PHCC
ECOLOGICAL MONITORING GUIDE

This document was initially put together for the Australian Government funded, Peel-Harvey Catchment Council 'Rivers 2 Ramsar-Connecting River Corridors for Landscape Resilience' project (R2R project). The Peel-Harvey Catchment Council (PHCC) and Project Partners committed to undertake key actions, including restoration and protection of river banks and riparian corridors, through weed and pest control and revegetation, spanning across the entire Peel-Harvey Catchment, with the aim to develop and strengthen connectivity, the condition and extent of biodiverse native habitats.

The adapted version was specifically designed for the Australian Government Funded, 'Rivers 2 Ramsar' project, South-west Western Australia.

The Department also acknowledges and recognises a number of similar methodologies that are used throughout Australia (Commonwealth Government 2014). With this in mind and with permission from the Department, the PHCC has evolved the departmental version of the Guide and produced this approved version, the ***'Rivers 2 Ramsar Ecological Monitoring Guide'***.

While it remains closely-fitted to the departmental Guide the '***Rivers 2 Ramsar Ecological Monitoring Guide'*** is more suited to the standard methodology used, past and present in the south-west of Western Australia. This adapted version will better ensure standard methodology and quality assurance/quality control (QA/QC) is used across all project sites.

The latest version 1.3, has been reviewed and updated so it can be used for other projects.

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Glossary

Bare ground	Ground that does not support living vegetation, cryptogams or exposed rock.
Canopy	The structural layer of foliage of the overstorey or midstorey in a forest, woodland, shrubland or heathland community at full development for a vegetation type.
Crown Type	The percentage of the ground that would be shaded by a vertical projection of foliage, branches and other life forms in the overstorey.
Cryptogams	Mosses, lichen, algae, ferns.
Department	The Australian Government Department administering Biodiversity Fund grants.
Exotic species	A plant or animal species that is not indigenous to any part of Australia.
Ground cover	The percentage cover of all elements of the ground layer.
Ground layer	The lowest layer of vegetation generally comprised of grasses, sedges, forbs, herbs, prostrate shrubs or seedling trees.
Midstorey	The middle layer of a vegetation community usually consisting of shrubs and small trees that grow below the canopy of the overstorey. Midstorey must meet a height threshold for each vegetation type.
Naturalised species	Native vegetation outside its normal range.
NVIS	National Vegetation Information System, a comprehensive data system that provides information on the extent and distribution of vegetation types in Australian landscapes.
Organic litter	Detached wood or leaf matter lying on the ground.
Overstorey	The tree canopy in a forest or woodland community. Overstorey must meet a height threshold for each vegetation type.
Plot	Quadrat within which ecological attributes are sampled in the field. Standard dimensions are 20 metres x 20 metres.
Project area	The area your project covers.
Project site	The site where you are undertaking activities within your project area. Some project areas and sites may be the same.
Projected crown cover	The proportion of the ground covered by the vertical projection of the tree crown, or more simply, the width of the tree crown.
Recruitment	Regeneration of plants following seed fall and germination and includes seedlings, saplings and other advanced regrowth.
Transect	A linear sampling unit at a predetermined start point, using a predetermined compass bearing that is established using a 50 m tape.
Treatment site	A site that is located in vegetation within which a specific intervention or activity is being carried out.

Abbreviations

CT	Crown Type
MVT	Major Vegetation Groups within the NVIS
NVIS	National Vegetation Information System
PCC	Projected crown cover

Introduction

Monitoring the change in condition of native vegetation is important for natural resource management programmes at both the project and programme scale. At the project scale, monitoring vegetation allows project participants to observe the response of ecological indicators such as ground cover and native plant diversity to specific interventions such as grazing control or weed management. At the programme scale, the data from a range of projects can provide information on the overall performance of the programme, across interventions, vegetation types and geographic regions.

This Guide provides practical instructions for carrying out standard vegetation condition assessments for funded projects. It describes how to establish your vegetation condition monitoring sites in your project area, how to set up a transect and plot, or series of transects and plots, and how to record data on vegetation cover and exotic fauna.

Before you begin this monitoring, you should read this Guide to understand what is required. Please ensure you have the correct equipment and follow the steps outlined.

Monitoring activities

1. Desktop identification of vegetation type and condition.
2. Locating your transect start and end point in the field.
3. Establish transect and plot in the field.
4. Recording evidence of exotic and native fauna.
5. Measuring native and exotic ground cover.
6. Over/midstorey projected crown cover- % vegetation.
7. Overstorey crown type- % vegetation.
8. Plant species diversity.

Monitoring approach

Activities require a minimum of one transect and plot in the site. Projects need to establish monitoring transects and plots based on the project area using the following guidelines:

- <10 ha 1 transect plot
- 10 – 100 ha 2 transect plots
- > 100 ha 3 transect plots

If your project has multiple sites you will need to select the most indicative of the projects work to carry out monitoring.

Other information

- Annual reporting is required, and is to be submitted with as part of Mid-Year Reporting, using the supplied Field Sheets at the end of this document (Appendix E).
- All transects and plots are to be established prior to any on-ground works being carried out at designated project sites.
- In Western Australia and below tropic of Capricorn monitoring will occur between August and November.
- This guide draws on common survey methods used in Western Australia (Casson et al 2009; Clarke et al 2009) and is based on the Australian Government's Biodiversity Fund Ecological Monitoring Guide (Commonwealth Australia 2013).
- Some of the information regarding NVIS and vegetation survey was provided by Jenny Borger (Botanical Consultant), using reference to Walker J and Hopkins M S (1990); Executive Steering Committee for Australian Vegetation Information (ESCAVI) (2003); and Cosier, et al. (2013).

Techniques and processes

(to be recorded on Site Detail Sheet - Appendix E)

Desktop identification prior to site visit

Before you begin any fieldwork, you should try and gather as much information on your project site, including major vegetation sub-groups and indicative height thresholds (Appendix A), to ensure you know which vegetation group your project fits within.

Fragmentation condition of the remnant you are working in is important to record as it allows you to record any changes over time. This may be important if you need to quantify changes for the better after fencing (protecting from domestic grazing), controlling weeds or other procedures put in place for which funding is provided. You should review imagery and check in the field which shows Fragmentation Phases (refer Appendix D).

Remnant information

- Location.
- Landholder/Manager.
- GPS coordinates of remnant corners so they can be checked during the site visit if there has been changes in the size of the remnant (e.g. shrinkage).
- Fragmentation Type shown on imagery which can be checked in the field (e.g. are there more tracks present; are there more clearings?).
- Connectivity – distance to neighbouring remnants – check in the field if there has been any attrition (loss of remnants or isolated paddock trees) or if there have been changes such as corridors planted.

Vegetation information

- Previous surveys of remnant (history), and neighbouring remnant/s.
- Check NatureMap for records in the target remnant and nearby remnants. This may give you an indication of species to expect and you can familiarize yourself with them.
- Ask the landholder if they know of any and who did them. See if you can get a copy.
- DAFWA data/ mapping.

Landform information

- IBRA sub-region.
- Previous catchment surveys or soil mapping.
- Geological map.

In the field – Transects and plots

Identify transect start point

- Locate your transect and Plot in an area that is most representative of the project site
- (At least 50m away from the edge of your project area where possible).
- Record Start Point in GPS unit and insert Marker Peg and ID (Point A, Figure 1).
- Record compass bearing for transect line.

Transect line – 50 m

(When measuring the transect be sure to peg the tape down at either end)

- Measure 10m from your Start Point (A) along the compass bearing and insert Marker Peg (B).
- Measure a further 40m from this point to the full 50m of the transect and record End Point in GPS unit and insert Marker Peg and ID (Point C, Figure 1).
- Leave the 50m tape in place throughout the monitoring process.

Recording photo id

- Take photo id at 10m, 20m, 30m, 40m along transect line.
- Take photo id at 50m along transect line.

The Plot – 10m x 10m

- Mark out the 10m x 10m Plot as shown in Figure 1, using string-line.
- To ensure that your 10m x 10m plot is set with Right Angles you may use the 3, 4,5 Rule. Although this can be done with one person it is much easier to have a second person assist.

3,4,5,Rule

1. At Start Point (A), Person 1 walk along the transect line for 4m and tie a pre-cut 5m length of string-line.
2. At Start Point (A), Person 2 walk at a 90° angle for 3m, using second tape measure.
3. Person 1 and 2 now walk towards each other until string and tape are taught.
4. You now have a right angle and can extend out to 5m using the measuring tape. Insert a Plot Marker Peg 1.
5. Repeat these steps to work out the next right angle. Insert a Plot Marker Peg 2.
6. Move the 5m string-line to Point (B) and measure out 5m at right angles to transect.
7. From Plot Marker Peg 1 walk for 10m perpendicular to transect using tape measure. Where string-line and measuring tape meet insert a Plot Marker Peg 3.
8. Repeat steps 6 and 7 and insert a Plot Marker Peg 4.

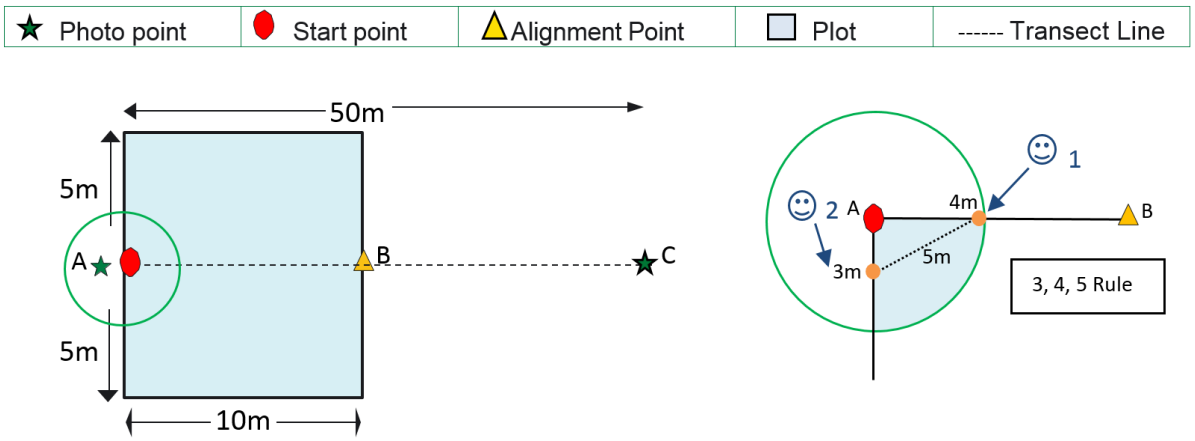


Figure 1. Establishing Right Angled Plot and Transect

Recording evidence of fauna – Native and Exotic

(to be recorded on Field Sheet 1 - Appendix E)

Native fauna

- Stand at the Start Point and hold the 1m Sampling Staff in front of you at right angles to the transect/Parallel to the ground.
- Walk the Length of transect and record any evidence of native fauna, Figure 3.
- Starting at the 50m Marking peg, walk the Length of transect to the Starting Point repeating this process.
- Note: If you have assistance then this process can be done in one sweep, with a person either side of transect walking the length of transect from 0m to 50m.

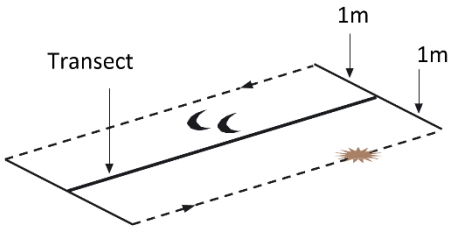


Figure 3: Measuring native and exotic animal evidence

Exotic fauna

- Repeat as above.

Measuring ground cover

(to be recorded on Field Sheet 2 – Appendix E)

- Hold a sampling staff vertically (with one end touching the ground) at each meter along transect. Starting at 1m and ending at 50m.
- Record and mark the numbers of any native or exotic plants between 0-1m in height that the staff touches (plant species, plant type and number of i.e. Native (Na) or Exotic (Ex).
- If the staff touches Acacia and organic litter, record it in the 'Na' column as '1', and 'OL' in the column as '1')
- If the staff does not touch a living plant at ground level follow the logic in Figure 2.

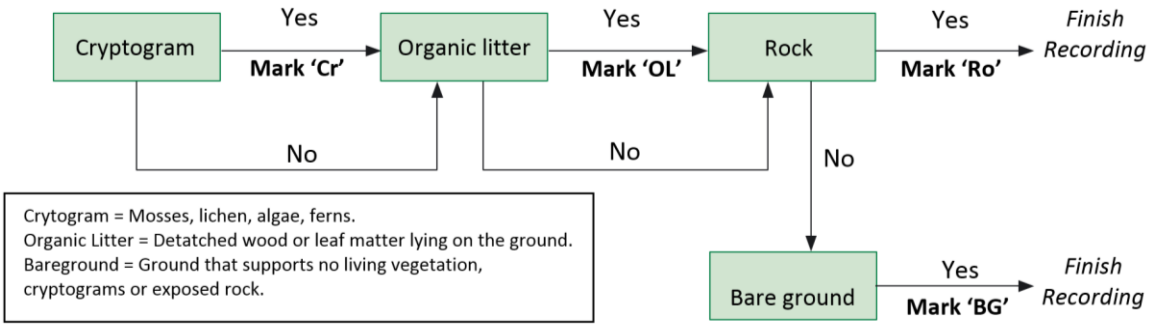


Figure 2: The logic below will guide you on recording ground cover

Measuring overstorey/midstorey projected crown cover (PCC) – Native and Exotic

(to be recorded on Field Sheet 3 - Appendix E)

Native PCC

If you are within a vegetation type that normally comprises a native overstorey, you will need to measure its projected crown cover (PCC). This includes all native overstorey species including naturalised natives (i.e. native vegetation outside its natural range) along the transect that achieve the minimum height threshold for your vegetation type.

You will need to refer to Appendix A to check what the thresholds are for your National Vegetation Information System (NVIS) Major Vegetation sub-group. Do not include overstorey plants that are shorter than this, and do not include tall midstorey plants if the vegetation type possesses a distinctive midstorey.

- To be sure that plants meet the overstorey species threshold, you can estimate their height using the technique shown in Figure 4.
- To estimate PCC walk along transect and record all distances that living canopy of native plants start and end, directly above the transect tape, Figure 5.
- The PCC for transect is calculated using the widths, for example: 5.3 + 1.2 + 10.2 + 2.4 = 19.1 m/ 50 = 0.382 x 100 = 38.2%.
- Repeat process for native midstorey plants, if applicable.

Exotic PCC

- Repeat steps as above.
- Note that if surveying exotic species carry out.

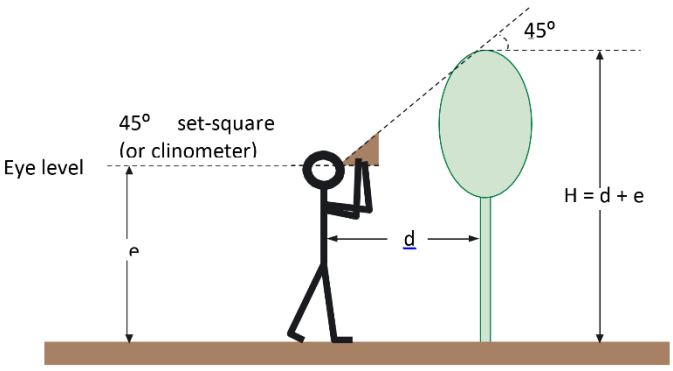


Figure 4: Measuring tree height (Height = eye level + distance from tree)

Note: You can measure the height using apps easily available for most smart phones.

1. Walk away from the tree (10-20m). Take note of distance from tree.
2. Measure the angle of elevation using smart phone virtual spirit level app (iPhone example: open compass and slide for level)
   - Select the angle measure. Bring the smartphone to your eye and sight along its edge, as if you're looking down a gun sight, aiming at the very top of the tree. You will need to hold the phone so that your fingers are not in the way. Read the angle shown on the phone (ignore the minus symbol on degrees if shown).
3. Open the scientific calculator and enter the angle of elevation (e.g.; 43.7), press tan (=0.9556), multiple this by the distance from the tree (e.g.: 21m), add the height to eye (e.g.: 1.73m) and press equals.

This is the height of the tree = E.g.: 21.798m

If the canopies of trees overlap you should measure the width of the tallest tree and begin counting the shorter tree where the taller tree finishes as illustrated below.

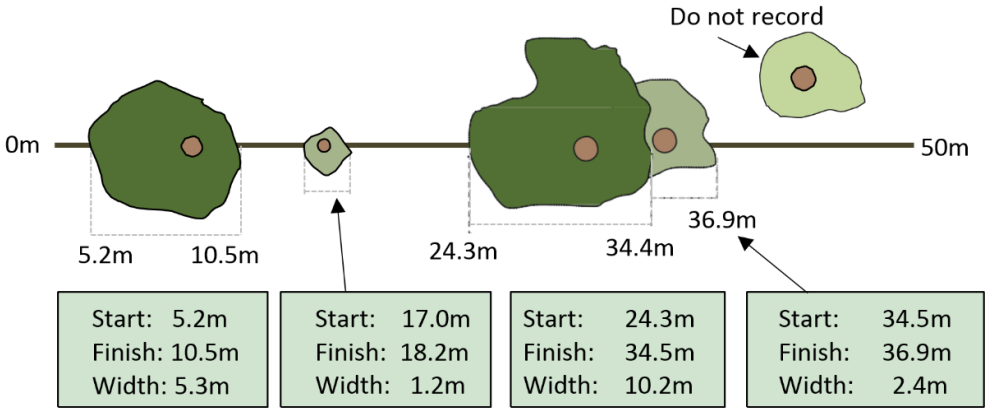


Figure 5: Measuring projected crown cover along a 50 meter transect

Record crown type (CT) of overstorey – Native and Exotic

(to be recorded on Field Sheet 4 - Appendix E)

Native CT

- As with the PCC method, it is important that you only include trees that plants meet the overstorey species threshold, (NVIS) Major Vegetation sub-group.
- Locate up to 10 points along the Transect (at least 3m apart) at which the native Overstorey canopy is directly overhead, (ensure that no clear sky can be seen around the edge of the canopy when viewing through a sighting tube).
- At each point record the distance along transect from the start point.
- Record the CT at each point by looking vertically upwards through a sighting tube (estimate cover percentage by reference to Appendix B).

Exotic CT

- Repeat as above.

Record plant species diversity

(to be recorded on Field Sheets 5– Appendix E)

- Walk the plot from side to side (ensuring to cover the whole area) and record all native and exotic species encountered (only record each species identified once).

- Record each species as Species1, Species 2, Species 3, etc. Continue this numbering for each new species found.

Equipment list

Equipment	Use
50m Tape	To establish transect (to be left in place during monitoring).
20m Tape	To establish the Plot.
GPS Unit (not supplied in kit)	To determine transect bearing/establish plot, Record start point latitude and longitude.
45' set square/ clinometer	To determine tree height.
String Line	To establish the Plot.
Flagging Tape	To identify boundaries of the Plot.
7 Marker Pegs (per plot/transect)	To help mark out the Plot/Transect.
Tent pegs	To temporarily fix Tape/s
Hammer	For the marker pegs.
1m Sampling Staff	For detection of exotic fauna, evidence and measuring native and exotic ground cover.
Sighting Tube-Empty roll toilet paper	Required to measure Crown Type (roughly 10cm Length x 4cm Diameter).
Field Sheets	To record data/ findings.
Botanical filed guides (R) (not supplied in kit)	To assist in determining native and exotic vegetation for ground cover and species diversity measures. E.g.: Weed Id; Flora Id; Scats Id; Veg Id

References

Australian Government (2014) Biodiversity Fund, Monitoring Evaluation Reporting and Improvement (MERI) for Australian Government natural resource management Programs, Biodiversity fund ecological monitoring. Available online: http://www.environment.gov.au/cleanenergyfuture/biodiversity-fund/meri/index.html

Bogaert J, R Ceulemans, and Salvador-Van Eysenrode D. (2004) Decision tree algorithm for detection of spatial processes in landscape transformation. Environmental Management. 33 (1): 62-73.

Borger, J (2014) NVIS Training_Peel Harvey Catchment Council_2014. National Vegetation Information System Training guide.

Commonwealth of Australia (2013) Biodiversity Fund Round Two: 2013–14; Grant application guidelines. Australian Government, Canberra.

Commonwealth of Australia (2013) Biodiversity Fund Ecological Monitoring Guide. Australian Government, Canberra.

Casson et al. (2009) Native vegetation condition assessment and monitoring manual for Western Australia. Department of Environment and Conservation, Kensington Western Australia.

Clarke, V., (2009) Department of Environment and Conservation Nature Conservation Service; Standard Operating Procedure, Establishing Vegetation Quadrats (SOP No: 6.1). Department of Environment and Conservation, Kensington Western Australia.

Cosier, *et al.* (2013) *Technical Paper #1: Native Vegetation Condition Account Standard: Working Draft V5.0 May 2014.* Available online: www.wentworthgroup.org/environmental accounts/technical papers

Executive Steering Committee for Australian Vegetation Information (ESCAVI) (2003) Australian Vegetation Attribute Manual: National Vegetation Information System, Version 6.0. Department of the Environment and Heritage. Canberra.

Forman, R (1995) Land mosaics-the ecology of landscapes and regions. Cambridge University Press, Cambridge.

Keighery, B. (1994) Bushland Plant Survey: A Guide for Community Surveys. Wildflower Society of Western Australia, Perth WA.

State of the Environment Committee (2011) State of the Environment 2011: Independent report to the Australian Government Minister for Sustainability, Environment, Water, Population and Communities. Australian Government, Department of Sustainability, Environment, Water, Population and Communities. Canberra.

Appendix A—Indicative height thresholds for major vegetation groups

Table 1: A table showing the major vegetation groups

NVIS Major Vegetation Group	NVIS Major Vegetation Subgroup1	Height thresholds (m)		
		Overstorey	Midstorey	Ground layer
Rainforests and Vine Thickets (MVG 1)	Temperate rainforests	>15	1–15	<1
	Tropical or sub-tropical rainforests	>20	1–20	<1
	Dry rainforests	>5	1–5	<1
	Vine thickets	>2	1–2	<1
Eucalypt Tall Open Forests (MVG 2)	Eucalyptus tall open forest with a dense broad-leaved and/or tree-fern understory (wet sclerophyll)	>20	1–20	<1
	Eucalyptus tall open forest with a fine-leaved shrubby understory OR Eucalyptus tall open forests and open forests with ferns, herbs, sedges, rushes or wet tussock grasses	>20	1–20	<1
Eucalypt Open Forests (MVG 3)	Eucalyptus open forest with a shrubby understory	>10	1–10	<1
	Eucalyptus open forest with a grassy understory	>10	1–10	<1
Eucalypt Low Open Forests (MVG 4)	-	>5	1–5	<1
Eucalypt Woodlands (MVG 5)	Eucalyptus woodlands with a shrubby understory OR Eucalyptus woodlands with a chenopod or samphire understory	>10	1–10	<1
	Eucalyptus woodlands with a grassy understory OR Eucalyptus woodlands with ferns, herbs, sedges, rushes or wet tussock grassland OR Eucalyptus woodlands with a hummock grass understory	>10	1–10	<1
Acacia Forests and Woodlands (MVG 6)	Brigalow (Acacia harpophylla) forests and woodlands	>10	1–10	<1
	Other Acacia forests and woodlands	>8	1–8	<1
	Mulga (Acacia aneura) woodlands and shrublands +/- tussock grass +/- forbs OR Mulga (Acacia aneura) woodlands and shrublands with hummock grass	>5	1–5	<1
Callitris Forests and Woodlands (MVG 7)	Callitris forests and woodland (Eastern occurrences)	>10	1–10	<1
	Callitris forests and woodlands (mallee, arid and semi-arid occurrences)	>4	1–4	<1
Casuarina Forests and Woodlands (MVG 8)	Casuarina and Allocasuarina forests and woodlands	>8	1–8	<1
	River Oak forests and woodlands	>15	1–15	<1

NVIS Major Vegetation Group	NVIS Major Vegetation Subgroup1	Height thresholds (m)		
		Overstorey	Midstorey	Ground layer
Melaleuca Forests and Woodlands (MVG 9)	Melaleuca open forests and woodlands	>8	1–8	<1
Other Forests and Woodlands (MVG 10)	Banksia woodlands OR Leptospermum forests and woodlands OR Other forests and woodlands	>10	1–10	<1
	Tropical mixed species forests and woodlands	>10	2–10	<2
Eucalypt Open Woodlands (MVG 11)	Eucalyptus open woodlands with a grassy understory OR Eucalyptus open woodlands with shrubby understory	>8	1–8	<1
	Eucalyptus low open woodlands with tussock grass OR Eucalyptus low open woodlands with hummock grass OR Eucalyptus low open woodlands with a shrubby understory OR Eucalyptus low open woodlands with a chenopod or samphire understory	>4	1–4	<1
Tropical Eucalypt Woodlands/Grasslands (MVG 12)	Tropical Eucalyptus forests and woodlands with a tall annual grassy understory	>10	2–10	<2
Acacia Open Woodlands (MVG 13)	Mulga (Acacia aneura) open woodlands and sparse shrublands +/- tussock grass OR Mulga (Acacia aneura) open woodlands and sparse shrublands with hummock grass	>2	1–2	<1
Mallee Woodlands and Shrublands (MVG 14)	Mallee with hummock grass OR Mallee with a tussock grass understory OR Mallee with a dense shrubby understory OR Mallee with an open shrubby understory	>4	1–4	<1
Low Closed Forests and Tall Closed Shrublands (MVG 15)	Low closed forests or tall closed shrublands (including Acacia, Melaleuca and Banksia)	>4	1–4	<1
Acacia Shrublands (MVG 16)	Acacia (+/- low) open woodlands and sparse shrublands with a shrubby understory OR Acacia (+/- low) open woodlands and sparse shrublands with chenopods OR Acacia (+/- low) open woodlands and sparse shrublands +/- tussock grass OR Acacia (+/- low) open woodlands and sparse shrublands with hummock grass	>2	1–2	<1
	Other Acacia tall open shrublands and shrublands	>4	1–4	<1

NVIS Major Vegetation Group	NVIS Major Vegetation Subgroup1	Height thresholds (m)		
		Overstorey	Midstorey	Ground layer
Other Shrublands (MVG 17)	Melaleuca shrublands and open shrublands OR Casuarina/Allocasuarina shrublands (C. equisetifolia, A. littoralis, A. verticillata) OR Other shrublands	>3	1–3	<1
	Lignum shrublands and wetlands	N/A	>1	<1
	Other sparse shrublands and sparse heathlands	N/A	>1	<1
Heathlands (MVG 18)	Heathlands	N/A	>1	<1
Tussock Grasslands (MVG 19)	Temperate tussock grasslands	N/A	N/A	<1
	Mitchell grass (Astrebla) tussock grasslands and Blue grass (Dichanthium) and tall bunch grass (Chrysopogon) OR Other tussock grasslands	N/A	N/A	<1
Hummock Grasslands (MVG 20)	Hummock grasslands	N/A	N/A	<1
Other Grasslands, Herblands, Sedgelands and Rushlands (MVG 21)	Sedgelands, rushes or reeds OR Wet tussock grasslands with herbs, sedges or rushes, herblands or ferns OR Other grasslands	N/A	>1	<1
	Saline or brackish sedgelands or grasslands	N/A	>0.5	<0.5
Chenopod Shrublands, Samphire Shrublands and Forblands (MVG 22)	Saltbush and/or Bluebush shrublands	N/A	>1	<1
	Mixed chenopod, samphire +/- forbs	N/A	>0.5	<0.5
Mangroves (MVG 23)	Mangroves (northern)	>5	0.5–5	<0.5
	Mangroves (southern)	>2	0.5–2	<0.5
Other Open Woodlands(MVG 31)	Callitris open woodlands OR Melaleuca open woodlands OR Other open woodlands	>4	1–4	<1
	Casuarina and Allocasuarina open woodlands with a shrubby understory OR Casuarina and Allocasuarina open woodlands with a chenopod shrub understory OR Casuarina and Allocasuarina open woodlands with a tussock grass understory OR Casuarina and Allocasuarina open woodlands with a hummock grass understory	> 4	1–4	<1

NVIS Major Vegetation Group	NVIS Major Vegetation Subgroup1	Height thresholds (m)		
		Overstorey	Midstorey	Ground layer
Mallee Open Woodlands and Sparse Mallee Shrublands (MVG 32)	Open mallee woodlands and sparse mallee shrublands with a dense shrubby understory OR Open mallee woodlands and sparse mallee shrublands with a sparse shrubby understory OR Open mallee woodlands and sparse mallee shrublands with a tussock grass understory OR Open mallee woodlands and sparse mallee shrublands with a hummock grass understory	>4	1–4	<1

[1] Adapted from NVIS Major Vegetation Subgroups version 4.1
http://www.environment.gov.au/erin/nvis/publications/major-veg-summary.html (updated from Department copy)

NVIS 4.1 Major Vegetation Groups (numeric order)

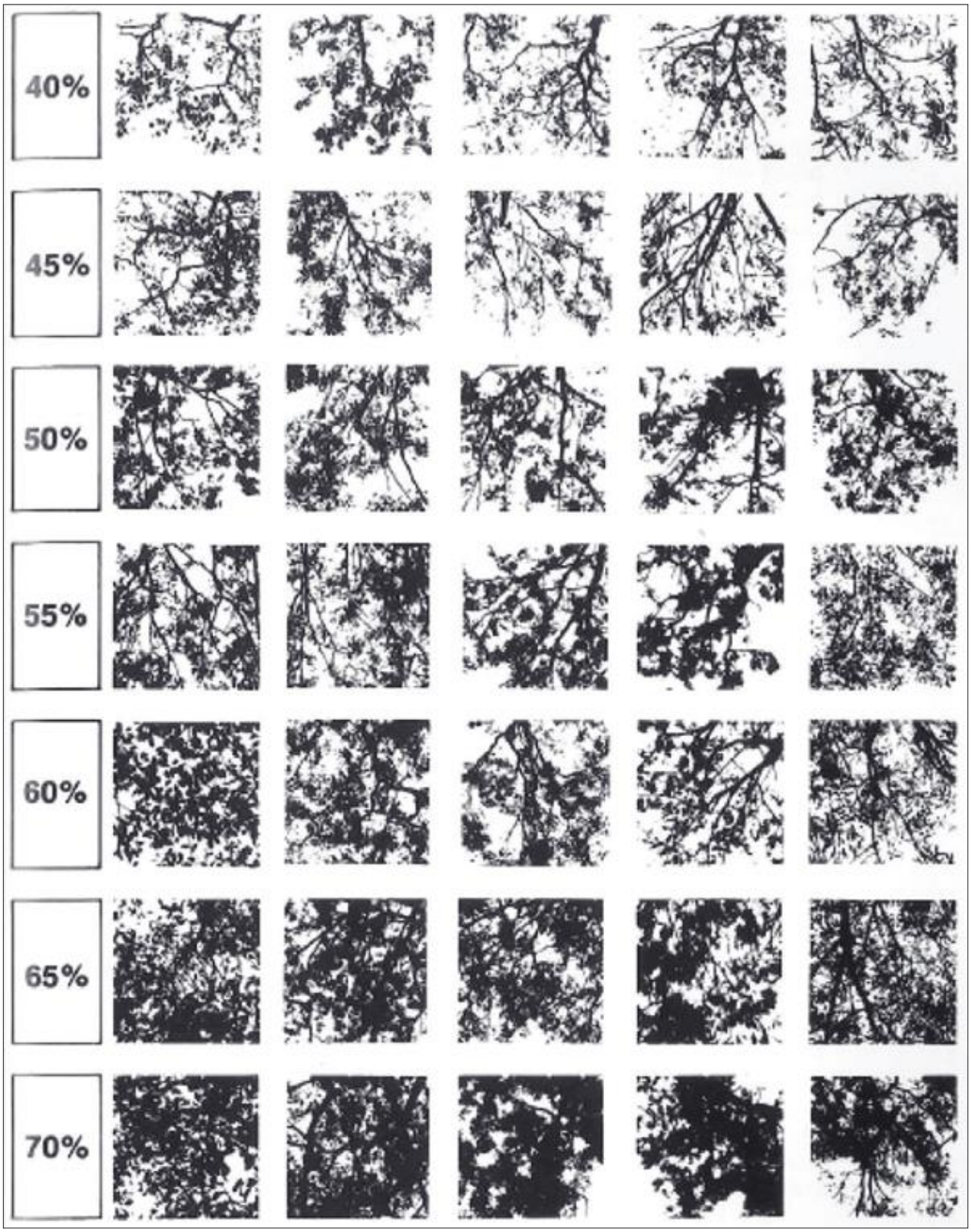
Table 2: A map showing the major vegetation groups can be found at *http://www.environment.gov.au/topics/science-and-research/databases-and-maps/national-vegetation-information-system/data-product-0 (Commonwealth of Australia 2014).*

MVG Number	MVG Name
1	Rainforests and Vine Thickets
2	Eucalypt Tall Open Forests
3	Eucalypt Open Forests
4	Eucalypt Low Open Forests
5	Eucalypt Woodlands
6	Acacia Forests and Woodlands
7	Callitris Forests and Woodlands
8	Casuarina Forests and Woodlands
9	Melaleuca Forests and Woodlands
10	Other Forests and Woodlands
11	Eucalypt Open Woodlands
12	Tropical Eucalypt Woodlands/Grasslands
13	Acacia Open Woodlands
14	Mallee Woodlands and Shrublands
15	Low Closed Forests and Tall Closed Shrublands
16	Acacia Shrublands
17	Other Shrublands
18	Heathlands
19	Tussock Grasslands
20	Hummock Grasslands
21	Other Grasslands, Herblands, Sedgelands and Rushlands

22	Chenopod Shrublands, Samphire Shrublands and Forblands
23	Mangroves
24	Inland aquatic - freshwater, salt lakes, lagoons
25	Cleared, non-native vegetation, buildings
26	Unclassified native vegetation
27	Naturally bare - sand, rock, claypan, mudflat
28	Sea and estuaries
29	Regrowth, modified native vegetation
30	Unclassified Forest
31	Other Open Woodlands
32	Mallee Open Woodlands and Sparse Mallee Shrublands
99	Unknown/no data

Appendix B—Crown type cover visual reference card

Different leaf shapes shown in separate columns arranged from large too small. Most Australian vegetation is between 40 and 70% foliage cover.



Appendix C—Keighery's description on condition of vegetation

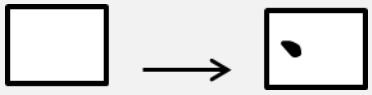
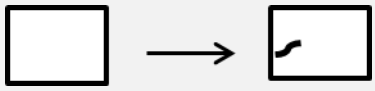
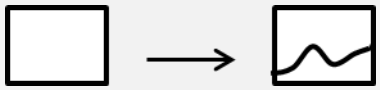
Condition	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very good	Vegetation structure altered, obvious signs of disturbance.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.
Completely degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

Keighery's description and condition of vegetation scale developed by B.J. Keighery (1994).

Appendix D— Fragmentation Type

The condition of the remnant is important to record as you will be able to identify changes over time. This may be important if you need to quantify changes for the better after fencing (protecting from domestic grazing), controlling weeds or other procedures put in place for which funding is provided. Another measure to be considered is the degree of fragmentation. The following six spatial patterns illustrated below can occur both consecutively and simultaneously (Bogaert J, et al., 2004; Forman, R., 1995).

Phases of fragmentation – habitat division and reduction

6 Fragmentation Phases (White areas are remnant vegetation)		
1. Perforation		First stages of landscape transformation, such as perforation of natural habitat through direct loss, often resulting from changes to other land uses (e.g., agricultural clearing, housing development).
2. Incision		Areas or patches where incomplete dissection occurs.
3. Dissection		Subdivision or sectioning through of patch (usually with consistent line widths). May occur by the introduction of roads or other transportation corridors through the landscape.
4. Dissipation		Dissipatpion of patches is a combination of Dissection and Shrinkage, reflecting the transitional stage between the two.
5. Shrinkage		Maintaining some original shape of the initial land cover patch but a progressive reduction in size of patches (without Attrition).
6. Attrition		Reduction or shrinkage and in some cases, complete disappearance of the number of patches of habitat.

Appendix E—Field sheets

Site Details

Please ensure you have the PHCC Ecological Monitoring Guide on site when carrying out survey monitoring.

Desktop (can be completed before site visit)	
Project ID/Site No:	Date:
Landholder/Manager:	Recorder:
Location/Address: (Place aerial map overleaf)	
Land use: (circle) commercial, conservation, cropping, industrial, livestock, recreational, residential, rural	
Site assessment purpose/objective: (biodiversity, flora survey, seedling survey, veg condition, weed mapping, other)	
Site assessment type: (control or intervention)	Site assessment stage: (initial, follow up 1st, follow up 2nd,…., final)

GPS Site Coordinates: (corners of project site)		
GPS Point 1:	Northing (lat): 6390129.59	Eastings (long): 390069.40
GPS Point 2:	Northing (lat):	Eastings (long):
GPS Point 3:	Northing (lat):	Eastings (long):
GPS Point 4:	Northing (lat):	Eastings (long):

Connectivity - neighbouring remnant/s: (land use can be multiple)	
Neighbour Land use: (circle) commercial, conservation, cropping, industrial, livestock, recreational, residential, rural	
Nearest neighbor 1 (m): _____(N S E W)	Nearest neighbor 3 (m): _____(N S E W)
Nearest neighbor 2 (m): _____(N S E W)	Nearest neighbor 4 (m): _____(N S E W)
Fragmentation phase: (circle) perforation, incision, dissection, dissipation, shrinkage, attrition (Refer Appendix D)	
Vegetation group: (Refer to Appendix A)	Vegetation sub-group:

Field Sheet (to be completed on site)	
Recorder:	Date:
Landform: (circle): plain, valley, hillside, hilltop, ridge, lake, river, stream, wetland (permanent or seasonal), bank, sand dune, other _____	
Slope: (circle) flat, gentle, moderate, steep	Slope position: (circle) upper, middle, lower
Keighery vegetation description condition: (circle) pristine, excellent, very good, good, degraded, completely degraded (Refer to Appendix C)	
Vegetation disturbance type: insect, rabbit, goat, domestic grazing, fungal, drought, waterlogging, salinity, flooding, mechanical, spray drift, weeds, timber removal, other _____ Type: _____ Extent: _____ Type: _____ Extent (%): _____ Type: _____ Extent: _____ Type: _____ Extent (%): _____	

Photo Id and Coordinates: (Transfer information to photo id sheets)		Compass Bearing: (along transect line at start point)
Start:	GPS Northing:	GPS Easting:
10m:	GPS Northing:	GPS Easting:
20m:	GPS Northing:	GPS Easting:
30m:	GPS Northing:	GPS Easting:
40m:	GPS Northing:	GPS Easting:

Site Map (Aerial)

Show details such as fragmentation, connectivity, gps coordinates and location of activities.

Field Sheet 1: Evidence of native and exotic fauna

Walking along transect 1m away from tape, record any evidence of fauna (native and exotic). See page 10 of the PHCC Ecological Monitoring Guide for more information.

Native Fauna		
Point (m)	**Evidence**	**Comment**
1.3	Hole	Same hole recorded as last time
7.6	Scats	Removed scats from transect

Please turn over if you require more space.

Exotic Fauna		
Point (m)	**Evidence**	**Comment**
1.3	Hole	Same hole recorded as last time
7.6	Scats	Removed scats from transect

Native Fauna		
Point (m)	Evidence	Comment
1.3	Hole	Same hole recorded as last time
7.6	Scats	Removed scats from transect

Exotic Fauna		
Point (m)	Evidence	Comment
1.3	Hole	Same hole recorded as last time
7.6	Scats	Removed scats from transect

Field Sheet 2: Ground cover

Record and mark the numbers of any native or exotic plants between 0m-1m in height that the staff touches. See page 10 of the R2R Ecological Monitoring Guide for more information.

Point (m)	Na	Ex	Cr	OL	BG	Ro	W	Species common name	Species scientific name (if known)
e.g.	*1*	*1*	*2*					*Fringe lily; Paterson's curse*; Fern, Fungi.*	*Thysanotus dichotumus; Echium plantagineum**
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									
11.									
12.									
13.									
14.									
15.									
16.									
17.									
18.									
19.									
20.									
21.									
22.									
23.									
24.									
25.									

Na=native plant; Ex=exotic plant; OL=organic litter; Cr=cryptogram (ferns, mosses, fungi); BG=bare ground; Ro=rock; W = water. *Mark exotics with an asterisk **.

Record and mark the numbers of any native or exotic plants between 0m-1m in height that the staff touches. See page 10 of the R2R Ecological Monitoring Guide for more information.

Point (m)	Na	Ex	Cr	OL	BG	Ro	W	Species common name	Species scientific name (if known)
e.g.	*1*	*1*	*2*					*Fringe lily; Paterson's curse*; Fern, Fungi.*	*Thysanotus dichotumus; Echium plantagineum**
26.									
27.									
28.									
29.									
30.									
31.									
32.									
33.									
34.									
35.									
36.									
37.									
38.									
39.									
40.									
41.									
42.									
43.									
44.									
45.									
46.									
47.									
48.									
49.									
50.									

Na=native plant; Ex=exotic plant; OL=organic litter; Cr=cryptogram (ferns, mosses, fungi); BG=bare ground; Ro=rock; W = water. *Mark exotics with an asterisk **.

Field Sheet 3: Overstorey and midstorey projected crown cover

Only complete this part if the vegetation type has a distinctive canopy and/or Midstorey. Include all native including naturalised species (native vegetation occurring outside of normal range), along transect that achieve a minimum height threshold for your vegetation (Refer Appendix A). Native and exotics should be recorded separately. See page 11 of the R2R Ecological Monitoring Guide for more information.

Native Transect (projected crown cover %)

Native overstorey	Native midstorey
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Total (m) ___	Total (m) ___
Total Width ___m / 50m = ___ x 100 = ____ % overstorey	Total Width ___m / 50m = ___ x 100 = ____ % overstorey

Exotic Transect (projected crown cover %)

Exotic overstorey	Exotic midstorey
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Start (m)_____ End (m) _____ Width (m) _____	Start (m)_____ End (m) _____ Width (m) _____
Total (m) ___	Total (m) ___
Total Width ___m / 50m = ___ x 100 = ____ % overstorey	Total Width ___m / 50m = ___ x 100 = ____ % overstorey

Sketch of projected crown cover along the 50m transect (optional)

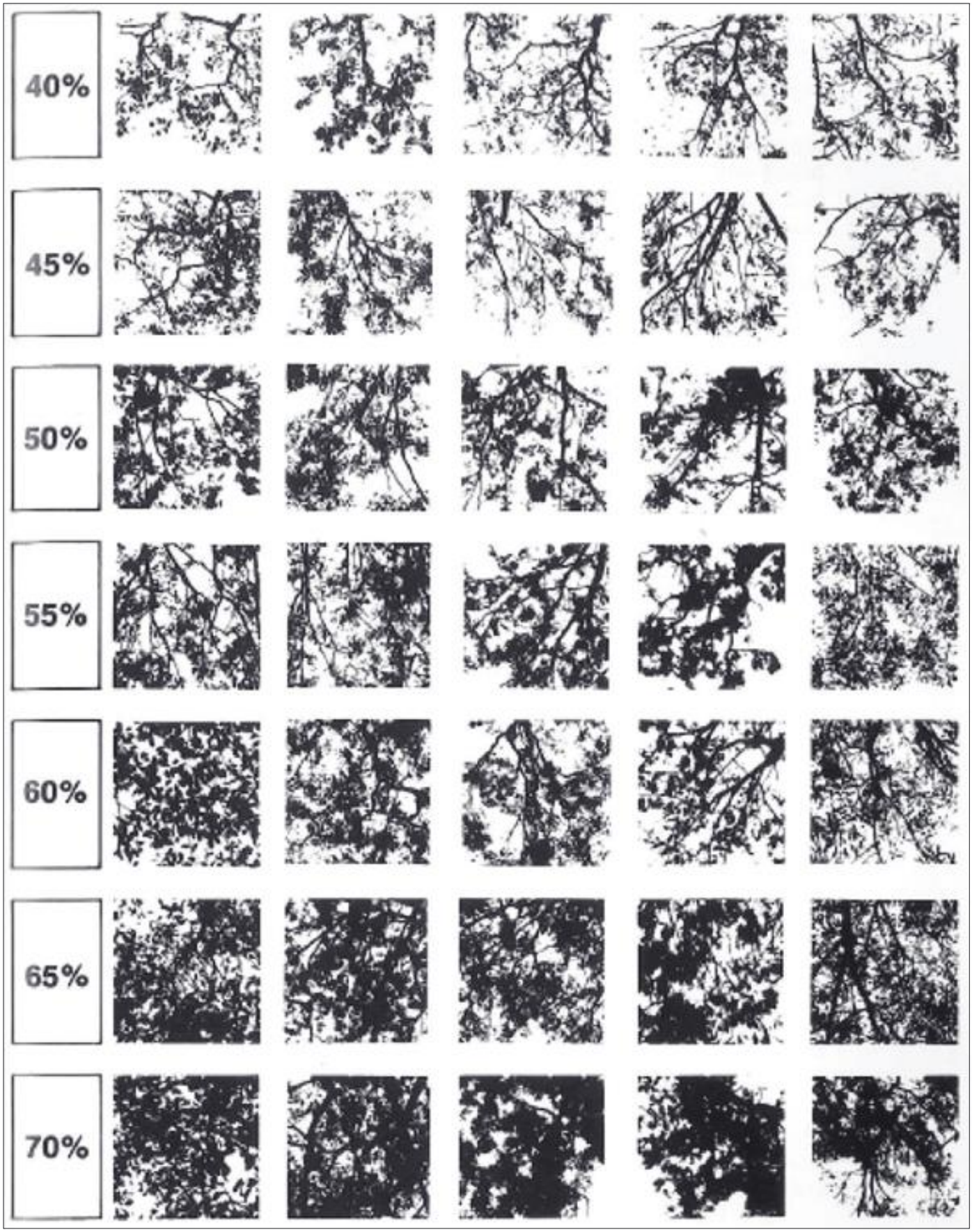
Field Sheet 4: Crown type

Locate up to 10 points along transect (at least 3m apart) at which the native overstorey canopy is directly overhead, (ensure that no clear sky can be seen around the edge of the canopy when viewing through a sighting tube). See page 12 of the R2R Ecological Monitoring Guide for more information.

Native CT	Distance along transect (m)	CT (%)
Tree canopy 1		
Tree canopy 2		
Tree canopy 3		
Tree canopy 4		
Tree canopy 5		
Tree canopy 6		
Tree canopy 7		
Tree canopy 8		
Tree canopy 9		
Tree canopy 10		

Repeat as above for exotics.

Exotic CT	Distance along transect (m)	CT (%)
Tree canopy 1		
Tree canopy 2		
Tree canopy 3		
Tree canopy 4		
Tree canopy 5		
Tree canopy 6		
Tree canopy 7		
Tree canopy 8		
Tree canopy 9		
Tree canopy 10		


40%
45%
50%
55%
60%
65%
70%

Field Sheet 5: Native and exotic plant species diversity

Walk the plot from side to side, ensuring to cover the whole area. Record all native and exotic species encountered (only record each species identified once). See page 12 of the R2R Ecological Monitoring Guide for more information.

No.	Native species common name	Native species scientific name
Native sp.1		
Native sp.2		
Native sp.3		
Native sp.4		
Native sp.5		
Native sp.6		
Native sp.7		
Native sp.8		
Native sp.9		
Native sp.10		
Native sp.11		
Native sp.12		

No.	Exotic species common name*	Exotic species scientific name*
Native sp.1		
Native sp.2		
Native sp.3		
Native sp.4		
Native sp.5		
Native sp.6		
Native sp.7		
Native sp.8		
Native sp.9		
Native sp.10		
Native sp.11		
Native sp.12		

Walk the plot from side to side, ensuring to cover the whole area. Record all native and exotic species encountered (only record each species identified once). See page 12 of the R2R Ecological Monitoring Guide for more information.

No.	Native species common name	Native species scientific name
Native sp.1		
Native sp.2		
Native sp.3		
Native sp.4		
Native sp.5		
Native sp.6		
Native sp.7		
Native sp.8		
Native sp.9		
Native sp.10		
Native sp.11		
Native sp.12		

No.	Exotic species common name*	Exotic species scientific name*
Native sp.1		
Native sp.2		
Native sp.3		
Native sp.4		
Native sp.5		
Native sp.6		
Native sp.7		
Native sp.8		
Native sp.9		
Native sp.10		
Native sp.11		
Native sp.12		

Photo monitoring

It is not necessary to take the following out on site. You can record details on Sheet 1 and transfer to the photo monitoring sheets when you insert photos.

Photo Id sheets

Date:	Recorder:	Project ID: *Rivers 2 Ramsar Site 1 Transect Site 1: Buchanan's Drain, Mead Way Pinjarra*
Site Description: *Shire of Murray Reserve, Revegetation site, bare ground (burnt and graded May 2014)*		
Observation: *Transect (50m), Plot 10m x 10m installed*		
Measurable objective: *Biodiversity changes over time*		
Compass bearing: *SW*	Projection: *UTM50*	Datum: *GDA94*
GPS Start Point:	Northing (lat): *6390129.59*	Eastings (long): *390069.40*
GPS End Point:	Northing (lat): *6390108.45*	Eastings (long): *390032.29*
Camera:	Camera description: *Panasonic DMC TZ40*	Camera zoom: *No zoom*
Shapefile ID, Location: *8000 R2R GIS\Site 1\Stage 3_Buchanans Drain_GIS\Mead Way_Reveg_Stage3*		
Photo Location: *\8000 R2R Photos\2014 8000 R2R 20140718 MeadWay_BuchanansDrain\P1000945*		
Comments:		

Photo	Photo point - start point Northing (lat): _____ Eastings (long): _____ Photo ID No.: _____ Description: _____

Photo	Photo point – 20m Northing (lat): _____ Eastings (long): _____ Photo ID No.: _____ Description: _____

Photo	Photo point – 30m Northing (lat): _____ Eastings (long): _____ Photo ID No.: _____ Description: _____

Photo	Photo point – 40m Northing (lat): _____ Eastings (long): _____ Photo ID No.: _____ Description: _____

Notes