-classes and height tiers

- **Use standard fixed-height tiers (Figs 1 & 2 and Table 1).** Fixed-height tiers provide standardised and repeatable data that are readily comparable between Recce descriptions on a survey and among surveys. Prior to beginning the field-survey, the predominant structure of vegetation within the survey area should be determined and the appropriate set of standard height tiers selected based upon the predominant vegetation (see Table 1).

- **Use the standard cover-abundance scale (Table 2) to assign a cover-class to each species in each tier (tiers 1–7).** The standard cover-abundance scale is modified from the Braun-Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg 1974).

- The cover-class assigned to each species in each tier represents percent canopy cover, which is the percentage of the Recce 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). 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. **Use the canopy cover scale in Appendix 4** to help determine percent canopy cover and assign cover-classes.

Table 1. Standard height tiers used when vegetation within the study area is: (a) predominantly non-woody (e.g. grassland, some grassland-shrubland mosaics, and some wetlands); these tiers are consistent with those used in standard grassland monitoring methods (Wiser & Rose 1997); and (b) predominantly woody (e.g. forests and tall shrublands); note that these tiers are consistent with those used on standard (20×20-m) permanent forest plots (Hurst & Allen 2007b). Within any one vegetation survey all Recce descriptions should be measured using the same set of height tiers (however, note that the standard height tiers in (a) can be supplemented as necessary with tiers 1 and 2 to deal with any isolated occurrences of plants taller than 12 m).

Tier	(a) Standard tiers used when vegetation within study area is predominantly non-woody	(b) Standard tiers used when vegetation within study area is predominantly woody
1		>25 m
2		12–25 m
3	5–12 m	5–12 m
4	2–5 m	2–5 m
5		0.3–2 m
5A	1–2 m	
5B	0.3–1 m	
6		<0.3 m
6A	0.1–0.3 m	
6B	<0.1 m	
7	Epiphytes (at any height)	Epiphytes (at any height)

Table 2. Cover-classes applied to species present in each height tier on the Recce vegetation description. Cover-classes are modified from the Braun-Blanquet cover-abundance scale (see Mueller-Dombois & Ellenberg 1974).

Cover-class	Percent (%) canopy cover
1	<1
2	1–5
3	6–25
4	26–50
5	51–75
6	76–100

- **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* all occurred c. 10 m above the ground, it would be recorded in tier 3 (5–12 m); and if a *Weinmannia racemosa* had foliage in each of tiers 1–6, then it would be recorded in all of these tiers.

- **The epiphyte tier** (tier 7) includes any plant growing on another living plant, or dead standing plants. Parasitic plants (e.g. mistletoes), where present, are also recorded in the epiphyte tier.

- **Lianas** are recorded in all tiers in which their foliage occurs.

- **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 (NOT the sum of the cover-classes for each individual species). The overall canopy cover of each tier must always be equal to or greater than the highest of the cover-classes recorded for any individual species in the tier. For each tier record the overall cover-class in the row labelled 'Overall cover' (see Appendix 2b).

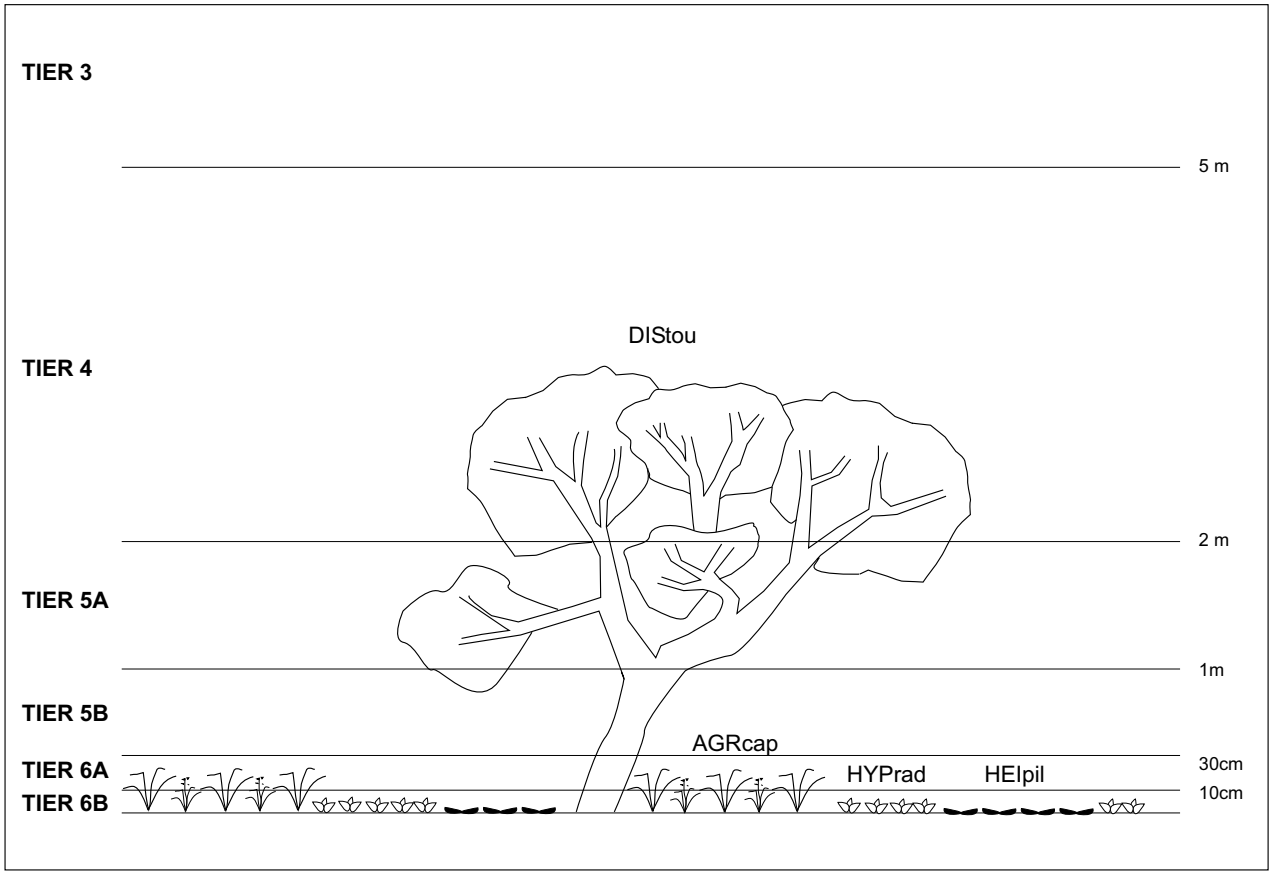

Figure 1. Height tiers used for Recce vegetation descriptions in study areas where vegetative cover is predominantly non-woody (see Table 1). In this simplified example, *Discaria toumatou* (DIStou) would be recorded in tiers 4 (i.e. 2–5 m), 5A (i.e. 1–2 m) and 5B (i.e. 0.3–1 m) as it has foliage in these tiers. *Agrostis capillaris* (AGRcap) would be recorded in tier 6A (i.e. 0.1–0.3 m) and tier 6B (i.e. <0.1 m) and both *Hypochaeris radicata* (HYPrad) and *Hieracium pilosella* (HIEpil) only in tier 6B (i.e. <0.1 m).

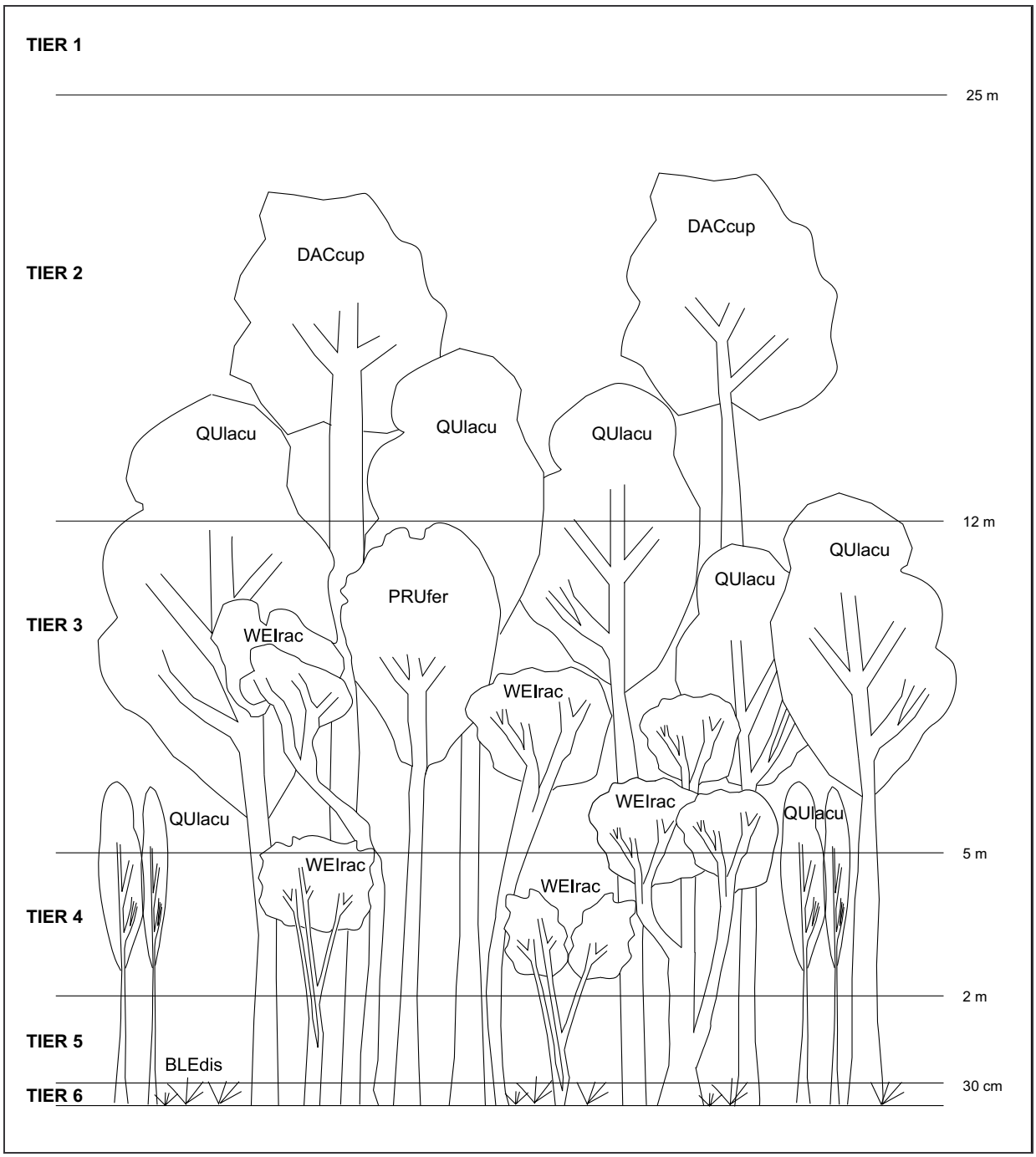

Figure 2. Height tiers used for Recce descriptions in study areas where vegetative cover is predominantly woody (see Table 1). A seventh 'tier' includes all epiphytes (not shown). In this example, *Quintinia acutifolia* (QUIacu) would be recorded in tiers 2 (i.e. 12–25 m), 3 (i.e. 5–12 m) and 4 (i.e. 2–5 m) as it has foliage in all of these tiers. By contrast, miro (*Prumnopitys ferruginea*, PRUfer) would be recorded only in tier 3 (i.e. 5–12 m), and rimu (*Dacrydium cupressinum,* DACcup) only in tier 2 (i.e. 12–25 m). Crown fern (*Blechnum discolor*, BLEdis) would be recorded in both tiers 5 (i.e. 0.3–2 m) and 6 (<0.3 m).

(b) Practical guidelines for completing the Recce vegetation description

- **Recording data:** Each species occurring should be allocated one row on the field-sheet, so that if the species occurs in more than one height tier it can be ticked on the same row (see Appendix 2b). Use a dash (i.e. '–') where a species does not occur in a shorter tier (see Appendix 2b), to allow the field-sheet to be readily checked for completeness before finishing the Recce. Where the number of plant species present exceeds the number of rows on the Recce field-sheet, use a second sheet, and ensure that each page used contains the same header information (e.g. unique Recce identifier, date) and that they are cross-referenced (e.g. Page 1 of 3).

- **Work in pairs where possible,** particularly where field staff are new to the method.

- **Adopt systematic procedures when completing the Recce vegetation description to ensure that species present are not missed.** For example:
    - Start by listing species present in the uppermost (tallest) height tier and work your way down through to the lowermost (shortest) tiers.
    - Once all obvious species are recorded, traverse the Recce description area, recording additional species in each tier as you see them. It is usually necessary to move around to gain better vantage points of the canopy, particularly in dense or complex vegetation.
    - For small or cryptic canopy foliage, gain a good vantage point and use binoculars if necessary to help ensure each species is correctly identified.
    - Small and rare species are important to record. Be aware that in the understorey tiers uncommon and small species can be easily overlooked. At the conclusion of the Recce vegetation description, conduct a systematic search of the Recce description area to ensure that all species present have been recorded.

- **Develop straightforward approaches to assigning cover classes to each species in each height tier.** For example:
    - In each tier, mentally move plants of each species to an edge of the area described, and then estimate what proportion of the area they cover. Use the canopy cover scale (see Appendix 4) to help arrive at accurate cover estimates.
    - When the cover of a species within a tier is very high, it may be

easier to estimate the proportion of the Recce area **not** covered by the species.
    - For species with very few individuals present, in each tier estimate and sum the area covered by each individual.
    - Visualise the canopy of each species squashed into a flat plane, and then estimate the proportion of the Recce area covered by the species (i.e. avoid biasing cover estimates because of high or low foliage density).

- **Take care to ensure that species are assigned to the correct height tiers**. Observers should calibrate height estimates frequently against heights measured, using a tape, height-pole, hypsometer, or equivalent instrument.

- **Observers should regularly compare their cover-class estimates** with one another. As a balance between the repeatability and accuracy required for cover estimations, trained field staff should generally be able to estimate cover-classes consistently and repeatedly to within one class of one another.

- Note that viewing cover of trees obliquely, rather than vertically, can result in overestimation of cover. Move around as necessary when making cover estimates.

6. Collecting and Recording Unknown Plants

Reporting patterns of plant biodiversity over time or between areas requires consistent, accurate taxonomic standards. Whenever unsure of the identity of a plant species on a Recce description, a collection should be made and the identity of the plant properly checked at the field-base or office. Adopt a systematic approach to collecting and storing specimens, recording specimens on field-sheets, and the correction of field-sheets once the specimen identifications are resolved. Be aware of any provincially or nationally threatened species that may be encountered, and ensure that collecting activities do not contribute to the decline of populations at risk.

6.1 Collection of unknown plant specimens

- **A specimen should be collected whenever the identity of a species on a Recce is unknown or uncertain.** If Recce descriptions are to be remeasured to monitor vegetation change, collect specimens from outside the Recce where possible and do not collect a specimen where doing so would completely eliminate the species from the Recce and immediate surroundings.

- **Aim to collect as much of the vegetative and floral parts as is practical.** The specimen should include (where appropriate) root, stem, leaves, flowers, fruits or seeds; and should provide an adequate example of the overall habit of the plant.

- **Give each collected species a provisional 'tag name'.** The tag name should reflect a notable feature of the plant or a potential genus or species. Each tag name should be treated as specific only to the Recce at which it was created.

- EVERY time that a collected unknown species occurs on the field-sheets, annotate the tag name record with the symbol '©' to indicate that a specimen was collected.

- **While AT THE RECCE, label the plant specimen using a suitable label** (e.g. a plant nursery label). Record the tag name (EXACTLY as it appears on field-sheets), survey name, Recce number, collection date, and collector's name, as well as any notable features of the plant's habit, height or substrate. Attach the label to the specimen and ensure that they cannot be separated during transportation back to the field-base.

- **Use a portable plant press** (e.g. hard-covered book with absorbent pages, or a smaller version of a standard plant press) or plastic bags to temporarily store collected specimens until arrival at the field-base.

6.2 Storage of unknown plant specimens

- **At the field-base, transfer each collected specimen into a plant press as soon as possible.** A plant press can easily be constructed using plywood, sheets of corrugated cardboard (and/or corrugated aluminium sheet), and absorbent paper (e.g. newspaper), held together using belts or straps.

- While transferring specimens, systematically check that all collected specimens were recorded on the field-sheets, and were annotated with a '©' symbol.

- **Carefully press each specimen.** Carefully place each specimen within a folded piece of plain newsprint, and separate specimens using sheets of cardboard and additional paper. Ensure that the natural habit of each plant is retained and that features important for a specimen's identification are not obscured. Fold large specimens neatly so that they fit inside the plant press. Place seeds or other loose material in a labelled envelope.

- **Change the paper in the plant press regularly** to prevent specimens from going mouldy, particularly in damp climates or where specimens were wet when pressed. Specimens will dry most quickly when the plant press is stored in a well-ventilated and sunny location.

6.3 Correction of field-sheets

Take a systematic approach to identifying collected specimens and ensuring that tag names on all field-sheets are corrected. When amending field-sheets, do not rub out the '©' symbol, but put a line through it to indicate that the identity of the specimen was resolved. For further details, refer to the expanded Recce manual (see http://nvs.landcareresearch.co.nz/).

7. Quality Control Procedures for Recce Surveys

Quality control procedures are an essential part of any vegetation inventory or monitoring programme. Quality control should consist of internal systems of routine technical activities and procedures, to ensure data consistency, comparability, and completeness. Refer to the expanded Recce manual (see http://nvs.landcareresearch.co.nz/) for an example of a quality control procedure for vegetation inventory and monitoring programmes using Recce descriptions.

8. Data Management and Storage Using the National Vegetation Survey Databank

Systematic data storage is essential to ensure data are easily accessible and safeguarded against loss. Storage of Recce description data is facilitated by the National Vegetation Survey (NVS) Databank, recognised as New Zealand's primary repository for ecological data on vegetation structure and composition. Further information on depositing Recce data into the NVS Databank can be obtained from the NVS website (http://nvs.landcareresearch.co.nz/), or by contacting the NVS database administrator (nvs@landcareresearch.co.nz).

9. Acknowledgements

The Recce description method described in this manual was largely developed and tested by John Wardle. Subsequently many people have contributed to ongoing refinements, including Colin Barr, Larry Burrows, Rob Guest, Jack Hayward, John Leathwick, Kevin Platt, Alan Rose, and Glenn Stewart. More recently, development of the New Zealand Carbon Monitoring System (NZCMS) resulted in further refinements to Recce measurement protocols that were eventually incorporated into the NZCMS data collection manual by Ian Payton, Claire Newell and Peter Beets (Payton et al. 2004). These refinements assisted the production of this manual.

Many other people contributed their ideas, expertise and time. Special thanks are due to Amy Hawcroft, Dale Williams, Duane Peltzer, Elaine Wright, Geoff Rogers, Hazel Broadbent, Kate McNutt, Larry Burrows, Meredith McKay, Mike Perry, Peter Bellingham, Phil Knightbridge, Roger Carran, Sean Husheer, Steve Deverell and Susan Wiser and for useful discussions and input on earlier drafts. We also thank staff of the Department of Conservation and other agencies who completed a survey and discussed methods and best-practice measurement procedures, prior to the manual revision.

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11. Appendices

Appendix 1 Equipment required to establish and measure Recce descriptions

Appendix 2 Example of a filled in Recce description sheet
a. Site description
b. Vegetation description

Appendix 3 Non-standard species codes for the New Zealand vascular flora

Appendix 4 Canopy Cover Scale

Appendix 1. Equipment required to establish and measure Recce descriptions

Equipment

Recce field manual
Plant identification texts
Species list compiled from other surveys in the area
Hard-covered book or lightweight plant press or for temporarily pressing plant specimens
Hip-chain and cotton
Laminated copies of the Canopy Cover Scale (Appendix 4)
Global Positioning System (GPS) receiver
Geological survey map, topographical maps and aerial photographs
Clipboards
Sighting compass and altimeter
Clinometer or equivalent instrument (e.g. hypsometer) for measuring slope
Binoculars
Bum-bags or toolbelts for carrying equipment
Steel measuring tape (8 m), extendable height pole or hypsometer (e.g. for calibrating estimated heights with measured heights)

Consumable items

Adequate supplies of the following consumable items should be available and the field-kit restocked each day as necessary:
Batteries for GPS, metal detector and other electronic equipment
Waterproof plant labels
Waterproof permanent marker for labelling plant labels
Plastic bags for transporting large plant specimens
Plastic bags for storing and transporting field-sheets
Hip-chain cotton

Field-sheets required per Recce

Four Recce description sheets (two on normal paper and two on waterproof paper)

Permanently marked fixed-area Recces

The following additional gear and consumable items are needed where Recce descriptions are to be permanently marked:
Tapes to establish the Recce description boundaries
Permolat or equivalent markers to mark the route to each Recce location
Suitable pegs or stakes to mark quadrat corners
Permolat markers (or equivalent) for marking quadrat corners

Other items required at field base

Access and collection permits from landowners
Plant storage and identification equipment: plant press, newsprint, blotters, plant labels, plant identification texts, hand lenses, large plastic bags
Envelopes and boxes etc. to store completed field-sheets

Appendix 2a. Recce field-sheet: Site description

RECONNAISSANCE (RECCE) PLOT SHEET

National Vegetation Survey Databank (http://nvs.landcareresearch.co.nz/) Page 1 of 2

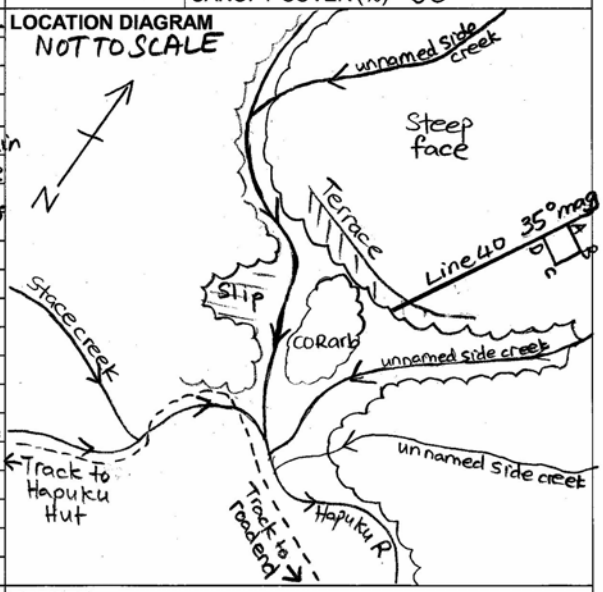
RECCE IDENTIFIER: 20-1
SURVEY: Hapuku
REGION: Nelson - Marlborough
CATCHMENT: Hapuku
SUB-CATCHMENT: None
MEASURED BY: Sofia Lund
RECORDED BY: Laura Spence

DAY/MONTH/YEAR: 10 March 2007
AERIAL PHOTO: None
TOPO. MAP NO. & NAME: NZMS260 031 Kaikoura
GPS REFERENCE: GPS Make & Model: Garmin Map76
Easting: 2565529
Northing: 5882267
~~Single~~ / (Averaged) ~~2D~~ / (3D) ± 9 m; Datum: (NZGD49) / ~~NZGD2000~~

SIZE OF RECCE 400 m²	**MESOSCALE TOPOGRAPHIC INDEX** (°, record +/–)	**SURFACE CHARACTERISTICS:**	
ALTITUDE (m) 390		Bedrock %	0
PHYSIOGRAPHY ~~Ridge~~, (Face) ~~Gully, Terrace~~		Broken rock %	50
ASPECT (0–359°) 195		Size of broken rock	~~>30cm~~ / (<30cm)
SLOPE (°) ~~Convex, Concave~~, (Linear)	N +32	~~Alluvial~~, (Colluvial) ~~Morraine, Volcanic~~	
PARENT MATERIAL Greywacke	NE +42	**GROUND COVER %:**	
~~Mapped~~ / (Observed)	E +24	Vegetation	75
DRAINAGE (Good) ~~Moderate, Poor~~	SE +13	Non-vascular	20
CULTURAL (None) ~~Burnt, Logged, Cleared~~	S +6	Litter	70
~~Mined, Grazed, Tracked~~	SW +3	Bare Ground	2
APPROACH From the Hapuku hut	W +20	Rock	20
(E2563745, N5881455) navigate to	NW +11	AVERAGE TOP HEIGHT (m)	20
E2565512 N5882257, where Line 40		CANOPY COVER (%)	60

Starts on the true left of the Northern-most branch of the Hapuku R, at the bushedge near a small unnamed side-creek. Transect is marked with red permolat on CORarb at bushedge, and again on a ~30cm PRUfer c.20m into bush. Recce is 60m further along transect at 35° mag.

LOCATION DIAGRAM
NOT TO SCALE



NOTES (including cultural)

Tall PRUtax and PRUfer dominated forest, with a thick subcanopy of COPgra, MELram and other ungulate palatable species.

Outside the RECCE plot there is evidence of previous fire (c.50m from Recce) – charcoal remains on large PRUtax trees.

Plot corners are marked A, B, C, D and Recce was bounded to plot boundary tapes.

BROWSE

Species	Severity	Herbivore	Species	Severity	Herbivore
COPgra	~~L M~~ (H)	Ungulate		L M H	
COPluc	~~L~~ (M) ~~H~~	Ungulate		L M H	
COPrha	~~L~~ (M) ~~H~~	Ungulate		L M H	
ASPapp	~~L~~ (M) ~~H~~	Ungulate		L M H	
MICpus	(L) ~~M H~~	Ungulate		L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

Bellbird, Fantail, NZ Falcon, Harrier hawk.
Frequent ungulate sign within plot.

Appendix 2b. Recce field-sheet: Vegetation description

Page 2 of 2

RECCE IDENTIFIER: 40-1 MEASURED BY: Roger Carran, Sofia Lund

DAY/MONTH/YEAR: 10 March 2007 RECORDED BY: Laura Spence

Cover-classes: 1 = <1%, 2 = 1–5%, 3 = 6–25%, 4 = 26–50%, 5 = 51–75%, 6 = 76–100%.

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall Cover		4	5	3	3	4
		PRUfer 4	✓ 4	✓ 2	✓ 1	✓ 1
Tier 7		PRUtax 3	✓ 2	✓ 1	✓ 1	✓ 1
Epiphytes		PITeug 2	✓ 2	✓ 1	✓ 1	✓ 1
PYRela 1			MELram2	✓ 2	✓ 1	✓ 1
MICpus 1			COPgra 2	✓ 2	✓ 2	✓ 2
			ARIser 1	✓ 1	✓ 1	✓ 1
			MYRaus 1	✓ 1	✓ 1	✓ 1
				PSEcol 1	✓ 1	✓ 1
				CARser 1	✓ 1	✓ 1
				COPluc 1	—	—
				RUBcis 1	✓ 1	—
					PITten 1	✓ 1
					COPrha 1	✓ 1
					PSEcra 1	✓ 1
					SOPmic©1	✓ 1
					ASPgra 1	✓ 1
					UNCunc©1	✓ 1
					POLves 2	✓ 1
					HEDarb 1	✓ 1
					ELAden 1	✓ 1
					GRIlit 1	✓ 1
					PARSON 1	✓ 1
					ELAhoo 1	✓ 1
					CLEfor©1	✓ 1
						UNCsca©1
						ASPhoo 1
						PTEROS 1
						TARoff 1
						CIRvul 1
						MICpus 1
						PELrot 1
						EPIbru©1
						BLEvul 2

Appendix 3. Non-standard species codes for the New Zealand vascular flora

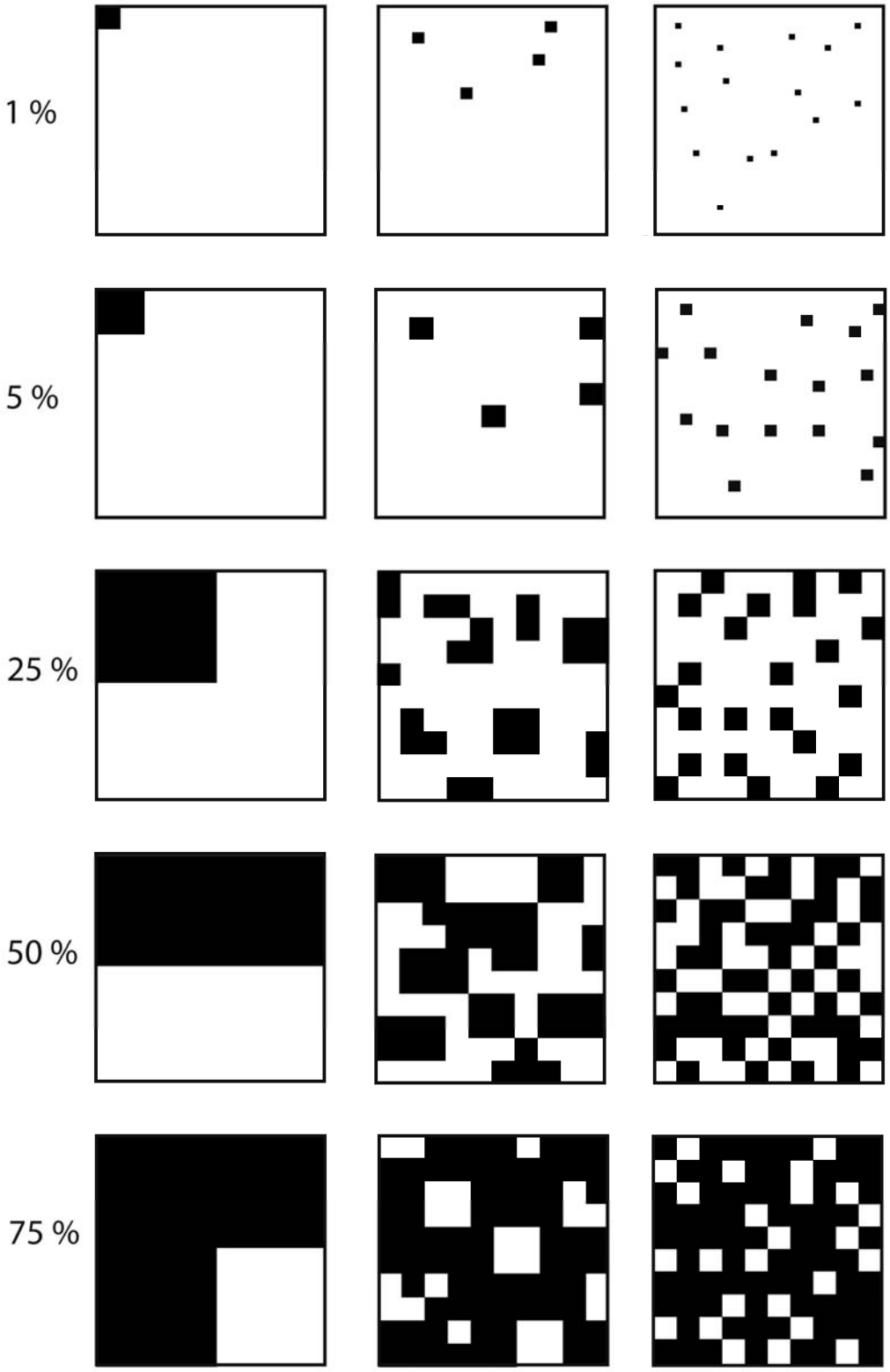
Use this list (current as at 28 February 2007) to check unintuitive six-letter species codes (see section 5.1 for details). A full list of species codes used in the NVS Databank can be obtained from the NVS website (http://nvs.landcareresearch.co.nz/).

Aciphylla similis	ACIsim
Aciphylla simplex	ACIsmp
Agrostis perennans	AGRper
Agrostis personata	AGRpes
Asplenium colensoi	ASPcol
Asplenium hookerianum var. *colensoi*	ASPhvc
Asplenium flaccidum	ASPfla
Asplenium flabellifolium	ASPflb
Astelia grandis	ASTgra
Astelia graminea	ASTgrm
Beilschmiedia tawa	BEItaw
Beilschmiedia tawaroa	BEIroa
Brachyscome species	BRACHY
Brachyglottis species	BRACHG
Carex coriacea	CARcor
Carmichaelia corrugata	CARcog
Cardamine corymbosa	CARcoy
Carex flaviformis	CARfla
Carex flagellifera	CARfgl
Carmichaelia flagelliformis	CARflg
Carex kirkii	CARkir
Carmichaelia kirkii	CRMkir
Carmichaelia petriei	CARpet
Carex petriei	CARptr
Carex virgata	CARvir
Carmichaelia virgata	CARvig
Celmisia gracilenta	CELgra
Celmisia graminifolia	CELgrm
Celmisia petriei	CELpet
Celmisia petiolata	CELpel
Celmisia spectabilis	CELspe
Celmisia spedenii	CELspd
Coprosma sp. (p) as in Eagle 1982	COPdum
Coprosma dumosa	COPdmo
Coprosma pseudocuneata	COPpse
Coprosma pseudociliata	COPpsc
Coprosma tenuicaulis	COPtec
Coprosma tenuifolia	COPtef
Cyathea colensoi	CYAcol
Cyathodes colensoi	CYTcol
Cyathea dealbata	CYAdea
Cyathodes dealbata	CYTdea
Cyperus eragrostis	CYPera
Cyperaceae species	CYPSPP

Deschampsia chapmanii	DEScha
Deschampsia species	DESCHM
Dracophyllum pronum	DRApro
Dracophyllum prostratum	DRAprs
Einadia triandra	EINtri
Einadia trigonos subsp. *trigonos*	EINtst
Epilobium brunnescens	EPIbrn
Epilobium brunnescens subsp. *brunnescens*	EPIbru
Hebe stricta	HEBstr
Hebe strictissima	HEBsts
Hebe tetragonal	HEBtet
Hebe tetrasticha	HEBttr
Luzula rufa	LUZruf
Luzula rufa var. *rufa*	LUZrvr
Microseris scapigera	MICsca
Microsorum scandens	MICscn
Myriophyllum aquaticum	MYRaqu
Myrsine aquilonia	MYRaql
Ourisia macrophylla	OURmac
Ourisia macrocarpa subsp. *macrocarpa*	OURmsm
Pittosporum crassicaule	PITcra
Pittosporum crassifolium	PITcrf
Plantago lanceolata	PLAlan
Plantago lanigera	PLAlng
Pseudognaphalium species	PSEUDG
Pseudopanax species	PSEUDO
Pseudotsuga species	PSEUDT
Pseudowintera species	PSEUDW
Pseudowintera colorata	PSEcol
Pseudopanax colensoi	NEOcol
Ranunculus gracilipes	RANgra
Ranunculus grahamii	RANgrh
Ranunculus macropus	RANmac
Ranunculus maculatus	RANmcl
Raoulia subulata	RAOsub
Raoulia subsericea	RAOsbs
Schizeilema nitens	SCHnit
Schoenus nitens var. *concinnus*	SCHnvc
Schoenus nitens var. *nitens*	SCHnvn
Stellaria gracilenta	STEgra
Stellaria graminea	STEgrm
Stenostachys gracilis	STEgrc
Trifolium glomeratum	TRIglo
Triglochin species	TRIGLC
Trichomanes strictum	TRIstr
Triglochin striatum	TRIsta
Trifolium striatum	TRIstt
Trifolium subterraneum	TRIsub
Triandrophyllum subtrifidum	TRIsut

Appendix 4. Canopy Cover Scale

Divisions of the standard cover-abundance scale (showing the proportion of the Recce area represented by each division). Use this scale when assigning cover-classes for the Recce vegetation description.



Notes