Operational Manual for *BioMetric 3.1*

A tool for assessing clearing and ecological thinning proposals on terrestrial biodiversity under the *Native Vegetation Act 2003.*

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Operational Manual for *BioMetric* 3.1.

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Approval Record

Name	Version approved	Position	Date
Lucian McElwain	v3.1clearing	Manager, Conservation Programs and Partnerships	21 Feb 2011

Summary

This manual is a guide for using *BioMetric* for assessing clearing proposals, including ecological thinning. *BioMetric* is a tool used to assess the impacts on terrestrial biodiversity of clearing remnant native vegetation and protected regrowth under the NSW *Native Vegetation Act 2003* (NV Act). Together with the Threatened Species Tool, *BioMetric* provides the software tool to support Chapter 5 of the Environmental Outcomes Assessment Methodology (EOAM).

BioMetric is a module in the Native Vegetation Assessment Tool (NVAT) package. *BioMetric* is used in conjunction with a GIS mapping tool, and tools that assess effects of clearing remnant native vegetation and protected regrowth on threatened species, land and soil, salinity, and water quality, in accordance with the EOAM. Invasive native scrub is assessed in a separate tool. The information from these assessments is stored in PADACS (PVPs, Agreements, Data and Customer Service). Depending upon the outcome of the assessment, a Property Vegetation Plan (PVP) may be developed using the information from the assessment using *BioMetric* and stored in PADACS.

Proposals to clear remnant native vegetation and protected regrowth

Clearing of remnant native vegetation and native vegetation that is protected regrowth is permitted under the NV Act if it improves or maintains environmental outcomes.

Vegetation that is overcleared or listed as an endangered or critically endangered ecological community (or vulnerable under Commonwealth legislation) cannot be cleared if the vegetation is not in low condition, unless minor variation or more appropriate local data provisions show that clearing of such vegetation will improve or maintain environmental outcomes.

Remnant native vegetation and protected regrowth can only be cleared if losses from the proposed clearing are offset by long-term gains from management. In *BioMetric*, offsets can only improve or maintain environmental outcomes in the following circumstances:

1. i) for vegetation types that are >70% cleared, offsets are in vegetation types of equal or greater Regional Value (the conservation status of the vegetation type) to the vegetation proposed for clearing; or

   ii) for vegetation types that are ≤70% cleared, offsets are in vegetation types of equal or greater Regional Value to the vegetation types proposed for clearing or have a percent cleared estimate of up to 10% less than the vegetation proposed for clearing; and
2. improvement in Landscape Value (the configuration of vegetation) from the offset equal or exceed the losses in Landscape Value from the proposed clearing; and
3. improvement in Site Value (the quality and quantity of vegetation) from the offset equal or exceed the losses in Site Value from the proposed clearing.

Contents

1 Introduction

This Manual is a guide for assessing proposals to clear remnant native vegetation and protected regrowth, including ecological thinning, using the *BioMetric* tool. Together with the Threatened Species Tool, *BioMetric* provides the decision rules in Chapter 5 of the Environmental Outcomes Assessment Methodology (EOAM) in a software form. *BioMetric* is used in conjunction with: a GIS mapping tool (NVAT Mapper), and tools that assess effects of clearing remnant native vegetation and protected regrowth on threatened species, land and soil, salinity, and water quality. Invasive native scrub is assessed in a separate tool.

BioMetric assesses losses of biodiversity from proposed clearing (including thinning) and gains in biodiversity from proposed offsets. *BioMetric* is a tool for assessing terrestrial biodiversity at the scale of the patch, paddock or property - it is not a broader-scale planning tool. Gibbons et al. (2009) provide background to *BioMetric*.

Neither *BioMetric* nor this manual deals with assessments of threatened species, invasive native scrub, water quality, soils or salinity. *BioMetric* does not deal with private native forestry, clearing for routine agricultural management activities, continuation of existing farming activities, or clearing of regrowth.

1.1 The NSW Native Vegetation Act 2003

Property Vegetation Plans (PVPs) are developed under the NV Act. The objects of the NV Act are:

a) to provide for, encourage and promote the management of native vegetation on a regional basis in the social, economic and environmental interests of the State, and

b) to prevent broadscale clearing unless it improves or maintains environmental outcomes, and

c) to protect native vegetation of high conservation value having regard to its contribution to such matters as water quality, biodiversity, or the prevention of salinity or land degradation, and

d) to improve the condition of existing native vegetation, particularly where it has high conservation value, and

e) to encourage the revegetation of land, and the rehabilitation of land, with appropriate native vegetation, in accordance with the principles of ecologically sustainable development.

Under the NV Act, PVPs may be submitted by landholders for native vegetation management. Among other things, PVPs may provide for:

a) proposals for clearing native vegetation on the land, and

b) proposals to enable landholders to obtain financial incentives for managing natural resources, including funding native vegetation management activities by Catchment Management Authorities (CMAs).

1.2 Proposals for clearing native vegetation

Proposals for clearing (including ecological thinning) remnant native vegetation and protected regrowth generally fall into one of the following categories:

- 'green light' category - actions that improve or maintain environmental outcomes in their own right and can be undertaken without offsets (thinning native

vegetation to benchmark stem densities for the vegetation type falls within this category)

- 'amber light' category - actions that usually require offsets to improve or maintain environmental outcomes (offsets that provide gains equal to, or exceeding, losses from clearing subsequently fall into the 'green' category)
- 'red light' category - actions that cannot be undertaken as they do not improve or maintain environmental outcomes (clearing native vegetation that is not in low condition and of a type, or within a landscape, that is highly cleared, generally falls into this category as do offsets that do not provide gains equal to, or exceeding, losses from clearing).

A flow chart outlining the framework for assessing proposals to clear remnant native vegetation and protected regrowth under Chapter 5 of the EOAM, using *BioMetric* is in Figure 1.

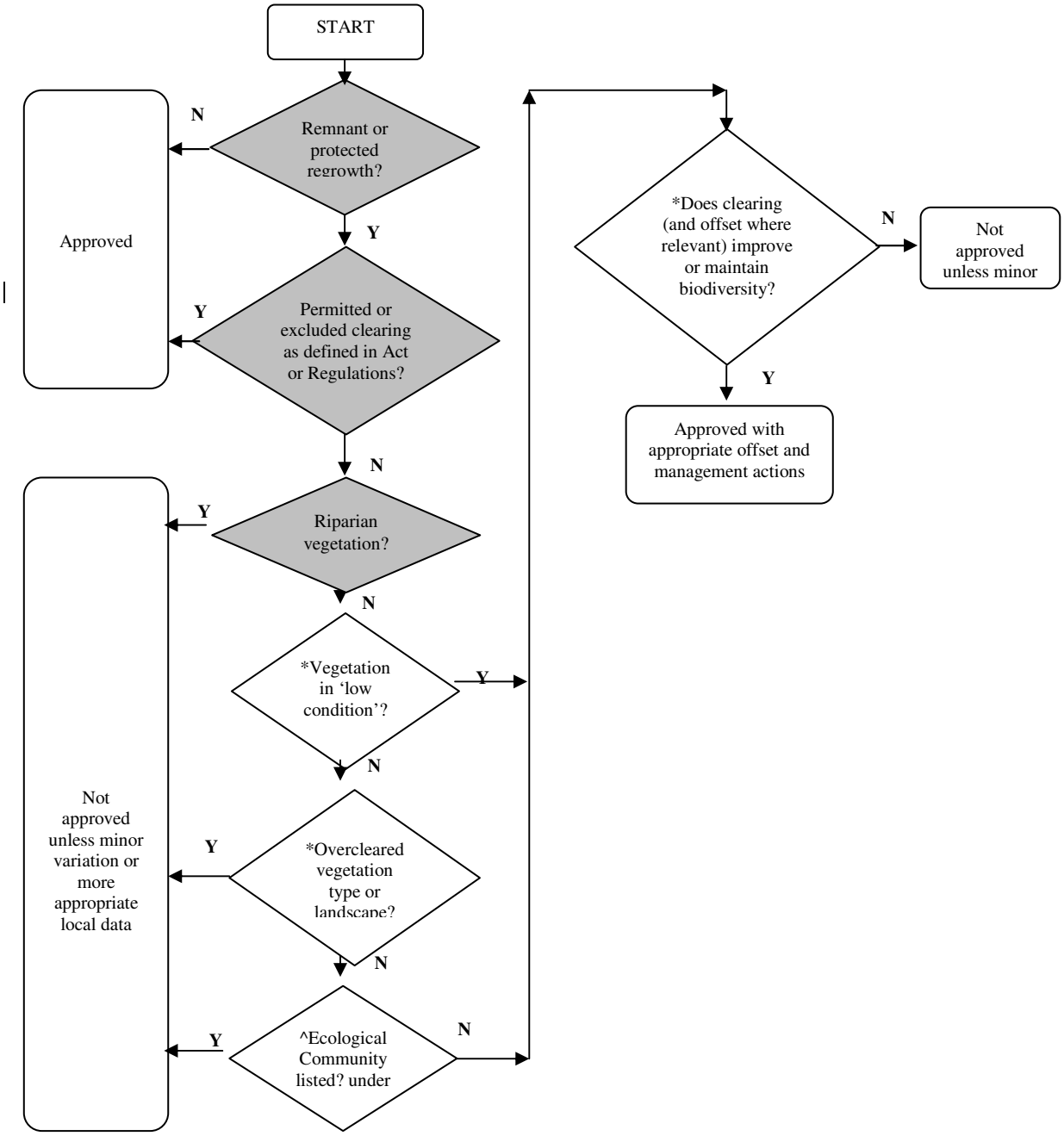


Figure 1. Flow chart of the assessment process for clearing in a PVP. Unshaded steps in the flowchart are in *BioMetric*. Steps shaded grey are not assessed using *BioMetric*. Note that threatened species, water quality, soils, salinity and invasive native scrub are assessed using other tools. All decision points are subject to minor variation except variations to riparian buffer distances (riparian areas). *indicates main assessment points subject to Minor Variation provisions. ^Critically endangered and endangered ecological communities under NSW *Threatened Species Conservation Act 1995* and critically endangered, endangered and vulnerable ecological communities under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

2 The assessment process

This section outlines the process for assessing proposals to clear or thin native vegetation using *BioMetric*.

2.1 Resources required to complete an assessment

The following resources are required to complete an assessment using *BioMetric*:

- hard copy of this *BioMetric* Operational Manual
- computer loaded with the latest NVAT software
- orthorectified digital imagery for the property extending a distance of at least 1.79km (1000ha) from the property boundary
- a digital layer of any vegetation mapping in the study area is desirable
- hard copy printout of imagery for the proposal that can be annotated
- hard copy data entry sheets (templates available in Appendix 9 and on the Native Vegetation Community of Practice). Alternatively – PDA or palmtop computer with data sheet templates loaded
- printed copy of relevant vegetation types and definitions for the CMA from *BioMetric* (i.e. there are descriptions of each vegetation type in the CMA in *BioMetric* that can be formatted as required). These are available at www.environment.nsw.gov.au/projects/BiometricTool.htm
- definitions of potential Ecological Communities (ECs) that may occur on the site listed under the *Threatened Species Conservation Act* (http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/home_species.aspx), and *Environmental Protection and Biodiversity Conservation Act* (http://www.deh.gov.au/cgi-bin/sprat/public/publiclookupcommunities.pl)
- relevant benchmarks for vegetation condition from http://www.environment.nsw.gov.au/projects/BiometricTool.htm or from reference sites
- Global Positioning System (GPS) receiver
- 2 x 50m measuring tapes and tent/surveyors pegs to secure tape ends
- small measuring tape/diameter tape
- clipboard and pencils
- digital camera (not essential)
- plant identification books if required (native and weeds)
- portable printer to leave preliminary copies of PVP with landholder, if feasible.

2.2 Prior to the site inspection

Background work done prior to the site inspection will reduce the amount of time spent at the site. An initial visit to the site prior to the inspection proper may be desirable. *BioMetric* can be used to do a desk-top simulation of proposals to obtain indicative results; however, all assessments must be ultimately validated with field data. The suggested actions prior to the site inspection are as follows:

1. Refer to both the *BioMetric* website and Native Vegetation Community of Practice for the most recent versions of supporting documentation and data:

(http://www.environment.nsw.gov.au/projects/BiometricTool.htm).

2. At first contact with the landholder obtain as much information about the clearing proposal as possible (i.e. boundaries and areas of clearing proposal and proposed offsets if relevant, vegetation types and general condition of vegetation in clearing and offset areas, and proposed nature of clearing). Discuss likely offset requirements with the landholder. This is likely to require an initial visit to the site.
3. Use the NVAT Mapper to approximately place the proposal area in the Mitchell Landscape layer and any available vegetation maps to determine whether the clearing proposal is likely to be in an over-cleared landscape or over-cleared vegetation type. Vegetation maps are usually too coarse for reliably showing vegetation types at the scale of the patch or paddock, so the actual vegetation types must be confirmed during a site visit. However, vegetation maps may indicate vegetation types likely to be at the site.
4. Undertake as much of the assessment as possible in the office using the NVAT Mapper and *BioMetric* and available data prior to the site inspection.
5. If sufficient information has been provided to indicate that the clearing proposal will be unsuccessful as it stands, then consider discussing with the landholder prior to the site inspection.
6. Print a hard copy of the orthorectified image with property boundary, riparian areas, proposal area (if known) and Mitchell Landscape boundaries marked on it. Annotate each Mitchell Landscape with its percent cleared estimate (obtained from Step 1 in *BioMetric*). Consider printing the 0.55km and 1.79km radii circles on a transparency at the same scale as the image/photo for overlaying in the field.
7. Print hard copies of all data sheets for completion in the field.
8. Print a copy of the relevant vegetation type definitions from *BioMetric*.
9. If data have been entered into *BioMetric*, save a copy of the preliminary assessment on a laptop in the NVAT and take it to the site inspection.

2.3 The site inspection

A suggested order of assessment using *BioMetric* is in this section (the actual order of assessment is at the discretion of the site assessor, and depends on information gleaned prior to the site inspection, availability of facilities to use a laptop computer and the complexity of the assessment). The process below assumes that data are initially entered in field sheets printed from *BioMetric* and a computer is not used until the end of the assessment (i.e. either at the property or back at the assessor's office). However, data can be entered into the tool at any stage through the assessment if conditions allow.

2.3.1 Proposals to clear native vegetation

The steps for assessing proposals to clear native vegetation (remnant native vegetation or protected regrowth) in the field are:

1. Outline the process with the landholder or proponent.
2. Map the clearing and offset proposal areas on the hard copy aerial photo or satellite image with the landholder.

3. Walk and/or drive around the clearing and offset proposal areas, identify and map the vegetation zones on the hard copy aerial photo or satellite image (see Appendix 1 for how to define and map vegetation zones).
4. Collect and assess required information for the proposed clearing and offset areas from field survey and imagery and record in the relevant field data sheet (see Section 3.2.1).
5. If the application is a 'red light' then discuss options with the landholder and relevant CMA and DECCW staff (e.g. modifying the proposal, using minor variation or more appropriate local data).
6. If the proposal is not a 'red light' then record the plot/transect data for each zone in the relevant field data sheet.
7. If facilities for using a laptop computer are available, transpose data from the data sheets into *BioMetric* at the property and discuss the offset requirements.
8. If facilities for using a laptop computer are not available then discuss the likely offset requirements with the landholder and undertake the assessment in *BioMetric* on the offset site(s) using the relevant data sheets. This process is similar to steps 2-5 (above) for the clearing assessment. If it is determined in the field that the offset is inadequate then this should be discussed with the landholder. Necessary data for the PVP should then be entered in the laptop to verify the results.
9. If all information has been collected on the site, and indoor facilities are available, complete the management actions for *BioMetric*, and print a draft PVP on site. The advantage of running *BioMetric* at the site is that modifications to the proposed clearing and offsets can be discussed and tested on site without a further site visit.
10. If the assessment cannot be completed on site then complete the above step in the CMA office. Discuss the results with the landholder via telephone or arrange another meeting. If the proposal is unsuccessful discuss options.
11. Obtain the appropriate clearance for the assessment, including any minor variation reports, etc., before finalising the PVP.

2.3.2 Proposals to thin native vegetation

The steps for assessing proposals to thin native vegetation in the field are:

1. Outline the process with the landholder or proponent.
2. Map the proposed thinning area(s) on the hard copy aerial photo or satellite image with the landholder.
3. Walk and/or drive around the proposed thinning area, identify and map the vegetation zones on the hard copy aerial photo or satellite image (see Appendix 1 for zone definitions and mapping information).
4. Collect required field information for each zone and record in the relevant field data sheets.
5. If there are indoor facilities available, then enter relevant data on benchmark stem densities for the vegetation type(s) on the *BioMetric* website (http://www.environment.nsw.gov.au/projects/BiometricTool.htm), or collected by the assessor on reference sites. If the landholder wishes to thin below benchmark stem density then the assessment cannot continue as an ecological thinning proposal, but could be considered for a clearing proposal or as an

invasive native scrub proposal under certain circumstances (see Chapter 7 of the EOAM).

6. Print a draft PVP on site if the proposal can proceed, and if feasible to do so. The advantage of running *BioMetric* at the site is that any modifications to the proposal can be discussed and tested on site without a further site visit.
7. If the assessment cannot be completed on site then complete the above two steps in the CMA office. Discuss the results with the landholder via telephone or arrange another meeting.
8. Obtain the appropriate clearance for the assessment before finalising the PVP.

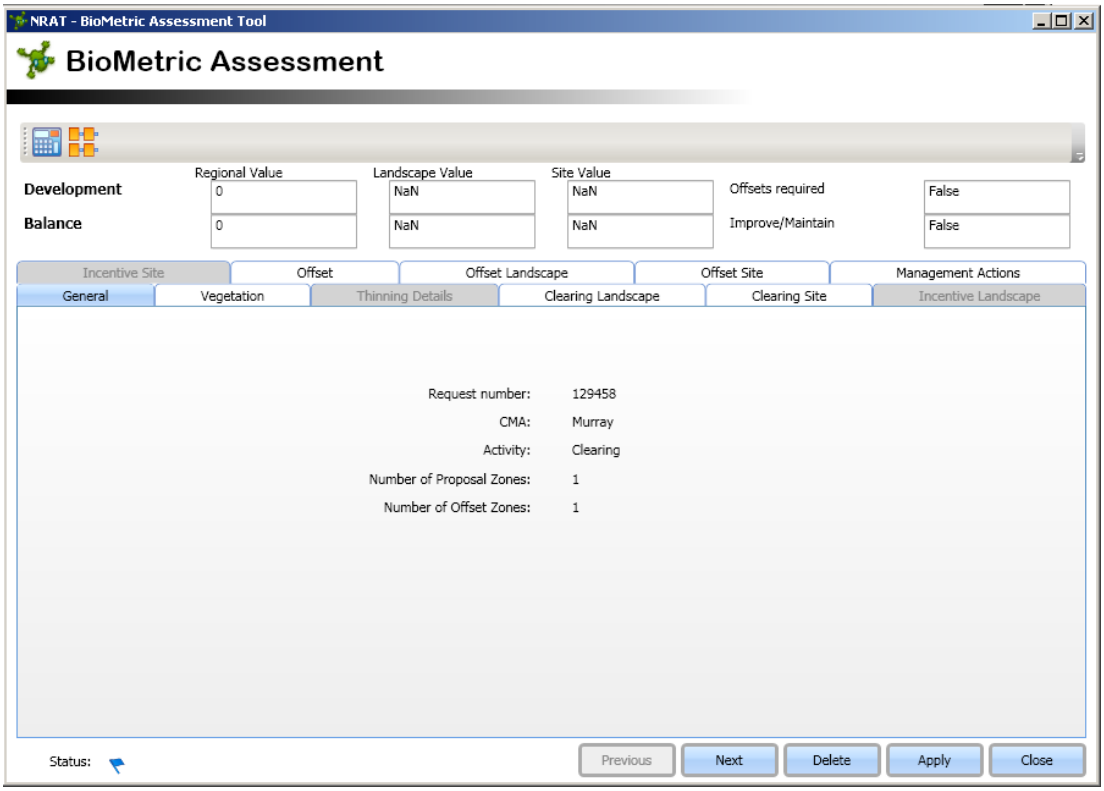
3 Proposals to clear native vegetation - running *BioMetric*

The following section describes how to work through the tabs in *BioMetric* for proposals to clear remnant native vegetation or protected regrowth (usually requires offsets).

For information on mapping clearing and offset areas consult the NVAT Mapper User Guide.

3.1 General tab

The General tab is the first screen the user sees when the tool is first opened.



As no data have been entered, some of the summary scores contain 'NaN'. This stands for 'Not a Number'. If you see this in the summary pane at the top of the screen during the assessment, you have not entered sufficient data to complete the assessment calculations.

3.1.1 Request number

The request number is automatically populated. It is generated in the PADACS system when the request is first created.

3.1.2 CMA

The CMA in which the clearing proposal occurs is automatically populated from the NVAT Mapper. All subsequent data for the assessment in *BioMetric* is linked to this CMA.

3.1.3 Activity

The activity is automatically populated based on the activity set in the NVAT Mapper. The following activities initiate the *BioMetric* tool:

- Clearing/Offsets
- Thinning

The subsequent steps in *BioMetric* vary with the type of activity that is set. *BioMetric* is run separately for different activity types.

3.1.4 Number of Proposal Zones

The number of proposal zones displays the number of clearing zones (called "proposal zones" in the tool) in the assessment. Check that the number of proposal zones (i.e., clearing zones) is correct before proceeding with the assessment.

If the number of clearing zones is incorrect, consult the NVAT Mapper User Guide to ensure that the appropriate number of clearing zones has been selected.

Refer to Appendix 1 for zone definitions and mapping information.

3.1.5 Number of Offset Zones

The number of offset zones displays the number of offset zones that are associated with the clearing zones in the assessment. The number of offset zones is only displayed for assessments to clear remnant native vegetation or protected regrowth, which are not ecological thinning. Check that the number of offset zones is correct before proceeding with the assessment.

If the number of offset zones is incorrect, consult the NVAT Mapper User Guide to ensure that the appropriate number of offset zones has been selected.

Refer to Appendix 1 for zone definitions and mapping information.

3.1.6 Status

The status of the assessment provides a summary of progress of the assessment. There are three status types:

 - Indicates that the assessment is yet to be finalised.

 - Indicates that the assessment has failed.

 - Indicates that the assessment has passed.

3.1.7 'Previous' button

The 'Previous' button allows the user to return to the previous tab. Tabs that are not required for the assessment type cannot be selected.

3.1.8 'Next' button

The 'Next' button allows the users to move to the next tab in the assessment. Tabs that are not required for the assessment type cannot be selected.

3.1.9 'Delete' button

The 'Delete' button deletes the current assessment. The user has to re-launch the tool from the NVAT Mapper if an assessment has been deleted, and all data have to be re-entered.

3.1.10 'Apply' button

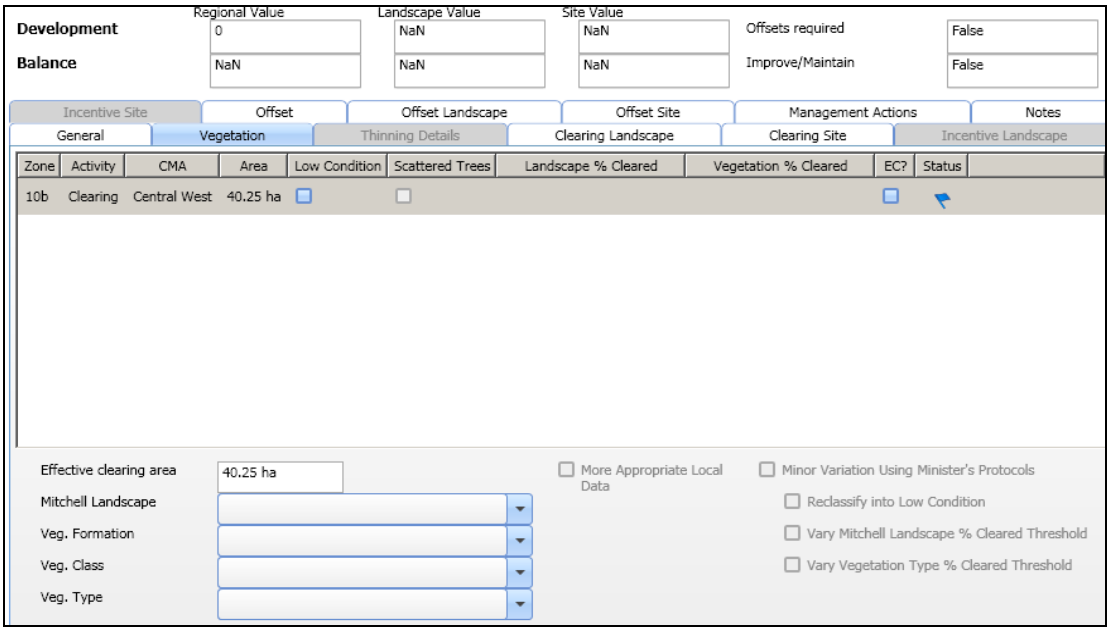
The 'Apply' button saves the current assessment data.

3.1.11 'Close' button

The 'Close' button closes *BioMetric*.

3.2 Vegetation tab

The first step in assessing clearing zones is to enter data on the 'Vegetation' tab.



This step identifies clearing zones that can proceed, and those that cannot proceed without minor variation or more appropriate local data. Remnant native vegetation and protected regrowth cannot be cleared if it:

1. i) occurs in an over-cleared landscape (i.e. >70% of native vegetation in the Mitchell landscape has been cleared), or

   ii) is an over-cleared vegetation type (i.e. >70% of that vegetation type in the CMA has been cleared), or

   iii) is an ecological community listed as 'critically endangered' or 'endangered' under the *Threatened Species Conservation Act 1995* (NSW) or listed as 'critically endangered', 'endangered', or 'vulnerable' under the *Environment Protection and Biodiversity Conservation Act 1999*; and

2. is NOT in low condition

unless minor variation or more appropriate local data are used (see below).

Vegetation that is in low condition, or vegetation that is not in low condition **and** does not meet any of criteria 1 above can be assessed further for clearing.

Minor variation and more appropriate local data can be used in assessing clearing applications. All aspects of the *BioMetric* component of Chapter 5 of the EOAM can be varied except riparian buffer distances (riparian areas) or associated offset requirements.

More appropriate local data can be used to vary data in any of the databases in *BioMetric*, namely to:

- vary data within the overcleared vegetation types database (e.g. percent cleared value)
- vary data within the overcleared landscapes database (e.g. the percent cleared value for Mitchell Landscape/s)
- vary data in the vegetation benchmarks database

Special requirements for minor variation exist around points 1 i) and ii) and 2 above, as per Box 1:

Box 1. Provisions when varying low condition and percent cleared thresholds.

The relevant Minister's Protocol must be followed when varying low condition and percent cleared thresholds. Other types of minor variation do **not** currently have Ministers Protocols.

The relevant Minister's Protocol (February 2008) must be followed if, and only if, the EOAM is varied in the following manner:

- vary the percent cleared *threshold* for vegetation type/s and/or Mitchell Landscape/s so as to alter an assessment outcome of "overcleared" to "not overcleared"
- vary the regional value, i.e., the percent cleared of a vegetation type in the CMA
- vary the classification of condition of vegetation from "not of low condition" to "low condition".

These changes trigger Clause 27 of the NV Regulation 2005 and must be accompanied by an accredited expert's report.

The Minister's Protocols are available on the EOAM page on the DECCW website: http://www.environment.nsw.gov.au/vegetation/eoam.htm

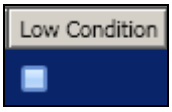
3.2.1 Zone, Activity, CMA and Area

The information on zone activity, CMA and area of zone is automatically populated from the NVAT Mapper. Check that the zones you are assessing are the correct zones. The tool accepts an unlimited number of vegetation zones. Refer to Appendix 1 for guidelines on how to map vegetation zones.

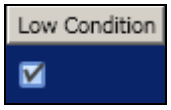
3.2.2 Low condition

If the vegetation in the clearing zone meets the definition of "low condition" then the assessment progresses to the next step regardless of whether the landscape and/or vegetation type are overcleared (>70%).

If the vegetation is not in low condition, then the tick box is left blank as follows:



If the vegetation is in low condition, then check the tick box as follows:



Vegetation in low condition has a high likelihood of not being viable in the long-term under current management, so an offset that improves long-term viability of other vegetation is appropriate. Definitions of vegetation in low condition are in Box 2. The Scattered Paddock Tree Tool (available via the NVAT Mapper) can be used to calculate whether a zone is in low condition and determine the Effective Clearing Area of the clearing proposal.

Box 2. Definitions of native vegetation in low condition.

A. Native woody vegetation is in low condition if:

The over-storey percent foliage cover is <25% of the lower value of the over-storey percent foliage cover benchmark for that vegetation type

AND

<50% of groundcover vegetation is indigenous species, or >90% of the area is ploughed or fallow, or ≥90% of the groundcover vegetation is regrowth but not protected regrowth.

B. Native grassland, wetland or herbfield is in low condition if:

<50% of groundcover vegetation is indigenous species, or >90% of the area is ploughed or fallow, or ≥90% of the groundcover vegetation is regrowth but not protected regrowth.

Notes:

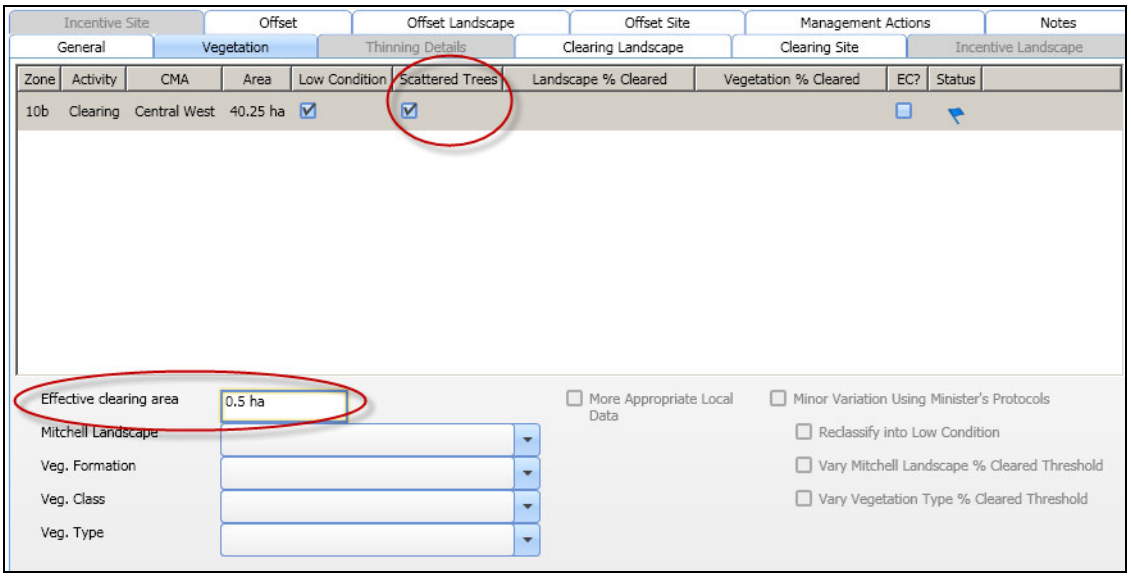
Only patches of vegetation >0.25ha are assessed separately (as distinct zones) from surrounding vegetation (e.g. a patch of vegetation with benchmark over-storey cover that is <0.25ha is not assessed separately from surrounding vegetation with sparser over-storey cover).

The over-storey is assessed using one of the methods in Appendix 4.

The groundcover is assessed using a method consistent with the NV Regulation or the method detailed in Appendix 4. The percentage of groundcover vegetation means the percentage of cover that is indigenous species, not percentage of species that are indigenous species.

3.2.3 Scattered trees and Effective Clearing Area

The Scattered Trees tick box should **only** be ticked if the vegetation has already been assessed as being in low condition (see section 3.2.2) when the zone is being assessed as scattered trees using the NVAT Scattered Paddock Tree Tool (accessible via the NVAT Mapper). When the Scattered Trees box is ticked, the Effective Clearing Area cell becomes active and provides the clearing area assessed as if the vegetation is just below 25% of lower benchmark for the percent foliage cover of the over-storey, using the NVAT Scattered Paddock Tree Tool. The Effective Clearing Area is then used in all calculations from this point on in the *BioMetric* assessment.

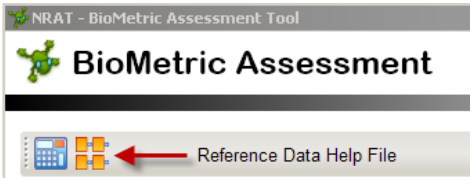


3.2.4 Mitchell Landscape

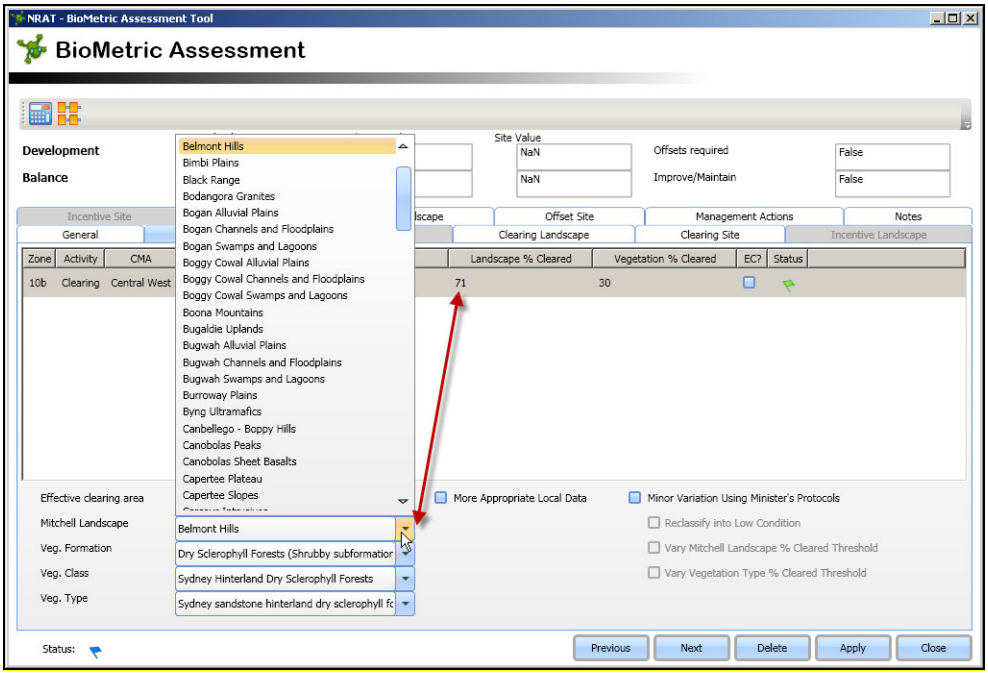
Native remnant vegetation cannot be cleared if it occurs in a Mitchell Landscape that is >70% cleared and is NOT in low condition (see definitions of low condition in Box 2 above), unless the relevant Minor Variation (see Box 1) or more appropriate local data provisions are applied.

The analysis of percent cleared by Mitchell Landscape was undertaken by overlaying the NSW Landscapes coverage (Mitchell 2002) with a presence/absence layer of native vegetation in NSW – an updated version of the layer developed by Pressey *et al.* (2000). These data were further revised during 2007 using a more recent presence/absence vegetation mask for NSW (see *BioMetric* website: http://www.environment.nsw.gov.au/projects/BiometricTool.htm).

Identify the Mitchell Landscape in which the site occurs using the Mitchell Landscapes layer (NSW Landscapes coverage - Mitchell 2002) loaded in the NVAT Mapper. Mitchell Landscapes are mapped at a broad scale (1:250,000) so the Landscape in which a clearing zone occurs may not always be the mapped Landscape (e.g. where the clearing zone occurs near the boundary of landscapes). Assessors can choose a Mitchell Landscape that is different from the Landscape indicated by the map in the NVAT Mapper in the drop-down list in *BioMetric* if the description of the adjacent Landscape more accurately reflects the environment in which the clearing zone occurs. Field descriptions of Mitchell Landscapes are loaded into *BioMetric* to enable this and are accessed by selecting the "Reference Data Help Files" button:

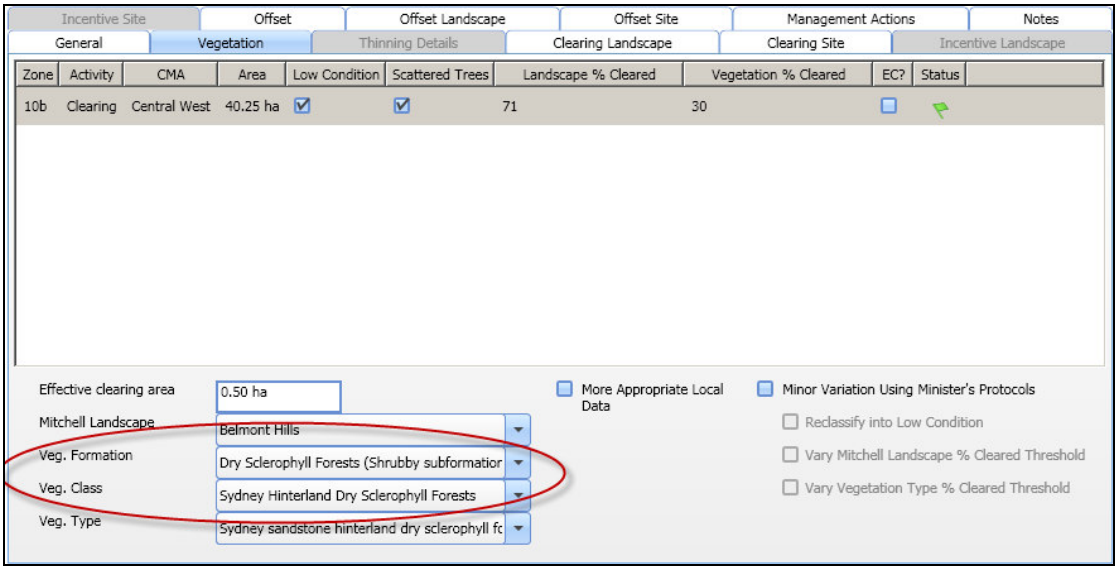


When a Mitchell Landscape is selected from the drop-down list in the bottom left corner of the screen, *BioMetric* automatically displays the percent of native vegetation cleared in this Landscape in the "Landscape % Cleared" field. This value can be annotated on the hard copy image printed for the site assessment.



3.2.5 Vegetation formation and class

Next, the assessor selects the vegetation formation and vegetation class (*sensu* Keith 2004) in each clearing zone to identify the list of possible vegetation types on the site. Select the vegetation formation and then vegetation class that best match the vegetation in the zone from the drop-down lists in the bottom left-hand corner of the screen (the "Reference Data Help Files" button links to a key to the vegetation formations). If the vegetation is in low condition and the vegetation type is not obvious, then the vegetation formation and class that originally occupied the site are assessed from the surrounding vegetation at similar positions in the landscape. Do not use predicted pre-clearing vegetation maps to make these decisions without field inspection to verify.



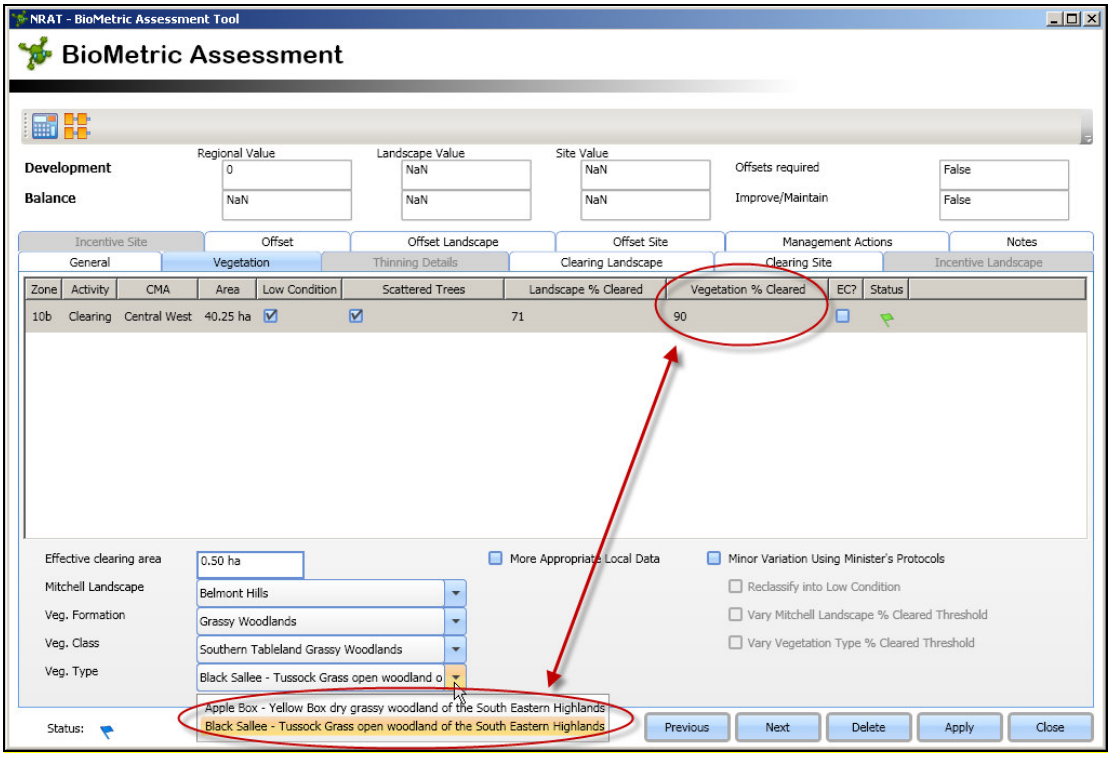
3.2.6 Vegetation type

Remnant native vegetation and protected regrowth cannot be cleared if it is a vegetation type that is >70% cleared and NOT in low condition (see definitions in Box 2 above), unless the relevant minor variation (see Box 1) or more appropriate local data provisions are applied.

The National Objectives and Targets for Biodiversity 2001-2005 Agreement (Commonwealth of Australia 2001) signed by NSW, and the Natural Heritage Trust Bilateral Agreement (2003) signed between NSW and the Commonwealth for the provision of NHT funding required NSW to prevent clearing of ecological communities that are already >70% cleared.

The vegetation type closest to the vegetation at the site or likely to have originally occurred at the site (i.e. pre-clearing, or pre-1750) is selected from the drop-down list in the bottom left corner of the screen. Select the original vegetation type at the site, not the derived vegetation type. Derived vegetation types are selected from the list only where the original vegetation type cannot be determined. The original vegetation type is not known for some derived communities (sometimes called "fully derived vegetation types"). In this situation, select the vegetation type that most corresponds to the derived community.

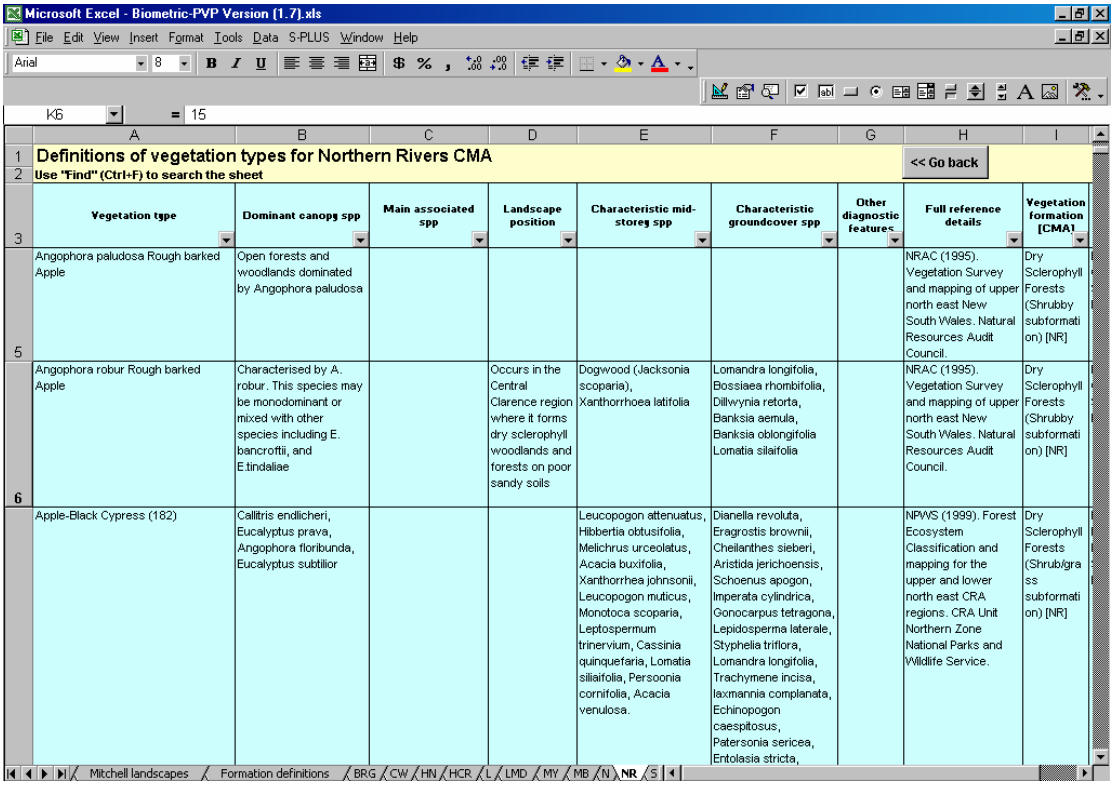
BioMetric displays the percent cleared of the selected vegetation type in the CMA in the "Vegetation % Cleared" field.



Vegetation types are an expression of environmental continua (Austin 1999) and therefore change continuously across a landscape. However, dividing vegetation into discrete communities is required for management. Some vegetation types in the field do not fit neatly into any of the vegetation types listed for a CMA in *BioMetric* (e.g. where the vegetation lies in an ecotone between two types). In these cases judgement is required to select the closest matching vegetation type in *BioMetric*. Vegetation type is used in *BioMetric* as a surrogate for regional conservation value. Thus, the vegetation type chosen from the list in *BioMetric* should reflect this. For example, the vegetation type selected for a site with a mix of plant species typical of flat, productive and highly cleared environments and plant species typical of steeper, less productive and less cleared environments should be the vegetation type that is most typical of the environment and soil at the site.

The lists of vegetation types by CMA were assembled from best available data (see the field definitions provided in *BioMetric* for a list of sources). The list undergoes periodic revision as new data and information become available (see *BioMetric* website for details). Only sources that provide percent cleared estimates can be used for the list of vegetation types. These sources are supplemented by expert knowledge where available.

A link to definitions for the vegetation types within the CMA is provided via the "Reference Data Help Files" button (Figure 2 below). The spreadsheet of vegetation types for each CMA can be filtered or formatted as required. The list of vegetation types should be printed for use in the field (or a subset comprising those vegetation types likely to be present at the proposal). Estimates of percent cleared for the vegetation type selected (rounded to the nearest 5%) are on the right of the screen on the Vegetation tab. These estimates are also provided with the field definitions.



Definitions of vegetation types for Northern Rivers CMA

Use "Find" (Ctrl+F) to search the sheet

<< Go back

Vegetation type	Dominant canopy spp	Main associated spp	Landscape position	Characteristic mid-storey spp	Characteristic groundcover spp	Other diagnostic features	Full reference details	Vegetation formation [CMA]
Angophora paludosa Rough barked Apple	Open forests and woodlands dominated by Angophora paludosa						NRAC (1995). Vegetation Survey and mapping of upper north east New South Wales. Natural Resources Audit Council.	Dry Sclerophyll Forests (Shrubby subformation) [NR]
Angophora robur Rough barked Apple	Characterised by A. robur. This species may be monodominant or mixed with other species including E. bancroftii, and E.tindaliae		Occurs in the Central Clarence region where it forms dry sclerophyll woodlands and forests on poor sandy soils	Dogwood (Jacksonia scoparia), Xanthorrhoea latifolia	Lomandra longifolia, Bossiaea rhombifolia, Dillwynia retorta, Banksia aemula, Banksia oblongifolia Lomatia silaifolia		NRAC (1995). Vegetation Survey and mapping of upper north east New South Wales. Natural Resources Audit Council.	Dry Sclerophyll Forests (Shrubby subformation) [NR]
Apple-Black Cypress (182)	Callitris endlicheri, Eucalyptus prava, Angophora floribunda, Eucalyptus subtilior			Leucopogon attenuatus, Hibbertia obtusifolia, Melichrus urceolatus, Acacia buxifolia, Xanthorrhea johnsonii, Leucopogon muticus, Monotoca scoparia, Leptospermum trinervium, Cassinia quinquefaria, Lomatia silaifolia, Persoonia cornifolia, Acacia venulosa.	Dianella revoluta, Eragrostis brownii, Cheilanthes sieberi, Aristida jerichoensis, Schoenus apogon, Imperata cylindrica, Gonocarpus tetragona, Lepidosperma laterale, Styphelia triflora, Lomandra longifolia, Trachymene incisa, laxmannia complanata, Echinopogon caespitosus, Patersonia sericea, Entolasia stricta,		NPWS (1999). Forest Ecosystem Classification and mapping for the upper and lower north east CRA regions. CRA Unit Northern Zone National Parks and Wildlife Service.	Dry Sclerophyll Forests (Shrub/grass subformation) [NR]

Figure 2. An example of definitions for vegetation types in CMAs.

3.2.6.1 Derived vegetation types

Some of the vegetation types listed in *BioMetric* are derived or secondary vegetation communities (i.e. they have been modified substantially since European settlement usually with loss of one or more structural layers). Derived vegetation communities are communities that have changed to an alternative stable state (*sensu* Westoby *et al.* 1989) as a consequence of management practices following European settlement. In practice, this often means that one or more structural components of the vegetation has been entirely removed or severely reduced (e.g. over-storey of grassy woodland), or has developed where it was previously absent (e.g. shrubby mid-storey in an open woodland system), in derived communities. Derived communities differ from modified natural communities in that derived communities are unable to revert to their pre-European state (i.e. community structure and/or composition) in the short to medium term following the simple removal (or reintroduction) of the disturbance pressures impacting upon them. Derived communities usually require significant management intervention to shift them out of their present state and return to their original state may not be realistically achievable for some derived communities.

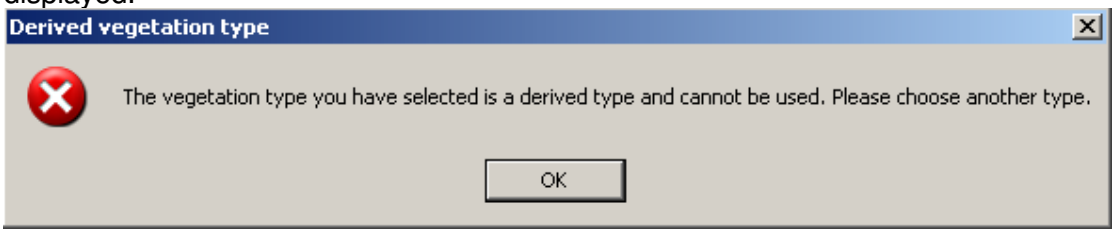
In *BioMetric*, derived vegetation is assessed against the original vegetation type(s) (where known), not against the derived type(s). Consequently, benchmarks for the original vegetation type(s) that were present should be used for assessing derived communities.

When assessing derived communities, the vegetation type for the original community should be selected according to the informed judgement of the assessor, taking into consideration the species composition of the remaining community, patterns of surrounding vegetation, landscape position, soil type, and historical land management practices.

The derived vegetation types in *BioMetric* include an indication of the original vegetation type(s), where possible. Some derived vegetation types also occur as the original community in the CMA. Where available, such information is also included in the definitions of vegetation types in *BioMetric*.

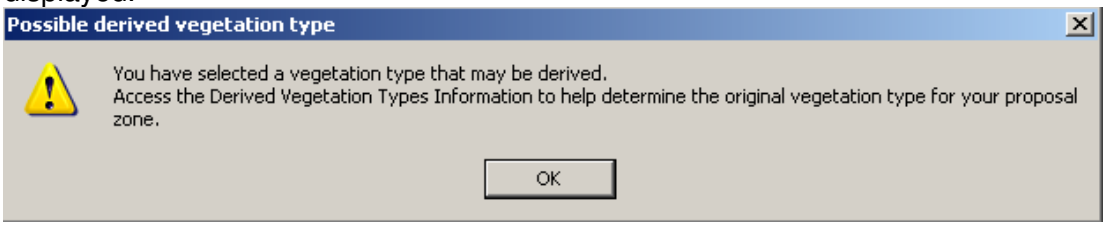
These rules for assessing derived vegetation communities apply to *BioMetric*. Rules for assessing derived communities may be different in other NVAT tools.

If a derived vegetation type is selected in *BioMetric*, the following message is displayed.



By clicking 'ok' you will be asked to select another vegetation type which is similar to the derived vegetation type if the original vegetation type is not known. In these circumstances select the vegetation type that most corresponds to the derived community, taking into account the likely decrease or increase in extent of the derived community and the percent cleared of the similar vegetation type.

If a vegetation type is selected that *may be* derived, the following message is displayed.



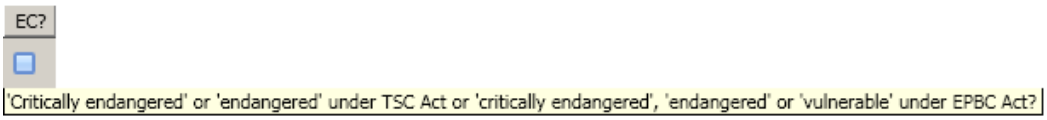
By clicking 'ok' you can continue or select another vegetation type.

Information is available on derived vegetation types in CMAs via the "Reference Data Help Files" button.

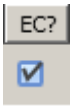
3.2.7 Listed ecological communities

Vegetation that is listed as a critically endangered or endangered ecological community under the *Threatened Species Conservation Act 1995* (NSW) (but not vulnerable ecological communities under this Act) or listed as critically endangered, endangered, or vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1*999*, AND is NOT in low condition (see definitions in Box 2) cannot be cleared, unless minor variation is used to vary low condition.

Vegetation types that equate to listed ecological communities were identified when the vegetation types data were last revised (2008). The assessment officer needs to check for more recent listings under the TSC Act: http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/home_species.aspx and the EPBC Act: http://www.deh.gov.au/cgi-bin/sprat/public/publiclookupcommunities.pl and from the Determinations and Listing Advice. A full list of listed ecological communities and their definitions should be assembled for the CMA prior to commencing assessments. This list should be updated periodically from the websites.



- Do not check the tick box if the vegetation type is not a listed ecological community (excluding listed vulnerable ecological communities in NSW) under threat.



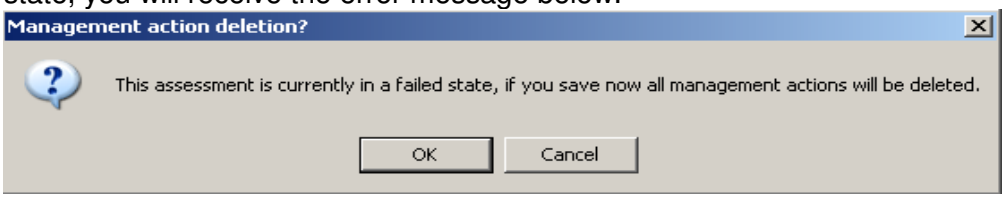
- Check the tick box if the vegetation type is a listed ecological community (excluding listed vulnerable ecological communities in NSW).

3.2.8 Status

A clearing zone can only proceed to the next step if a green flag exists for all zones or if minor variation is used.

If a red flag exists for any zone, then consider options for relocating that clearing zone.

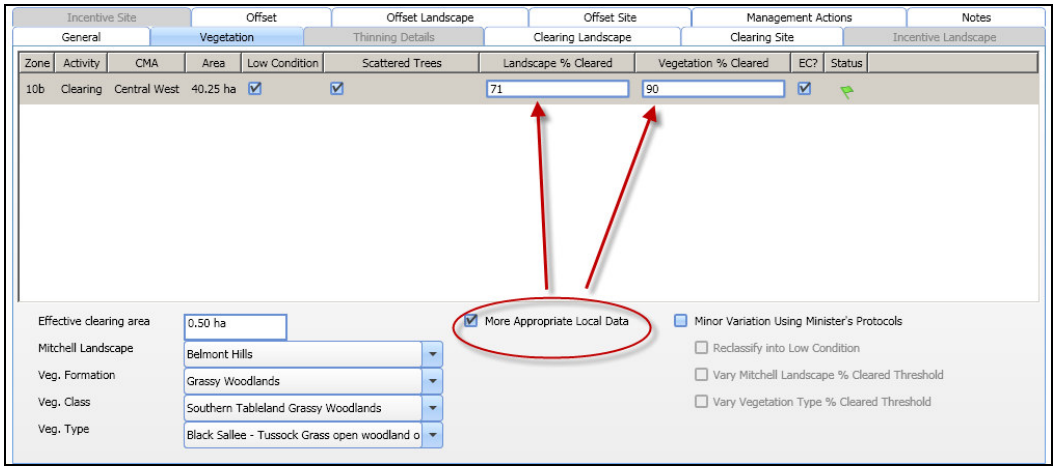
Even though a red flag may exist at this stage, you can proceed with the assessment. However, the assessment cannot be finalised as it is in a failed state. If you attempt to generate management actions when the assessment is in a failed state, you will receive the error message below.



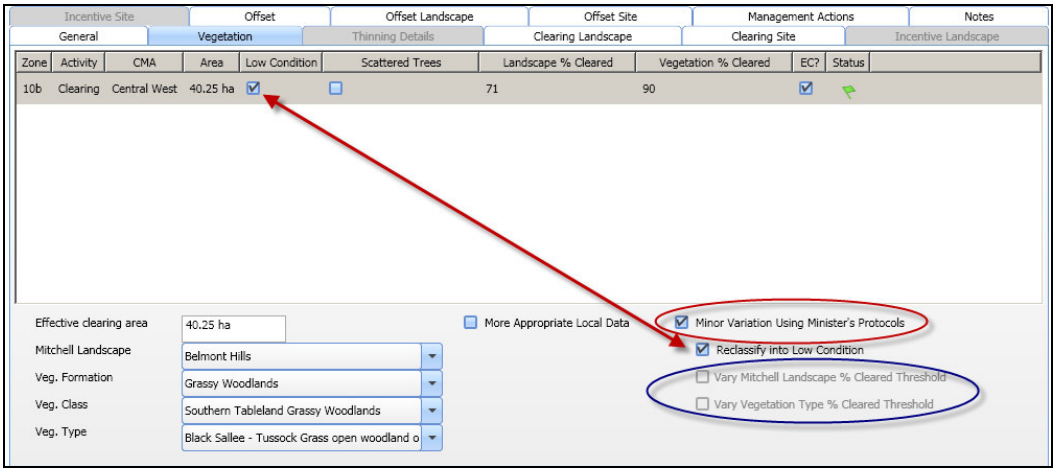
3.2.9 Use of Minor Variation to vary classification of condition of vegetation, classification of vegetation type or landscape as overcleared or assessment of Regional Value of the vegetation

Box 1 specifies when and how Minor Variation provisions may be applied at this stage in the assessment process. Record use of these provisions by checking the appropriate tick box(es) at the bottom of the screen.

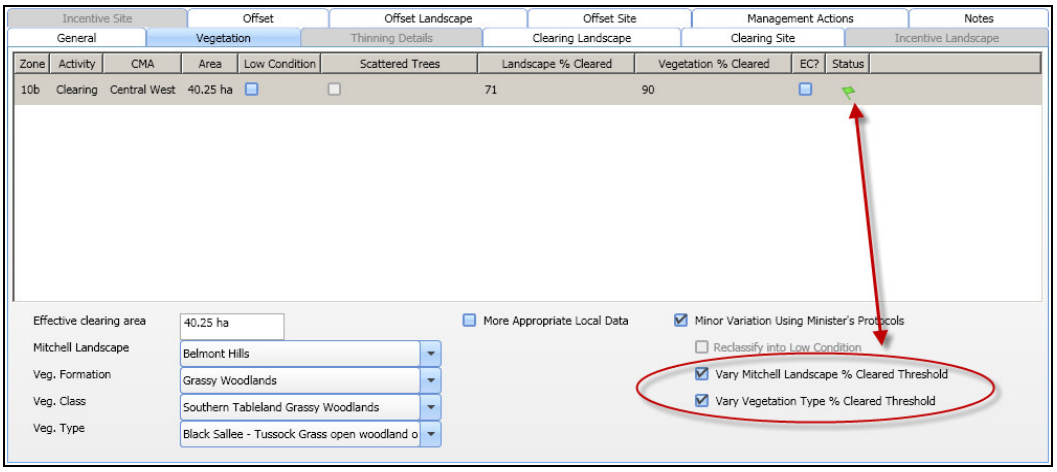
The percent cleared values for the Mitchell landscape and vegetation type can be altered when the 'More Appropriate Local Data' box is ticked. Record the modified percent cleared value/s for the assessment. Using more appropriate local data in these circumstances is the same as using more appropriate local data in any other circumstances to vary data in the databases in the tools:



When the ‘Minor Variation Using Minister’s Protocols’ box is ticked, and the ‘Reclassify into Low Condition’ box is ticked, both of the subsequent ‘Vary threshold’ options are greyed out, and the ‘Low condition’ tick box is automatically ticked:

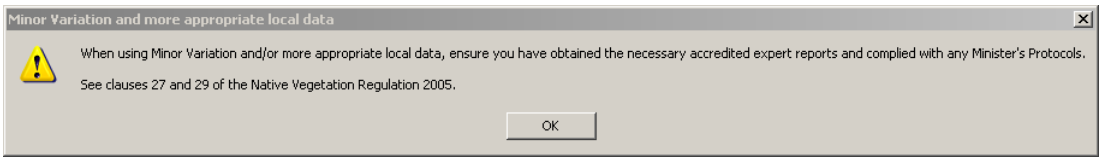


The ‘Vary Mitchell Landscape % Cleared Threshold’ and ‘Vary Vegetation Type % Cleared Threshold’ options can only be selected when the chosen Mitchell Landscape and/or vegetation type are more than 70% cleared AND when the “EC?” tick box is NOT checked. When the ‘Minor Variation Using Minister’s Protocols’ box is ticked, and either or both of the ‘Vary threshold’ options are ticked, then the ‘Reclassify into Low Condition’ option is greyed out, and the Status flag is automatically changed to green:

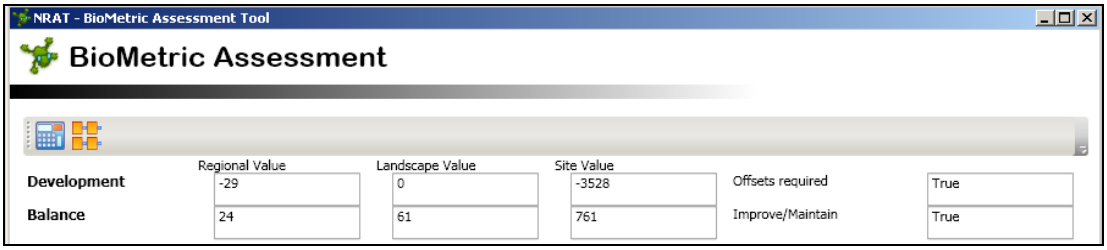


A pop-up message appears when either (or both) of the ‘More Appropriate Local Data’, or the ‘Minor Variation Using Minister’s Protocol’ tick boxes are selected. the reasons for using the Minor variation or More Appropriate Local Data provisions has to be documented in the accredited expert report/s. These reports are made publicly available on the Public Register of “CMA discretions for approved clearing PVPs and development applications” website:

http://www.environment.nsw.gov.au/vegetation/CMAdiscretionsPR.htm .



3.2.10 What are the impacts of clearing?



The impacts of clearing are assessed in terms of Regional Value (incorporating percent cleared value(s) for the vegetation type(s)), Landscape Value (the configuration of vegetation) and Site Value (the quality and quantity of vegetation). These impacts are summarised in the fixed summary pane at the top of the screen. Negative impacts are represented by negative numbers.

3.2.11 Regional Value

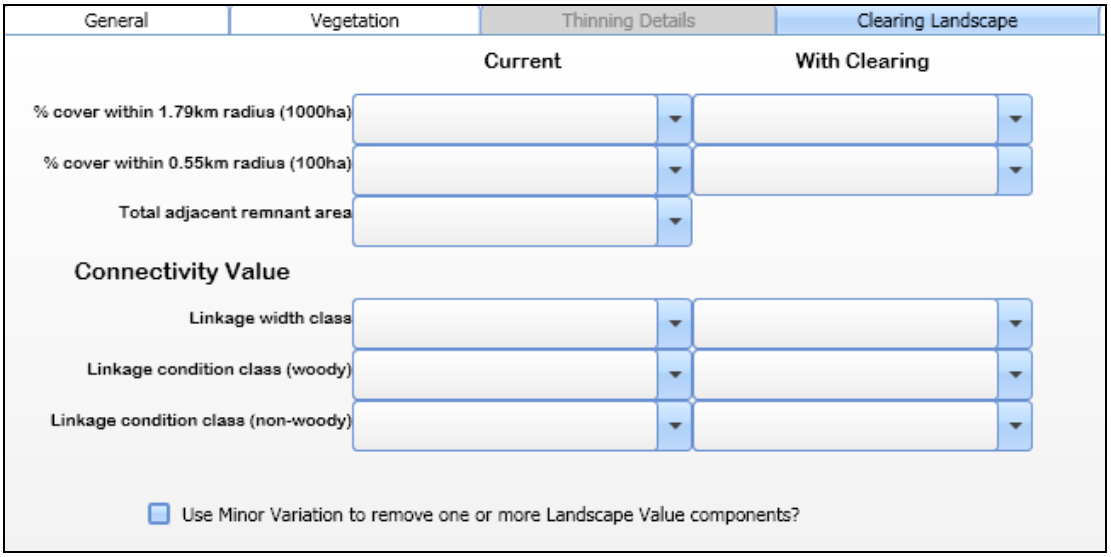
Regional Value is based on the relationship between the percent cleared of the vegetation types on the site relative to their pre-European (or pre-1750) extent within each CMA. A score is allocated based on the relationship between percent cleared and a generic species area curve (Rosenzweig 1995):

$$\textit{Regional Value} = \sum_{i-1}^{n}\left(\left(1-\left(1-\left(\frac{\%cleared}{100}\right)\right)^{0.25}\right)\times\left(\frac{ZoneArea}{TotalArea}\right)\times 100\right)_i$$

Where:
i is the *n*th vegetation zone (of either the clearing or offset site);
%cleared is the percent of the vegetation type in the *i*th vegetation zone that is cleared;
ZoneArea is the area of the *i*th zone in hectares; and
TotalArea on the clearing site is the sum of the area of all clearing zones in hectares, where a site includes more than one zone.
TotalArea on the offset site is the sum of the area of all offset zones hectares.

Regional Value is calculated and displayed automatically by *BioMetric* after Site Value data has been entered, and is altered if More Appropriate Local Data provisions are used and a modified percent cleared value is entered (see section 3.2.9).

3.3 Clearing Landscape tab



3.3.1 Landscape Value

Landscape Value is an assessment of the spatial configuration of vegetation, *viz.* total cover up to 1000ha around the proposal, adjacency and connectivity of native vegetation. The current, and future states with clearing, of vegetation cover and connectivity in and around the clearing site are assessed, together with the current remnant area of which the clearing site forms part.

The change in Landscape Value at the clearing site(s) is determined using the following formula:

$$\textit{Landscape Value}_{\textit{Clearing site}} = \left(\sum_{v=a}^{d}(s_v w_v)\right)_{\text{Current}} - \left(\sum_{v=a}^{c}(s_v w_v)\right)_{\text{With proposed clearing}}$$

where:
s_v is the score for the vth variable (*a*-*d*) as defined below
w_v is the weighting for the vth variable (*a*-*d*) as defined below
a = percent cover of native vegetation within a 1.79 km radius of the site (1000 ha)
b = percent cover of native vegetation within a 0.55 km radius of the site (100 ha)
c = connectivity value
d = total adjacent remnant area

The measures and assessment of the components of Landscape Value are explained further below.

3.3.1.1 percent native vegetation cover in the landscape.

Current native vegetation cover and native vegetation cover after clearing is assessed within radii of 1.79km (1000ha) and 0.55km (100ha) circles around the clearing site, taking into account extent and condition of the vegetation. Cover (extent and condition) is estimated in categories of 10% cover (deciles) using the imagery in the NVAT Mapper or on the hard copy printouts. The scores change most between 0 and 30% (increase by 1.8), moderately between 30 and 70% (increase by 1.2) and least between 70 and 100% (increase by 0.6) cover, reflecting the recognised thresholds at which fragmentation effects generally escalate for different biota (Andren 1994, McIntyre *et al.* 2000). The different radii recognise that different biota range over, and are affected by, activities at different scales.

Tools in the NVAT Mapper draw circles with the two radii (note: a 10ha circle is also drawn by the tools, which may be used in the assessment of Threatened Species using the separate tool). The circles are placed to encompass the maximum change, and the 1000ha and 100ha circles are not necessarily concentric (see Figure 3 below). Where the clearing site is not entirely encompassed within a single 1000ha radius, multiple circles at this scale should be placed to encompass the clearing site. Judgement is required to determine how many circles should be used to cover the clearing site, especially where the area is long and narrow. Minor variation can be applied to alter the area of the circles where appropriate.

There is no requirement to include the clearing and offset sites within the same circle(s).

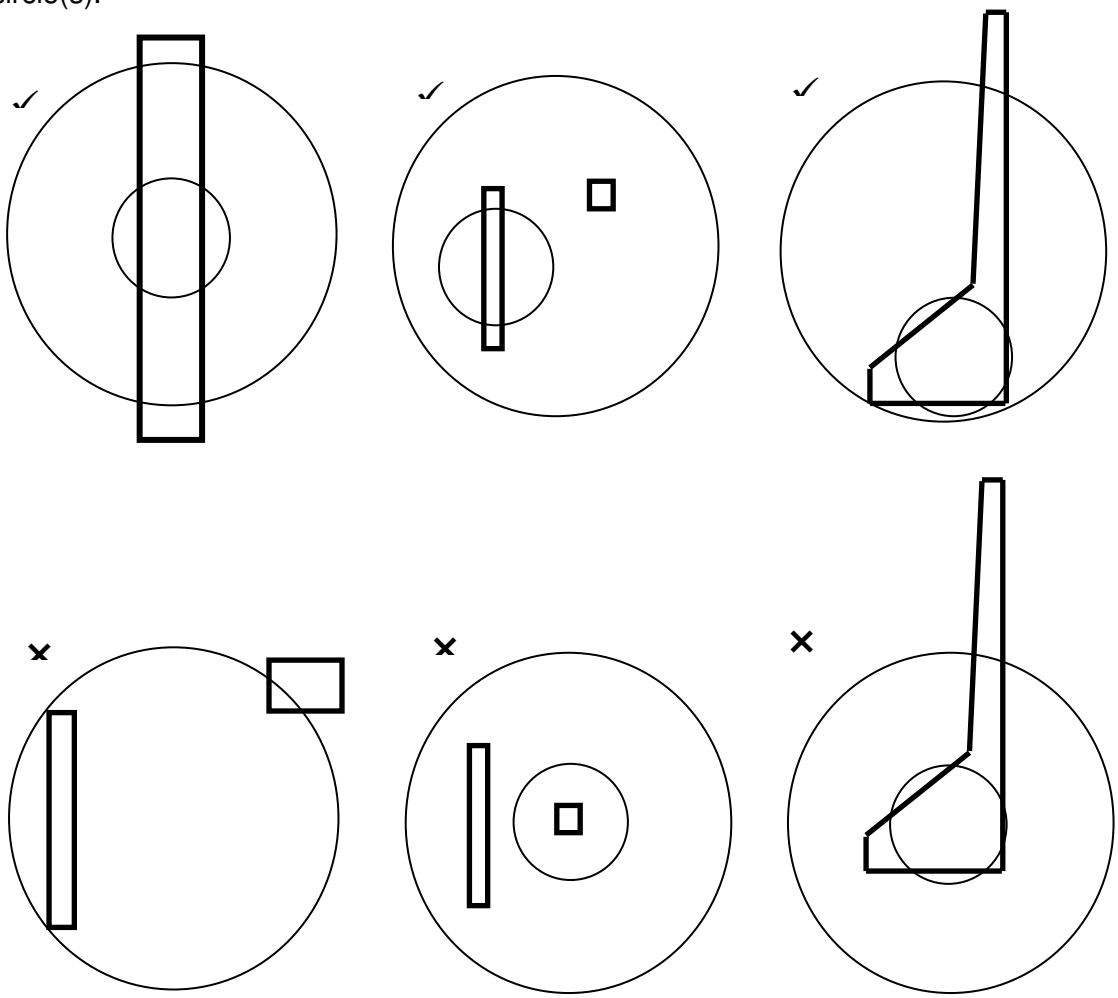


Figure 3. Examples illustrating how to assess percent native vegetation cover in the landscape for different zones in a clearing or offset site (outlined in bold). The circles in which cover is assessed are centred so that each captures the maximum area of the site. Non-contiguous sites should be split into separate zones if they are not completely contained within the largest circle.

The cover estimates are made from the imagery and knowledge of the area. Any vegetation native to Australia can contribute to the measure of cover (i.e. planted native species not indigenous to the area can contribute to this measure). Judgement is applied when scoring cover of native vegetation in the circles to determine vegetation condition from imagery. Judgement is particularly used to score loss or gain in percent cover of native vegetation where the loss or gain in the percent cover moves up or down a decile and the overall loss or gain is less than 10% and to take vegetation condition into account (see below).

Cover estimates are based on the cover of native woody and non-woody (where known) vegetation relative to the approximate benchmarks for the vegetation type(s), taking into account vegetation condition and extent. For practical reasons, over-storey is generally used to assess cover in the circles in woody vegetation types, and native ground cover is used to assess cover in non-woody vegetation types. Where possible, cover of native mid-storey and ground cover should be included in assessment of vegetation condition and extent in the circles for woody vegetation, although this is not usually possible.

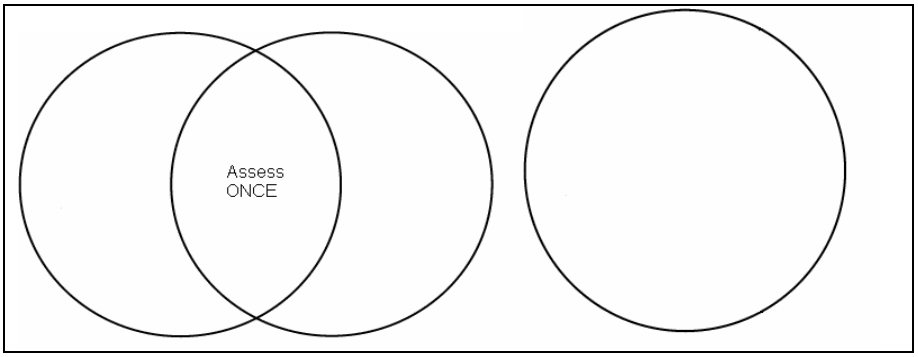
For example, a completely vegetated circle around the proposal with benchmark over-storey cover would be assessed as 100% cover (i.e. in the >90-100% category) whether it is open woodland or closed forest. However, if the over-storey cover occurred across the whole circle, but was around 25% of the benchmark over-storey cover for that vegetation type then the estimate of cover would be 25% (>20-30% category). If only 30ha of native over-storey cover was present in the 100ha circle (or 300ha in the 1000ha circle) and the condition of this vegetation was 25% of benchmark, then it would be scored in the category of 0-10% cover.

In non-woody vegetation (e.g. grassland) the assessment is based on the amount of vegetation in the landscape that is not in low condition, taking into account its condition status where this can be ascertained.

Appendix 2 contains diagrams to assist with visual estimates of native vegetation cover in landscapes. Digitising tools in the NVAT Mapper can be used to estimate the percent vegetation cover in a circle if the percent cover is close to a threshold and cannot be confidently assessed by eye.

To assess and enter values for percent vegetation cover:

a) Using the NVAT Mapper, place one or more 1000ha circles over the clearing site, to encompass the site. By preference, the circles should not overlap, however if they need to overlap to ensure complete coverage of the site, do not assess any area/s of overlap more than once (see diagram);



b) within each 1000ha circle, determine the 'Current' percent cover either visually or by digitisation, taking into consideration:

   i) the percent cover of each woody vegetation type taking into account extent and condition relative to benchmark condition, and

   ii) the percent cover of non-woody vegetation not in low condition, taking into account extent and condition (see above).

c) Calculate the total percent cover by summing the cover estimates for all circles and diving by the number of circles used. E.g. if 6 circles are used to cover the

site and the percent cover estimates are 25, 34, 15, 67, 42 and 12; then the calculation is (25+34+15+67+42+12)/6 = 32.5%

d) Choose the corresponding category from the drop down boxes for 'Current' percent vegetation cover in *BioMetric*.

e) Calculate the percent cover with clearing assuming the clearing has occurred, using the method in (c) above. Determine the percent vegetation cover for the clearing site if clearing was to occur, depending on the type of clearing (e.g. full or partial clearing of structural layers). Choose the corresponding category from the drop down boxes for 'With Clearing' in *BioMetric. BioMetric* will automatically calculate the loss in percent vegetation cover due to the clearing, and corresponding scores.

f) Repeat steps (a) – (e) for the 100ha scale assessment.

g) Repeat steps (a) – (f) for the offset site to assess the total gain in percent vegetation cover. *BioMetric* will automatically calculate the gain in percent vegetation cover due to the offset site, and corresponding scores. Calculate the gain with the offset(s) as though the clearing has taken place. The words 'Current' and 'With Offset' mean cover with the offset, assessed as though the clearing has taken place. They do not mean the net of the clearing and the offset.

3.3.1.2 Total adjacent remnant area.

The aim of this measure is to encourage offsets to be established adjacent to, or as part of, remnants that are of equivalent size or larger than the remnant in which clearing is proposed to occur. This reflects findings that vegetation that is adjoining, and therefore part of, large remnants is generally of more value to biota than vegetation that is adjoining, and therefore part of, smaller remnants (e.g. Platt 2002).

Total adjacent remnant area is the area of native vegetation that is not in low condition of which the clearing or offset site is a part. The adjacent remnant vegetation area may extend off site to include adjoining areas of native vegetation not in low condition that are ≤100m (≤30m for non-woody vegetation) from the clearing or offset site, as shown in Figure 4. If all the adjacent remnant vegetation (including that on the clearing or offset site) is in low condition, then the size of the adjacent remnant area is zero. Where both woody and non-woody vegetation occur in different parts of the remnant then judgement needs to be used to determine the threshold for what constitutes adjoining vegetation. In most instances, the threshold for the predominant vegetation category (woody or non-woody) is used to determine whether a separation threshold of ≤100m or of ≤30m should be used to determine whether or not the vegetation is adjoining.

Total adjacent remnant area is calculated separately for the clearing and the offset sites, as follows. The value for the clearing zone and for the offset zone that undergoes the greatest change (loss/gain) is then entered into *BioMetric*.

a) Determine the 'Current' total adjacent remnant area of which the site is a part. This includes the area that is to be cleared that is not in low condition. Total adjacent remnant area categories are: Extra large, Very large, Large, Medium, or Small. These categories are defined differently according to the extent to which the Mitchell Landscape in which most of the site occurs has been cleared (Table 4). This percent cleared value can be obtained from the Vegetation tab in *BioMetric*. Digitising tools in the NVAT Mapper can be used to help estimate the area of the adjacent remnant if necessary.

b) Determine what the total adjacent remnant area will be if the clearing and offset were to proceed (i.e. minus the area to be cleared plus the area to be improved through management as an offset).

c) If there is more than one zone, and they are not contiguous, then use total adjacent remnant area for the zone which undergoes the greatest change (loss/gain).

d) Transcribe the 'Current' category to *BioMetric* for the clearing site and the 'With Offset' category for the offset site.

Table 4. Criteria used for assessing total adjacent remnant area. Adjacent remnant area refers to the area (ha) of native vegetation that is not in low condition (see Box 2 for definitions) and is linked to (≤100m for woody vegetation or ≤30m for non-woody vegetation) the clearing or offset site. The percent of native vegetation cleared in the Mitchell Landscape in which most of the clearing or offset site occurs is obtained from the NVAT Mapper.

Level for total adjacent remnant area	percent native vegetation cleared in the Mitchell Landscape in which most of clearing or offset site occurs			
	<30%	30-70%	>70-90%	>90%
Extra large	>1000 ha	>200 ha	>100 ha	>50 ha
Very large	>500-1000 ha	>100-200 ha	>50-100 ha	>20-50 ha
Large	>200-500 ha	>50-100 ha	>20-50 ha	>10-20 ha
Medium	>100-200 ha	>20-50 ha	>10-20 ha	>1-10 ha
Small	≤100 ha	≤20 ha	≤10 ha	≤1 ha

3.3.1.3 Connectivity value.

This measure assesses the impact of the clearing and (separately) the offset on connectivity with adjoining vegetation on the basis of changes in the width and overall vegetation condition of the connecting linkage with the adjoining vegetation. Where there is more than one connecting linkage with the adjoining vegetation from the clearing or offset site, the linkage with the highest combination of current linkage width class and condition class is used to determine connectivity value. This linkage is referred to as the primary linkage.

Detailed information on assessing connectivity and examples are in Appendix 3.

The site is linked to adjoining vegetation where the adjoining vegetation:

- Is not in low condition; and
- Has a patch size greater than 1ha; and
- Is 100m or closer for woody vegetation or 30m or closer for non-woody vegetation from the site; and
- Is not separated from the site by a barrier such as a dual-lane or wider higher (or railway lines or large water body)

Steps to determine Connectivity Value:

a) Determine the current linkage width class as per Table 5. The linkage width is the average width of the area of vegetation that links the clearing or offset site

with the adjoining vegetation. The area of connected vegetation can include vegetation on and off the clearing or offset site. Enter the 'Current' linkage width class into *BioMetric*.

b) Determine the linkage width class that will result from the clearing or offset site as per Table 5. Enter the 'With Clearing' (for the clearing site) or the 'With Offset' (for the offset site) linkage width classes into *BioMetric. BioMetric* will determine the number of linkage width class thresholds that have been crossed.

Table 5. Linkage width classes and thresholds.

Linkage widths (metres)				
0 – 5	>5 – 30	>30 – 100	>100 – 500	>500
Very Narrow	Narrow	Moderate	Wide	Very Wide

c) Determine the current linkage condition class as per Table 6a (for woody vegetation) or 6b (for non-woody vegetation). The linkage condition assessment for woody vegetation assesses over-storey cover and either the mid-storey cover or ground stratum cover, depending on which is most relevant to the vegetation. Only the ground stratum cover is assessed for non-woody vegetation types. The average condition class of the vegetation that forms the connecting linkage is assessed across the entire link. Enter the 'Current' linkage condition class into *BioMetric* for whichever vegetation structure is appropriate. Note: only one vegetation structure can be entered.

d) Determine the linkage condition class that will result from the clearing site or the offset site (Table 6a or 6b). At the clearing site, the assessor must consider the impact the clearing will have on the condition of the overall link, including any land use change. At the offset site, the assessor should consider whether the improved condition that will result from undertaking management actions at the offset site will improve the overall condition of the link. Enter the 'With Clearing' or 'With Offset' linkage condition classes into *BioMetric. BioMetric* will determine the number of linkage condition class thresholds that have been crossed.

Note: for the purposes of assessing connectivity, shrubland vegetation that is less than one metre in height with no over-storey (i.e. the over-storey benchmark is zero) is assessed as non-woody vegetation (using Table 6b). Non-woody vegetation such as sedges, rushes or bulrushes that is one metre or greater in height is assessed as for woody vegetation (i.e. both over-storey and ground stratum cover are assessed) using Table 6a.

Table 6a. Woody vegetation linkage condition classes and thresholds. Judgement should be used to assess condition linkage class when the woody vegetation is very dense, ie, twice the upper benchmark or greater. Very dense woody vegetation impedes the movement of some biota, particularly birds.

		Over-storey condition			
		No native over-storey OR Exotic vegetation with similar structure to the proposal	% foliage cover <25% of lower benchmark OR Exotic vegetation with similar structure to the proposal	% foliage cover ≥25% of lower benchmark to lower benchmark	% foliage cover within benchmark
Mid-storey or ground stratum condition	No mid-storey or ground stratum cover OR Exotic vegetation with similar structure to the proposal	Nil	Nil-Low	Low	Low-Mod
	% foliage cover of mid-storey or ground stratum cover <25% of lower benchmark OR Exotic vegetation with similar structure to the proposal	Nil-Low	Low	Low-Mod	Moderate
	% foliage cover of mid-storey or ground stratum cover ≥25% of lower benchmark to lower benchmark	Low	Low-Mod	Moderate	Mod-High
	% foliage cover of mid-storey or ground stratum cover within benchmark	Low-Mod	Moderate	Mod-High	High

Table 6b. Non-woody vegetation Linkage Condition Classes and thresholds. When a proposal takes the condition from one state to another, it is counted as crossing *two* thresholds in non-woody vegetation.

Linkage Condition Class	Vegetation condition
Nil	Meets none of the definitions below
Low	Percent foliage cover is less than 25% of lower benchmark in native grassland, wetland or herbfield OR exotic vegetation with similar structure to the proposal.
Moderate	Percent foliage cover is greater than or equal to 25% of lower benchmark and less than lower benchmark in native grassland, wetland or herbfield
High	Percent foliage cover is within benchmark in native grassland, wetland or herbfield

BioMetric automatically calculates Connectivity Value which contributes to Landscape Value, according to Table 7.

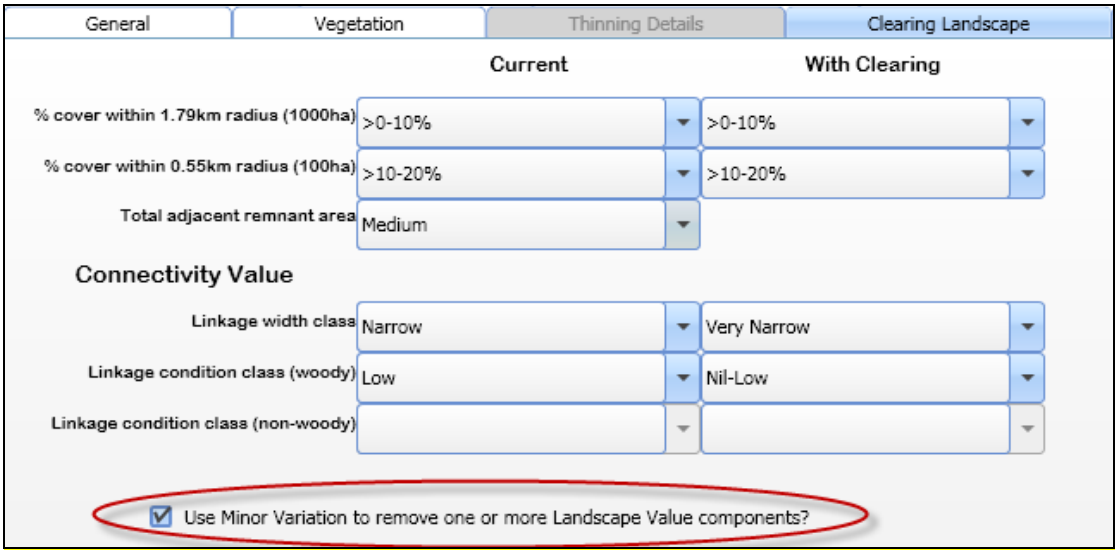
Table 7. Scores for loss/gain of connectivity value based on number of thresholds crossed.

		Number of linkage width thresholds crossed			
		0	1	2	3 or 4
Number of linkage condition thresholds crossed	0	0	2	4	6
	1	1	3	5	7
	2	2	4	6	8
	3	3	5	7	9
	4	4	6	8	10
	5	5	7	9	11
	6	6	8	10	12

Further guidance of assessing connectivity is in Appendix 3.

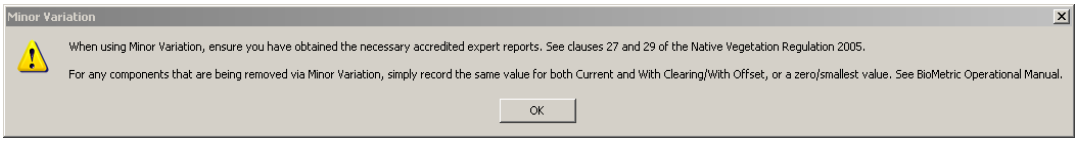
3.3.2 Use of Minor Variation provisions

Minor Variation provisions may be applied at this stage in the assessment process, as at other stages. Record use of this provision by checking the tick box at the bottom of the screen. These changes trigger Clause 27 of the NV Regulation 2005 and must be accompanied by an accredited expert's report.



A pop-up message appears when the 'Use Minor Variation to remove one or more Landscape Value components' tick box is selected. Use of minor variation requires an expert report, which is made publicly available on the Public Register of "CMA discretions for approved clearing PVPs and development applications" website:

http://www.environment.nsw.gov.au/vegetation/CMAdiscretionsPR.htm.

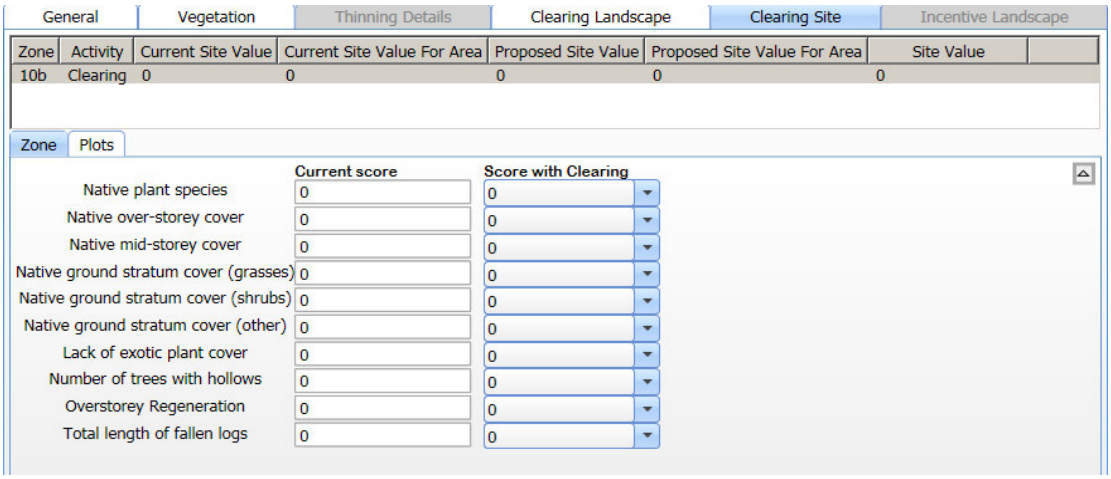


When using Minor Variation provisions, enter the same value (or a zero/smallest value) for 'Current' and 'With clearing' (and/or 'With offset') for each of the Landscape Value attributes for which the Minor Variation provision is being used. For example, if using Minor Variation to remove the assessment of cover within the 100ha circle, tick the 'Use Minor Variation' box and ensure the same % cover is selected for both the 'Current' and 'With Clearing' drop down boxes for '% cover within 0.55km radius (100ha).

3.4 Clearing Site tab

3.4.1 Site Value

Click on the zone, towards the top of the screen, to commence assessment of a vegetation zone for Site Value.



Site Value is assessed for each zone by measuring the ten condition variables in plots or transects and comparing the measured values with benchmarks. Benchmarks represent the range of variability for the condition variables in relatively unmodified examples of the same vegetation type. Each condition variable is allocated a score in *BioMetric* from 0 to 3 (0=low, 1=moderate, 2=high, 3=very high) based on the difference between its measured value and its benchmark. This scoring system is explained in Table 8.

Table 8. Explanation of the way each variable in Site Value is scored. The term 'within benchmark range' means a measurement that is within the benchmark for that variable for that vegetation type. The percentages refer to the proportion of lower or upper benchmark, where 100% is within benchmark range.

Variable	Score in *BioMetric*			
	0	1	2	3
a. Native plant species richness	0	>0-<50% of benchmark	50-<100% of benchmark	≥ benchmark
b. Native over-storey cover	0-10% or >200% of benchmark	>10-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	within benchmark range
c. Native mid-storey cover	0-10% or >200% of benchmark	>10-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	within benchmark range
d. Native ground stratum cover (grasses)	0-10% or >200% of benchmark	>10-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	within benchmark range
e. Native ground stratum cover (shrubs)	0-10% or >200% of benchmark	>10-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	within benchmark range
f. Native ground stratum cover (other)	0-10% or >200% of benchmark	>10-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	within benchmark range
g. Exotic plant cover (calculated in *BioMetric* as percent of total ground stratum and mid-storey cover)	>66%	>33-66%	>5-33%	0-5%
h. Number of trees with hollows	0 (unless benchmark includes 0)	>0-<50% of benchmark	50-<100% of benchmark	≥ benchmark
i. Proportion of over-storey species occurring as regeneration	0%	>0-<50%	50-<100%	≥100%
j. Total length of fallen logs	0-10% of benchmark	>10-50% of benchmark	>50-<100% of benchmark	≥ benchmark

Site Value is assessed as follows:

1. Plots/transects are established in each zone. Zones are relatively homogeneous units within the site. As there is always variation in native vegetation, plots/transects should be established in each zone in approximate proportion to the range of condition within the zone to achieve a representative sample.

   Recommended steps for establishing plots/transects within a zone are as follows:

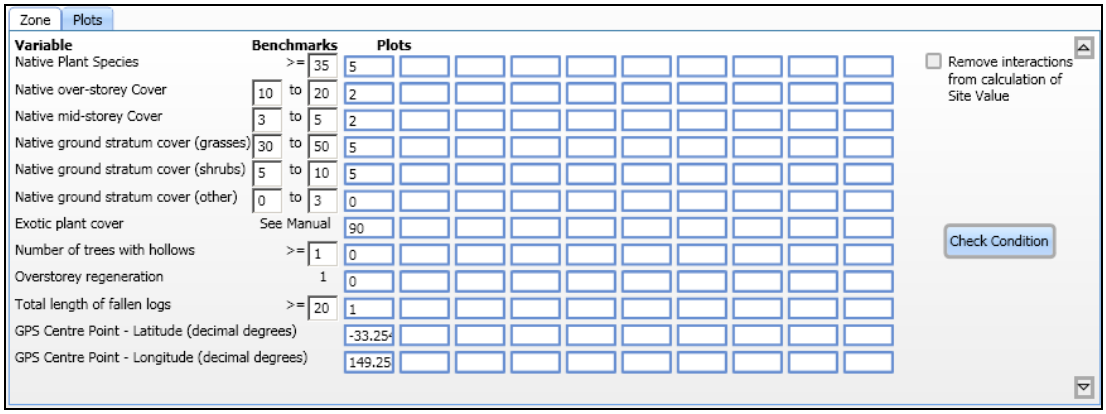
(a) divide the zone roughly into homogeneous units based on vegetation condition (e.g. denser and sparser vegetation) using the imagery (these units do not need to be digitised or recorded);

(b) roughly estimate the proportion of the zone taken up by each unit;

(c) allocate a minimum of one plot/transect to the smallest unit and then allocate plots/transects randomly within the remaining units, roughly in proportion to their area (e.g. if there are two units and the smallest is approximately one third of the total area of the zone then allocate one plot to the smallest unit and two plots to the larger unit).

Generally, a maximum of ten plots or transects should be measured within a zone. More than ten plots/transects may be required in very large zones that have high internal variability. Plots/transects should be established randomly within a zone or stratified to sample internal variation in condition within a zone, as above. Random sampling can be undertaken by marking points randomly on the imagery within the zone and establishing plots/transects at all, or some, of these points or pacing a random distance into the zone, establishing a plot/transect at this point and then repeating the process.

The ten Site Value variables are measured in plots/transects or across the zone, recorded on a data entry sheet in the field (see Appendix 9) and transcribed into the *BioMetric* Plots tab. Methods for measuring Site Value variables in the field are described in Appendix 4.



2. Benchmark data are available for most Vegetation Classes (*sensu* Keith 2004) in each CMA at http://www.environment.nsw.gov.au/projects/BiometricTool.htm. Benchmark data for the Vegetation Class (or Type in Hawkesbury Nepean CMA) are automatically populated in *BioMetric.* However, these benchmarks are compiled from a combination of quantitative data and expert knowledge. In most CMAs, benchmarks are provided for Vegetation Classes (*sensu* Keith 2004), which encompass multiple vegetation types, and do not always provide sufficiently precise benchmarks for individual vegetation types. Assessors are strongly advised to check the benchmarks, as some benchmarks are erroneous and others are too broad for the vegetation type.

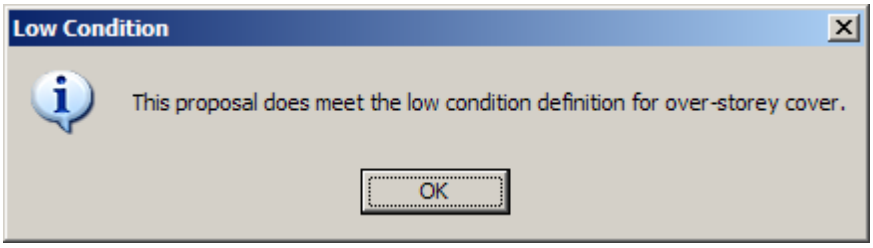
   If benchmark data are not available for a vegetation type, or if more suitable local benchmarks are needed, they are obtained from reference sites of the same vegetation type in relatively unmodified condition or from published sources.

   Assessors are strongly encouraged to collect plot/transect data at reference sites in benchmark condition to check the accuracy of vegetation class benchmarks, especially where seasonal or climatic impacts may not be reflected in the

benchmarks. Reference site data can be collected for specific condition variables. Methods for obtaining benchmarks from reference sites are described in Appendix 5. Use the field data sheet in Appendix 9 to record data collected from reference sites. Use the "Data entry – Benchmarks" worksheet, available on the Community of Practice website to enter benchmark data obtained from plots/transects at reference sites. This worksheet automatically calculates benchmark values, which then need to be manually transcribed by the assessor to the Plot tab in *BioMetric*.

NOTE: assessment officers are strongly encouraged to check the benchmarks in the benchmarks database and to obtain their own benchmark data from reference sites and/or published sources.

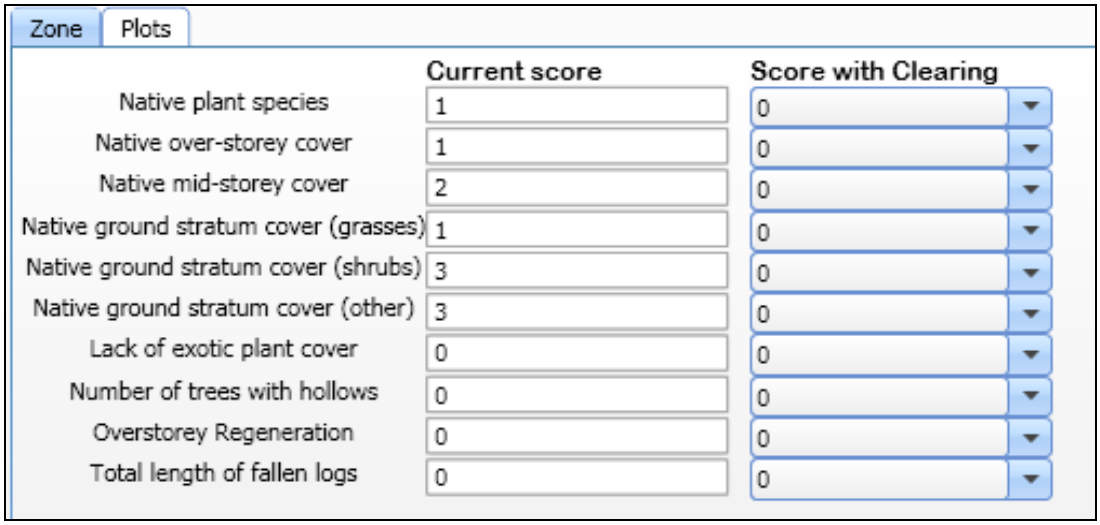
3. The 'Check Condition' button may be used to check whether the vegetation is in low condition, based upon data entered for the plots/transects. Assessors may then go back to the Vegetation tab to check whether they have correctly indicated whether or not the vegetation is in low condition (see section 3.2.2).



4. When the vegetation formation on the Vegetation Tab has been selected as Grasslands, Heathlands, Alpine Complex, Freshwater Wetlands, Saline Wetlands or Arid Shrublands, a tick box on the plot data entry screen allows some of the interactive terms in the Site Value equation to be removed. Ticking this box removes the interaction between *native over-storey cover* x *over-storey species occurring as regeneration* and *number of trees with hollows* x *total length of fallen logs* from the calculation of Site Value.

   It is appropriate to remove these interactions in these vegetation formations when they contain small amounts of woody over-storey cover, so an unwarranted heavy weighting is not given to the woody variables in these largely non-woody formations. The presence of the woody variables in these formations is still valued by their inclusion in other areas of the Site Value calculation. The assessor needs to use judgement as to when it is appropriate to remove the interactions for these variables. The interaction terms should usually only be removed from the Site Value equation when the upper benchmark for native over-storey cover is 10% or less.

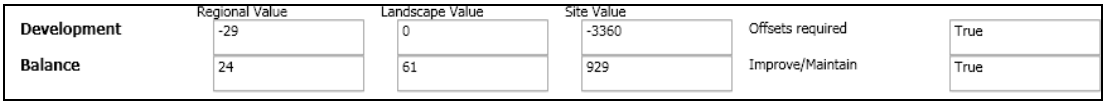
5. A score from 0 to 3 for each variable in each zone is generated in *BioMetric* based on the differences between observed data and benchmark data for each variable (**note that a higher score is given for low exotic plant cover and a low score for high exotic cover).** These scores are recorded on the Zone tab. The assessor then predicts the impact of the clearing on each condition variable in each zone using the information in Appendix 7.



6. Site Value for each zone is calculated in *BioMetric* as the difference in the Site Value of the clearing zone before and after clearing multiplied by the area of the zone. The total Site Value is this figure summed across all zones.
7. The summary panel at the top of the window pane indicates when an offset is required, i.e. if the proposed clearing does not improve or maintain environmental outcomes without an offset.

   An offset is required when 'Offsets required' = True

   An offset is not required when 'Offsets required' = False



If an offset is required then the next step is described in section 3.5.

If an offset is not required then you can select the 'Management Action' tab to finalise the assessment. This is described in section 3.8.

3.5 Offset tab

Loss of biodiversity from clearing must be offset by commensurate gains to biodiversity on other sites for the clearing to improve or maintain environmental outcomes. Offsets can only improve or maintain if:

a. for vegetation types that are >70% cleared, offsets are in vegetation types of equal or greater Regional Value (the conservation status of the vegetation type) to the vegetation proposed for clearing; OR

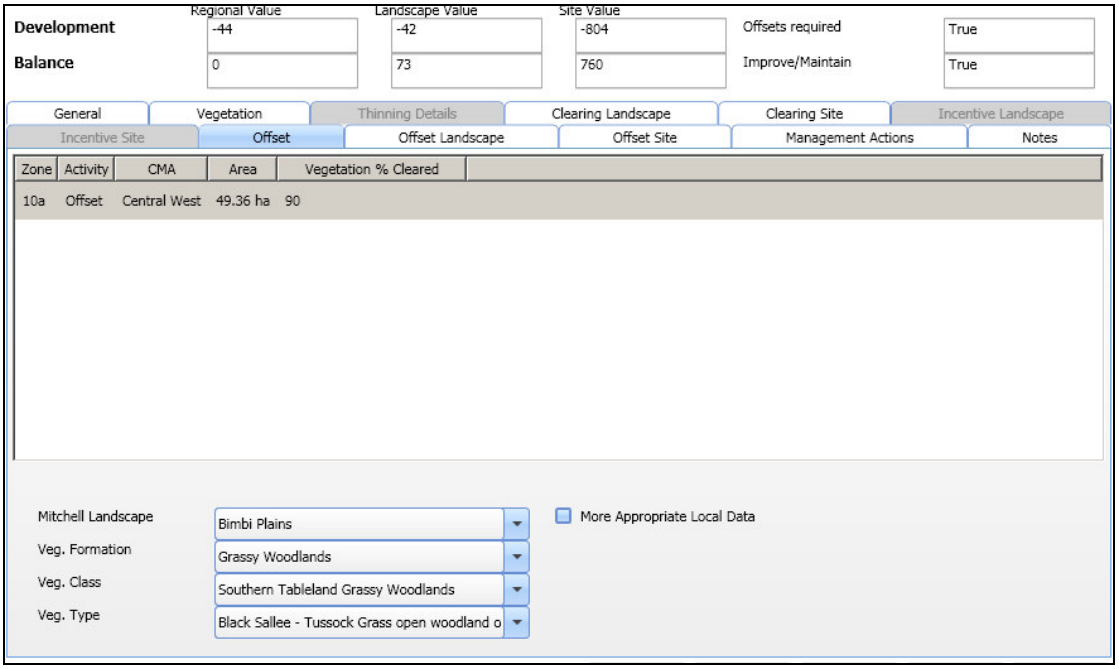
b. for vegetation types that are ≤70% cleared, offsets are in vegetation types of equal or greater Regional Value to the vegetation proposed for clearing, or are in vegetation types that have a percent cleared estimate of up to 10% less than the vegetation proposed for clearing; AND

c. improvement in Landscape Value (the configuration of vegetation) from the offset are commensurate with losses in Landscape Value from the proposed clearing; AND

d. improvement in Site Value (the quality and quantity of vegetation) from the offset are commensurate with losses in Site Value from proposed clearing.

The impacts of the clearing and offset assessments appear in the summary panel at the top of the screen in this tab. As you fill out the relevant sections in this step the balance will be updated. Offsets can only improve or maintain environmental outcomes if the value for each component of the assessment is not negative.

The negotiation of offsets could require several iterations, requiring modification of the initial clearing and offset sites. This requires the assessor to go backwards and forwards in *BioMetric*. The *BioMetric* tool can be used to explore what-if scenarios based on estimated data, but the final assessment must be underpinned by actual data.



3.5.1 Zone, Activity, CMA and Area

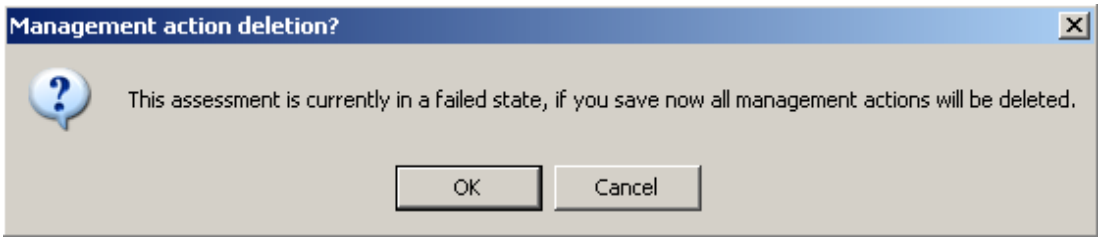
Zone, Activity, CMA and Area are automatically populated from NVAT Mapper. Before proceeding you need to check that you are assessing the correct zones. The

tool accepts an unlimited number of vegetation zones. Refer to Appendix 1 for guidelines on how to map vegetation zones.

3.5.2 Regional Value

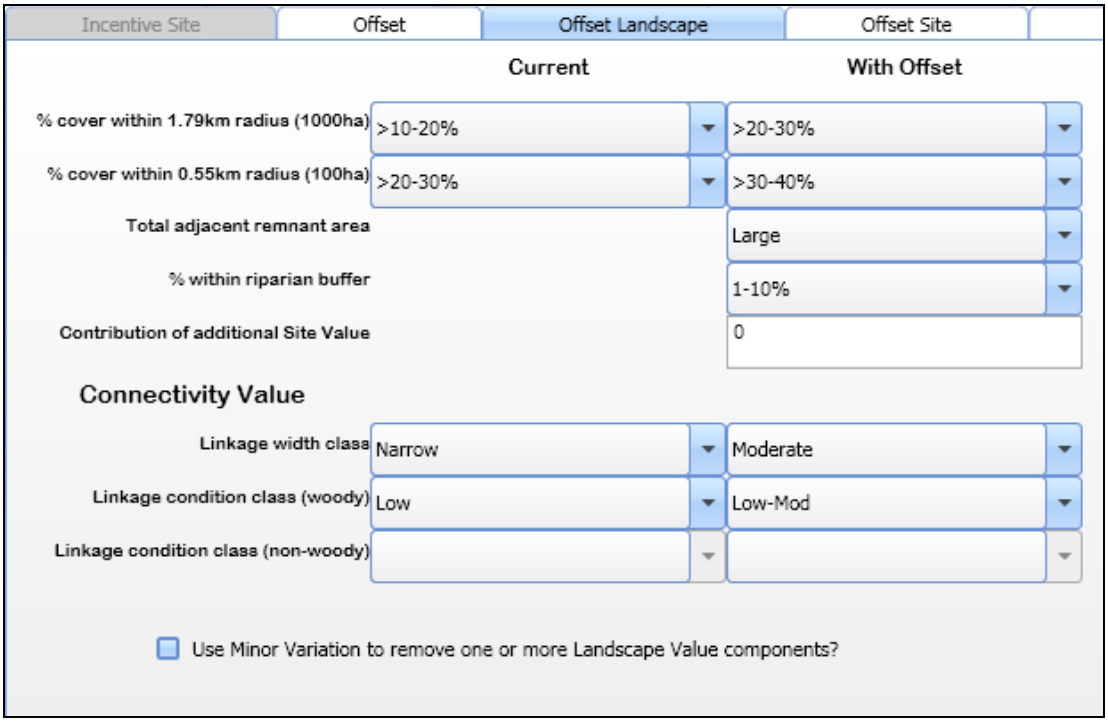
This is measured in the same way as described in section 3.2.11.

Regional Value is calculated automatically after Offset Site Value data has been entered. If the offset for Regional Value returns a negative balance in the summary panel at the top, the assessment can still be completed, however the following message will be returned.



If this occurs, the assessor needs to discuss options with landholder, and possibly with CMA and DECCW colleagues and modify the assessment, including use of minor variation or more appropriate local data, or terminate the assessment.

3.6 Offset Landscape tab



3.6.1 Landscape Value

Landscape Value is measured as described in section 3.3.1. Both the 'Current' and 'With Offset' categories for offset zones are assessed as though clearing has taken place. 'With Offset' does not mean the net effect of clearing and offset on Landscape Value, rather it means Landscape Value for the offset zone with the cleared vegetation removed. Two additional measures for offset zones; (1) "percent within

riparian buffer", and (2) "Contribution of additional Site Value", also contribute to Landscape Value.

The change in Landscape Value at the offset site(s) is determined using the following formula:

$$\textit{Landscape Value}_{\textit{Offset site}} = \left(\sum_{v=a}^{f}\left(s_v w_v\right)\right)_{\text{With proposed offsets}} - \left(\sum_{v=a}^{c}\left(s_v w_v\right)\right)_{\text{Current}}$$

where:
s_v is the score for the *v*th variable (*a*-*f*) as defined below
w_v is the weighting for the *v*th variable (*a*-*f*) as defined below
a = percent cover of native vegetation within a 1.79 km radius of the site (1000 ha)
b = percent cover of native vegetation within a 0.55 km radius of the site (100 ha)
c = connectivity value
d = total adjacent remnant area
e = percent within riparian area
f = contribution of additional Site Value offsets to Landscape Value

3.6.1.1 "percent within riparian buffer" score

Offsets with ≥1% of their area within riparian area (as defined in Appendix 6) receive an additional score of 4-12 points (see Table 9). This recognises the high value of riparian areas for biodiversity (e.g. MacNally *et al.* 2000). The 'With Offset' part of the assessment is made on the assumption that the proposed clearing has occurred. Choose the appropriate percentage of the offsets that are in the riparian area from the drop down box in *BioMetric.*

Table 9. Criteria for assessing total percent of offset within riparian area (riparian buffer distances as defined in Appendix 6).

Score	0 points	4 points	8 points	12 points
percent within riparian area	<1%	1-10%	>10-25%	>25%

3.6.1.2 "Contribution of additional Site Value" score

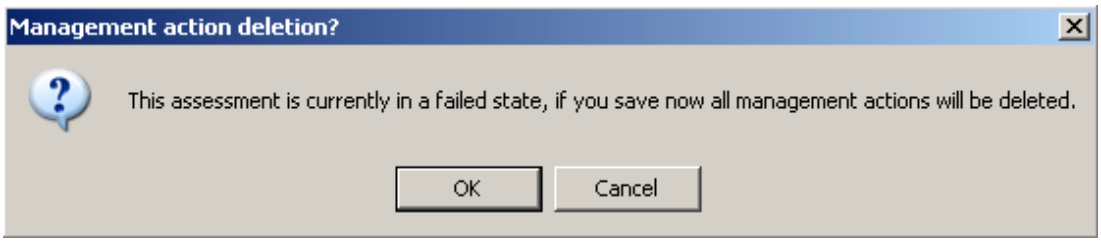
Improvements in Site Value on offset zone(s) above those required to offset losses in Site Value on clearing zone(s) can contribute the additional Site Value score to the Landscape Value score for the offset. This applies to clearing zone(s) where the Mitchell Landscape (ML) and Vegetation Type (VT) are both ≤30% cleared in the CMA. For zone(s) that meet this criterion, *BioMetric* automatically calculates the additional score using any excess Site Value gain above that required to offset all Site Value losses. This value is calculated as a proportion of the required Site Value score (for the relevant zones only) using the equation below, and converted to a score according to Table 10. Therefore, the overall Landscape Value for the offset cannot be determined until Site Value data have been entered.

Additional SV (percent) = {(Total SV gains-Total SV losses)/SV losses for clearing zone(s) that are ≤30% cleared (ML and VT)} x 100%

Table 10. Criteria for scoring additional Site Value score contribution to Landscape Value for offset sites. Both the Mitchell Landscape and Vegetation Type must be ≤30% cleared for zones to qualify for bonus score.

percent cleared status of clearing zone	Additional Site Value as a proportion of Site Value required for zone/s ≤30% cleared	Additional points that contribute to the Landscape Value score
Mitchell Landscape and/or Vegetation Type are >30% cleared in the CMA area	n/a	0
Mitchell Landscape and Vegetation Type are both ≤30% cleared in the CMA area	0	0
	>0 - 10%	1
	>10 - 20%	2
	>20 - 30%	3
	>30 – 40%	4
	>40 – 50%	5
	>50 – 60%	6
	>60 – 70%	7
	>70 – 80%	8
	>80 – 90%	9
	>90 – 100%	10
	>100%	12

If the offset for Landscape Value returns a negative balance in the summary panel at the top of the screen, the assessment can still be completed, but the tool will not save the management actions and the following message will be returned. The tool and its data will be saved as a record of the red light.



If this occurs the assessor must discuss options with the landholder and CMA colleagues, and modify the assessment including using minor variation and/or more appropriate local data, or terminate the assessment.

3.7 Offset Site Tab

3.7.1 Site Value

This part of the assessment can proceed regardless of whether the offset has passed the Regional and Landscape Value components of the assessment (recorded as the Balance in the summary panel at the tope of the window), to allow assessors to explore offset options at the site scale. However, failed assessment cannot be saved.

The 'Current' score is measured as described in section 3.4.1.

The 'Score with Offset' is based on how much the management action(s) proposed by the landholder are predicted to improve each condition variable. Note that these do not need to be new management actions - they may include or comprise actions that the landholder is already undertaking and for which further gains are expected. For example, a landholder can propose an area in which grazing was previously excluded and will continue to be excluded as part of the management of the offset.

The assessor predicts the future condition of the ten condition variables for each zone based on the proposed management action(s), taking into consideration the

current site condition, past and present disturbance factors at the site, and hence the likely trajectory of site recovery. The predicted improvements in condition should take into account the duration of the offset. Guidelines for scoring management actions are provided in Appendix 7, and should be used in conjunction with the disturbance history of the zone (where known). Each CMA is encouraged to develop guidelines specific to local conditions.

Proposed management actions can advance the score for each variable by increments of 0.5. Predicted score improvements need to reflect the rate at which improvement in some condition variables occurs. The score for a variable should generally be advanced by 1 (sometimes by 0.5). Movements of scores by greater amounts (e.g. two increments) should be limited to management actions to improve condition variables that have a low risk of failure (see Appendix 7 for information).

Record the proposed management action(s) for each zone in tick boxes (multiple actions can be ticked). Management actions that are mutually exclusive (e.g. grazing exclusion and strategic grazing) cannot both be selected at the same time. A red warning message and red square around the relevant management actions will appear and the assessor will need to unselect one of the management actions.

Note that these tick boxes are not automatically linked to the scoring system for Site Value, i.e. the effects of management must be scored manually. There is space for recording the specific details of each management action in the next step. An example of an assessment of current and predicted Site Value is in Figure 4.

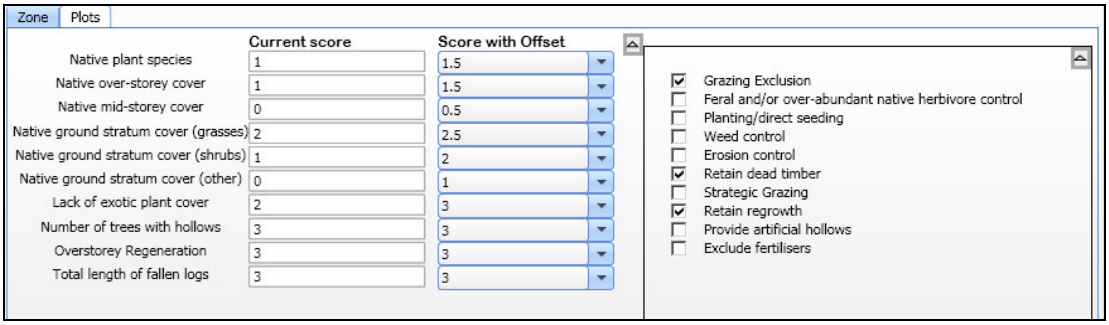


Figure 4. Assessing improvement in Site Value on an offset zone. Site Value with the proposed offset is determined by predicting how each site value (condition) variable will change with the agreed management actions. The predicted change is based on the current site condition, past and present disturbance factors and the proposed management action(s).

In the zone information section of the tab, the 'Current Site Value for Area' and 'Proposed Site Value for Area' is calculated separately for each zone from the Site Value equation:

$$Site\ Value = \sum_{z=1}^{n} \left(\left(\frac{\left(\sum_{v=a}^{j} (s_v w_v) + 5\left((s_a s_g) + (s_b s_i) + (s_h s_j) + (s_c s_k) \right) \right) \times 100}{c} \right) \times (ZoneArea) \right)_z$$

where:
z is the nth vegetation zone
s_v is the score for the vth variable (*a-j*) as defined in Table 8
w_v is the weighting for the vth variable (*a-j*) as defined in Table 8
$k = (s_d + s_e + s_f)/3$

c is the maximum score that can be obtained given the variables *a-j* that have a benchmark greater than zero for the vegetation type (i.e. this varies depending on which variables are in the vegetation type)
ZoneArea is the total area of the *n*th vegetation zone in hectares

Condition variables with a benchmark of zero (or a benchmark range from 0-0) are removed from the Site Value calculation (from both the numerator and the denominator).

The final 'Site Value' score for each zone is not simply the difference between the 'Current Site Value for Area' and 'Proposed Site Value for Area'. Two additional factors are also taken into consideration:

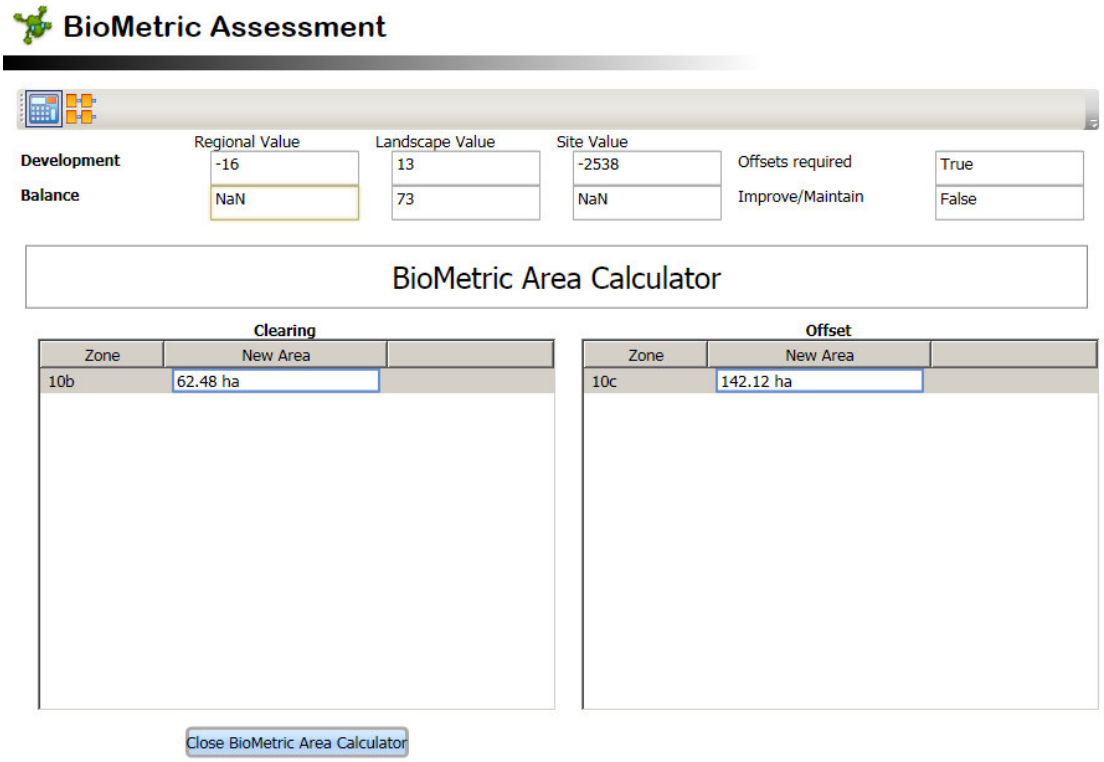
- minimum legislative standard – the extent to which the zone could be degraded over time within the minimum standards set by the *NV Act* is taken into account. This means that landholders will not get a better score by degrading native vegetation (within the standards of the *NV Act*) on the offset site prior to the assessment;
- past good management – a bonus gain of 0.5 is awarded for each variable for which the current score on an offset zone is 3 (i.e. within benchmark condition). This means that landholders who have managed their native vegetation above the standards of the *NV Act* are rewarded for that management.

The 'Balance' at the top of this window indicates whether the gain from the offset is sufficient to balance the loss from the clearing to pass the three components of the assessment. If none of the three balances in the summary is negative, the "Improve/Maintain" outcome is "True", and the assessment may proceed to the Management Actions tab. If the proposal outcome is "False", then the proposal must be modified or the assessment is terminated.

If an offset is sufficient and the assessment passes, the assessor can select the Management Actions tab to finalise the assessment.

3.8 *BioMetric* Area Calculator

Once vegetation type, landscape and site details have been entered for both clearing and offset zones (or at any stage throughout the assessment) the assessor can use the results from the entered data to test the effects of modifying the areas of the clearing and/or offset zones. This is done using the BioMetric Area Calculator (click on icon in top left of screen to launch the calculator):

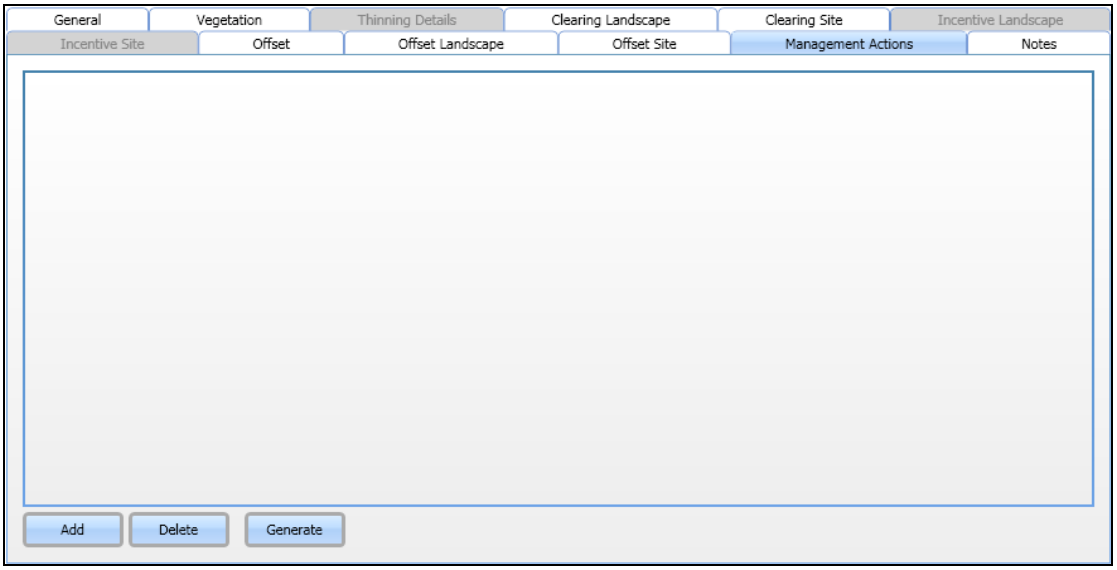


Scores for Regional and Site Value can be adjusted for each zone. Any new areas here will not be saved in *BioMetric*. Once the calculator is closed all areas revert back to the mapped areas in NVAT Mapper. Any changes required to clearing and/or offset areas will need to be made to the polygons within NVAT Mapper and the *BioMetric* assessment re-run from the activity layer.

3.9 Management Actions Tab

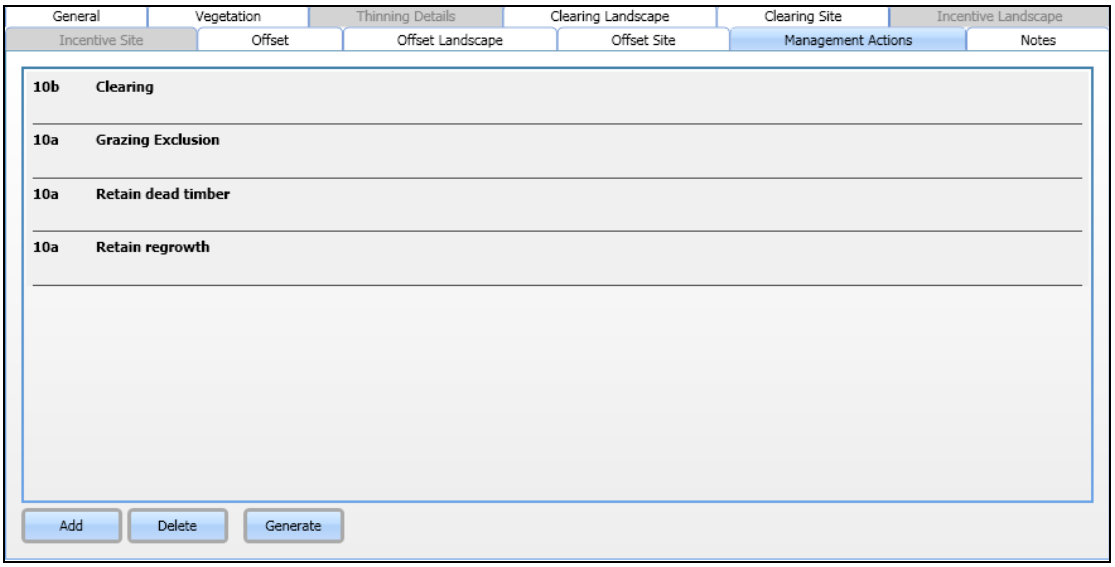
The final step is to generate and develop the agreed detailed management actions.

When you first click on the Management Actions tab, the following screen will be displayed.



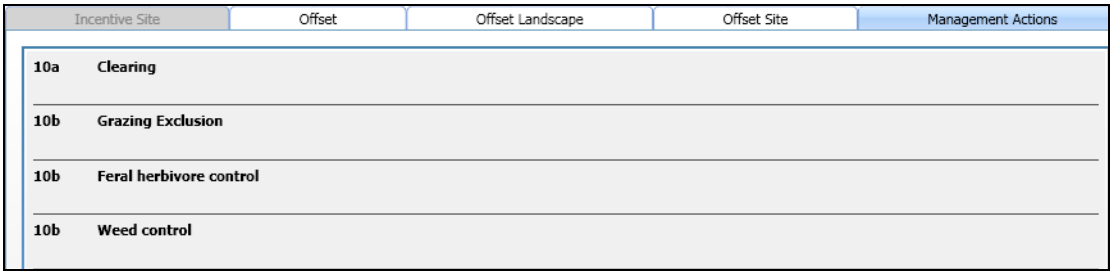
3.9.1 Generating Management Actions

The assessor clicks on 'Generate' to generate the management actions that have previously been specified on the Site Value tab. The management actions will be displayed as follows:



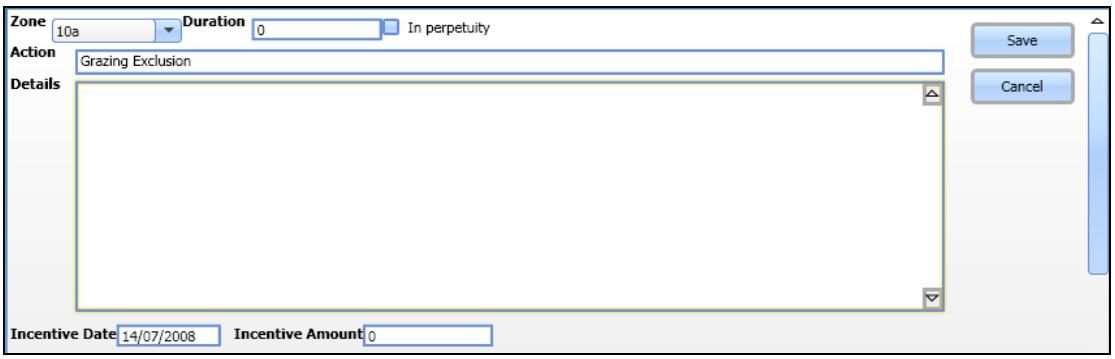
For each clearing zone, a standard 'Clearing' management action is generated by *BioMetric* which prescribes the clearing that can take place.

The management actions for the offset zones will have been agreed to by the CMA and the landholder and chosen from the Offset Site tab.



3.9.2 Editing Management Actions

To edit a management action, click on the management action that you want to edit and then click the 'Edit' button



3.9.3 Duration

The duration of the action must be entered:

- The duration of management actions for clearing zones is limited to a maximum of 15 years; shorter timeframes can be specified.
- The duration of management actions is usually 'In perpetuity' for offset zones; a shorter time may be specified if the duration of the action is sufficient to offset the impacts of clearing.

3.9.4 Description of management actions

The assessor provides a description of each management action within each zone. The description of each management action should include:

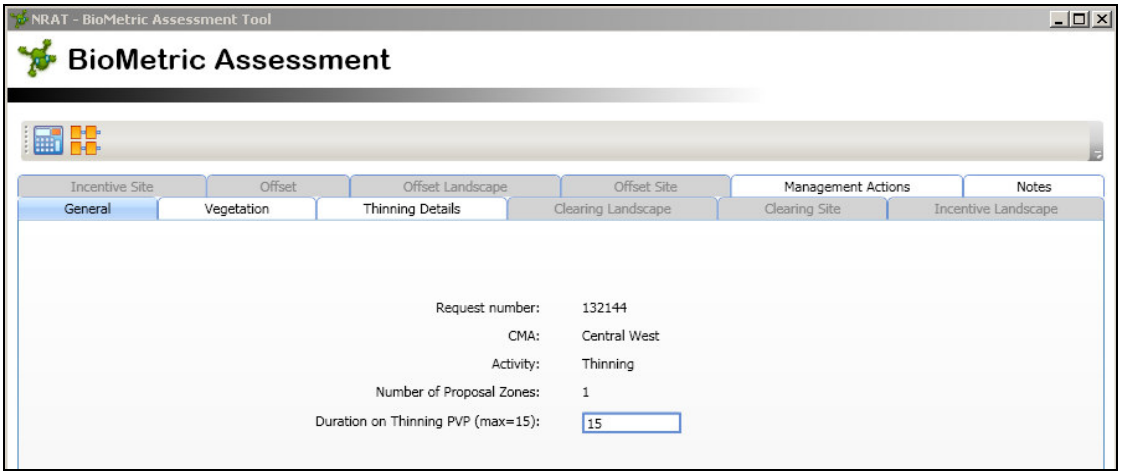
1. who is responsible (generally the landholder);
2. what they are to do or what outcome they are expected to achieve;
3. where this action is to be done (usually a Map Zone);
4. when it should be done (e.g. a date or event);
5. how long it should continue (e.g. "at all times" or until a specified date);
6. the purpose of the action (e.g. to achieve a specific outcome)

Principles for developing management agreements are provided in separate PVP documentation. These can be accessed via the Native Vegetation Community of Practice website (http://deccnet/natcon/NvCoP/ResManAction.htm).

4 Proposals to thin native vegetation – running *BioMetric*

The following section describes how to work through the tabs in *BioMetric* for proposals to thin remnant native vegetation or protected regrowth to benchmark stem densities.

For information on mapping thinning areas consult the NVAT Mapper User Guide.



This component of *BioMetric* is available when the activity of the area to be thinned has been set in NVAT Mapper as 'Thinning'.

Thinning improves or maintains environmental outcomes and does not require offsets if, in relation to each vegetation zone:

- The area over which thinning takes place is no more than 80% of the area of each zone; and
- The number of stems to be retained in each stem diameter class for the vegetation type is greater than or equal to the benchmark stem density for the stem diameter class for the vegetation type; and
- Stems greater than 30cm DBHOB (stem diameter at breast height, i.e. at 1.3m above the ground, measured over bark) are not removed; and
- Thinning is undertaken by removing individual trees and shrubs with no or minimal disturbance to native groundcover, soil and non-target plants (e.g. by means such as chemical treatment of individual plants, ringbarking or grubbing); and
- Within riparian areas (see Appendix 6) thinning is only undertaken by removing individual trees and shrubs with no disturbance to native groundcover, soil and non-target plants; and
- The number of stems retained for each diameter class are retained at that density on each one hectare of the proposal area; and
- Thinning is not undertaken in patches of less than one hectare in area that are not linked to adjoining vegetation; and
- The thinning is ecological thinning.

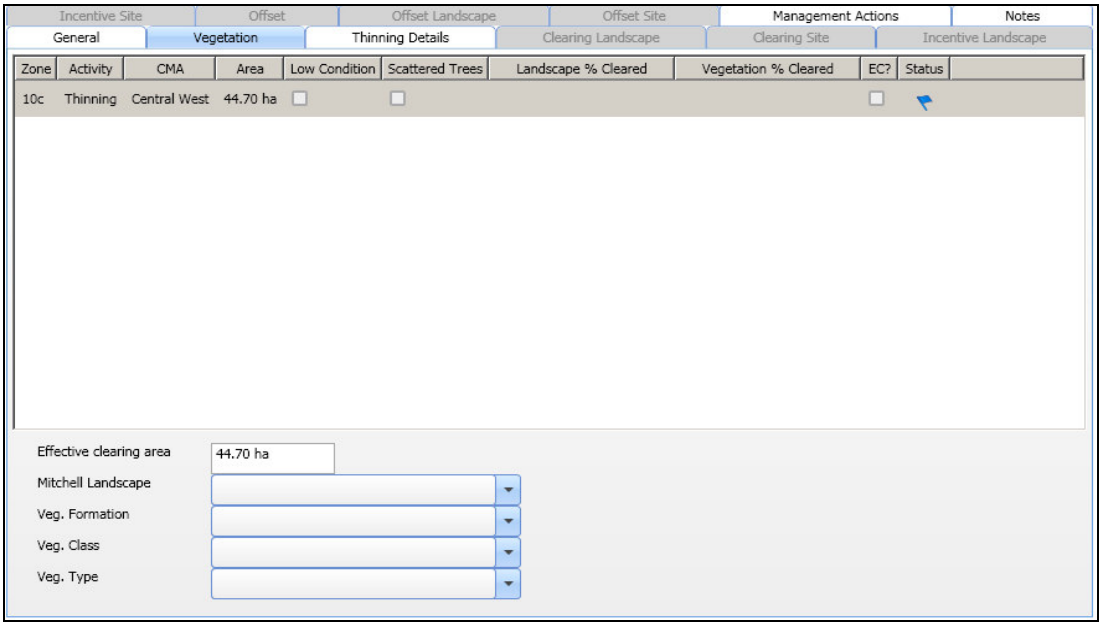
If proposed thinning does not meet these criteria the assessment fails and if the landholder wishes to proceed, the assessor needs to discuss options with the landholder (and possibly with CMA and DECCW colleagues), and modify the

assessment, including use of minor variation, or assess the proposal as a different clearing application or terminate the assessment.

Ecological thinning is the removal of individual trees or shrubs where they are above benchmark stem densities. The purpose of ecological thinning is to reduce competition between the trees or shrubs to allow growth and maturation of the remaining trees and shrubs, and growth of groundcover. Ecological thinning allows natural regeneration and subsequent growth of native trees, shrubs and groundcover, thus improving or maintaining vegetation composition and structure.

4.1 Vegetation tab

Zone, Activity, CMA and Area are automatically populated from NVAT Mapper. Before proceeding you need to check that the zones that you are assessing are the correct zones. Vegetation types with different stem density benchmarks, and areas of vegetation with different stem densities must be assessed as separate zones. Refer to Appendix 1 for further guidelines on how to map vegetation zones.



Low Condition, Scattered Trees, and Ecological Community tick boxes are greyed out as they do not affect the assessment for thinning. It is useful to record the Mitchell Landscape information for reporting purposes.

Record the Mitchell Landscape, Vegetation Formation, Class and Type for each zone in the same way as for a regular clearing proposal (see sections 3.2.4, 3.2.5 and 3.2.6).

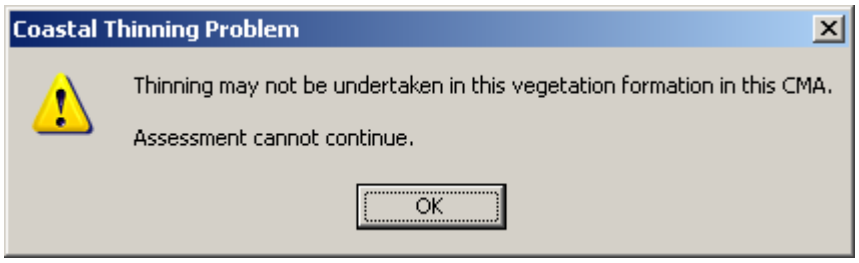
In coastal CMAs, thinning is permitted only for genera listed in the Coastal Thinning Genera Database (see Table 11), within vegetation types that occur in the following Vegetation Formations (*sensu* Keith 2004):

- Wet Sclerophyll Forests (grassy subformation)
- Wet Sclerophyll Forests (shrubby Subformation)
- Grassy Woodlands
- Dry Sclerophyll Forests (shrub/grass subformation)
- Dry Sclerophyll Forests (shrubby subformation).

Table 11. Coastal Thinning Genera Database.

Genus	Maximum dbhob that may be thinned (cm)
Eucalyptus	30
Corymbia	30
Angophora	30
Melaleuca	20
Casuarina	20
Allocasuarina	20
Callitris	20
Acacia	20

If a Vegetation Formation is selected in which thinning is not permitted, the following warning message is displayed:



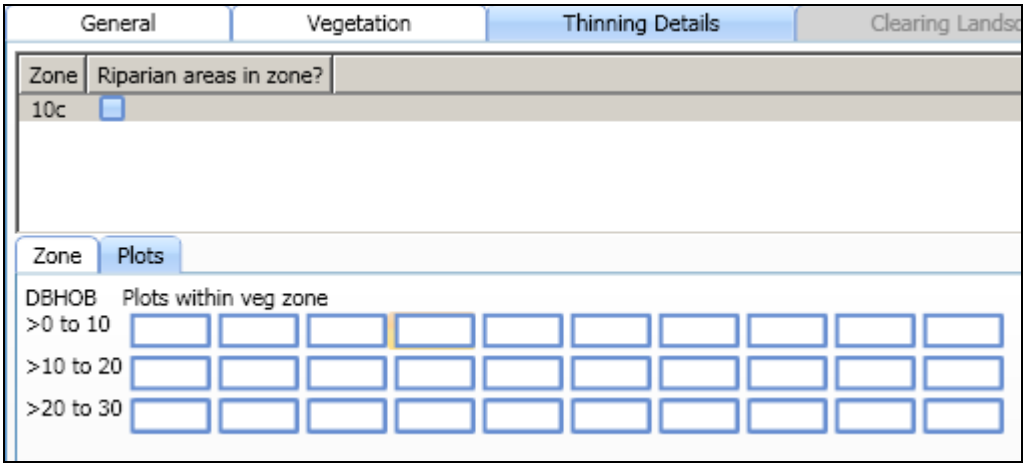
Thinning in non-coastal CMAs is not restricted by genus.

4.2 Thinning Details tab

Thinning proposals are assessed as follows:

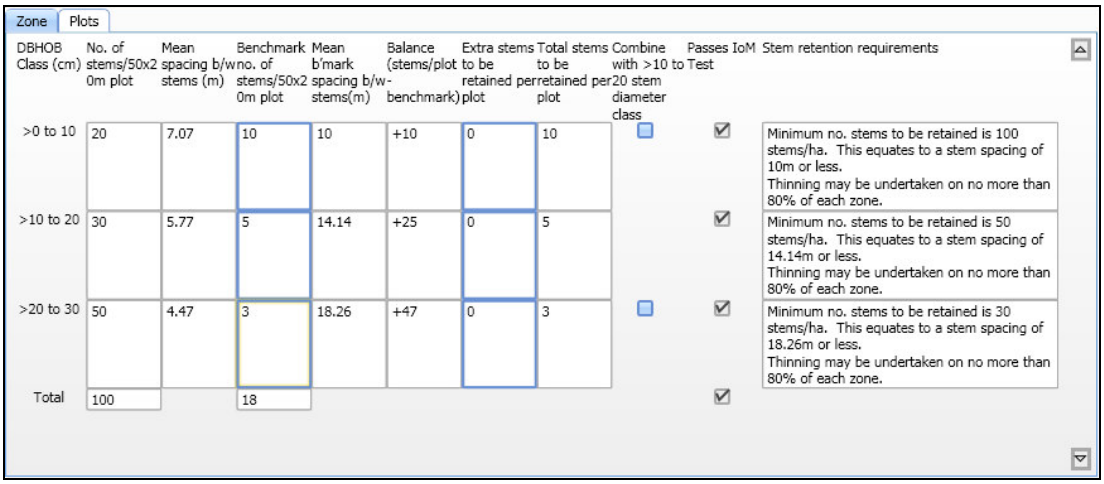
1. Determine if riparian areas are present in the zone to be thinned. This is done by running the Water Quality Tool, which places buffers around the riparian areas and draws them onto the map that will be provided with the PVP. If riparian areas exist, tick the box. This limits the type of thinning that may be undertaken in these areas, that is, no disturbance to groundcover, soil and non-target plants.
2. Establish 50x20m (0.1ha) assessment plots in each zone as per section 3.4.1, with a maximum of 10 plots per vegetation zone. Alternatively, plotless methods of assessing stem numbers in each stem diameter class, such as nearest neighbour techniques, can be used. *BioMetric* is not currently set up to accept data in this format and the data collected must be converted to stems per 0.1ha.

   The numbers of stems in each specified stem diameter (DBHOB) class in the plots are recorded on a data entry sheet in the field (see Appendix 9) and transcribed into the Plot tab for the corresponding zone. Methods for assessing stem numbers in the field are described in Appendix 4.



3. Benchmark stem density data are also required. Some benchmark stem density data are available from

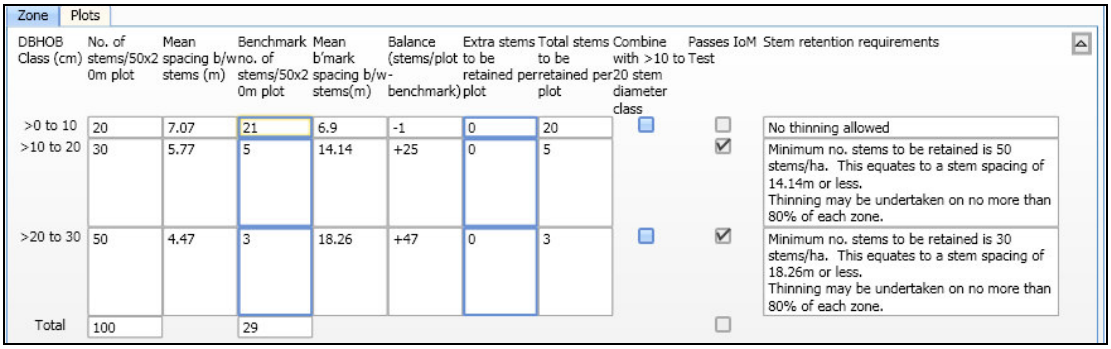
   http://www.environment.nsw.gov.au/projects/BiometricTool.htm. Reference sites are usually required to obtain benchmark stem counts (see Appendix 5). Enter the benchmark data into the Zone tab.



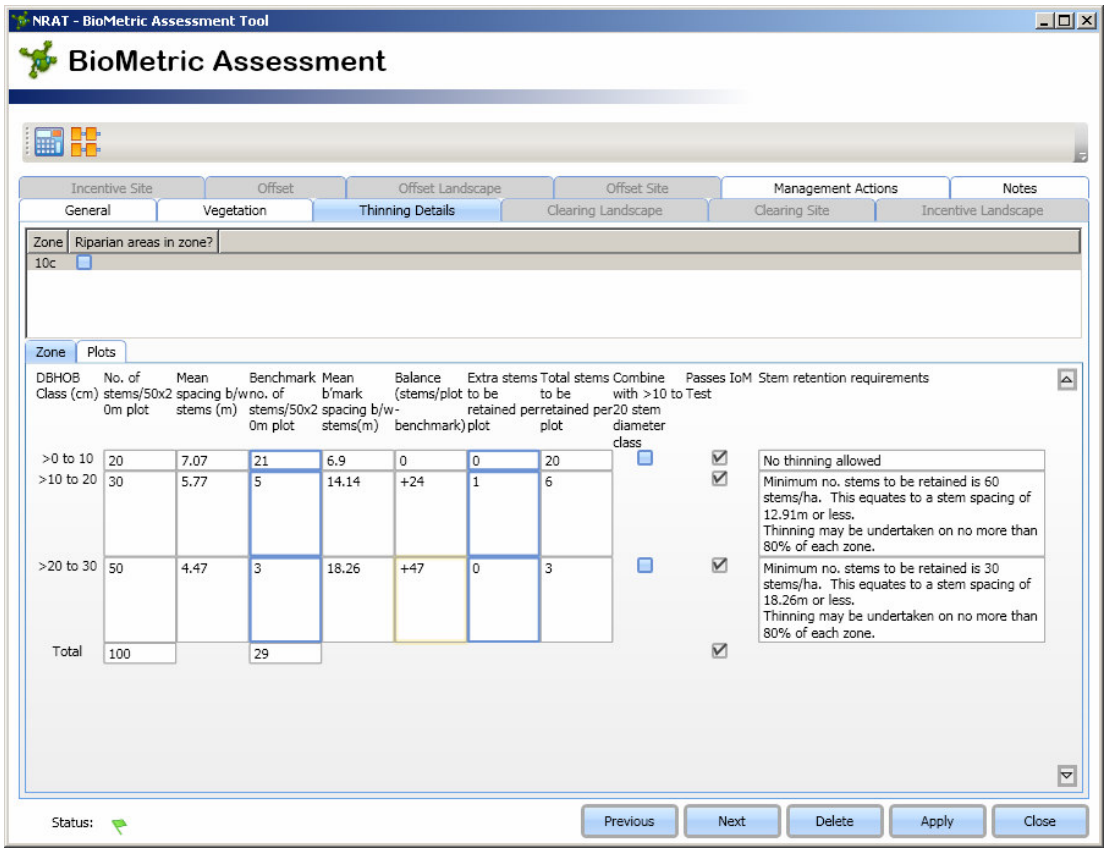
4. For each DBHOB class in each zone, *BioMetric* will:
   a. automatically calculate the mean spacing between stems and the corresponding mean stem spacing under benchmark conditions;
   b. determine whether the number of stems is above benchmark (Passes IoM Test boxes will be automatically ticked);
   c. indicate the stem density to be retained per 0.1ha in the zone;
   d. indicate whether thinning can proceed; and
   e. outline the stem retention requirements.

Note that "extra and total stems retained per plot" in the second last and last columns in the screen shot above are part of the calculation to determine the number of stems retained per hectare. Stems are retained per hectare not per plot (which is one tenth of a hectare).

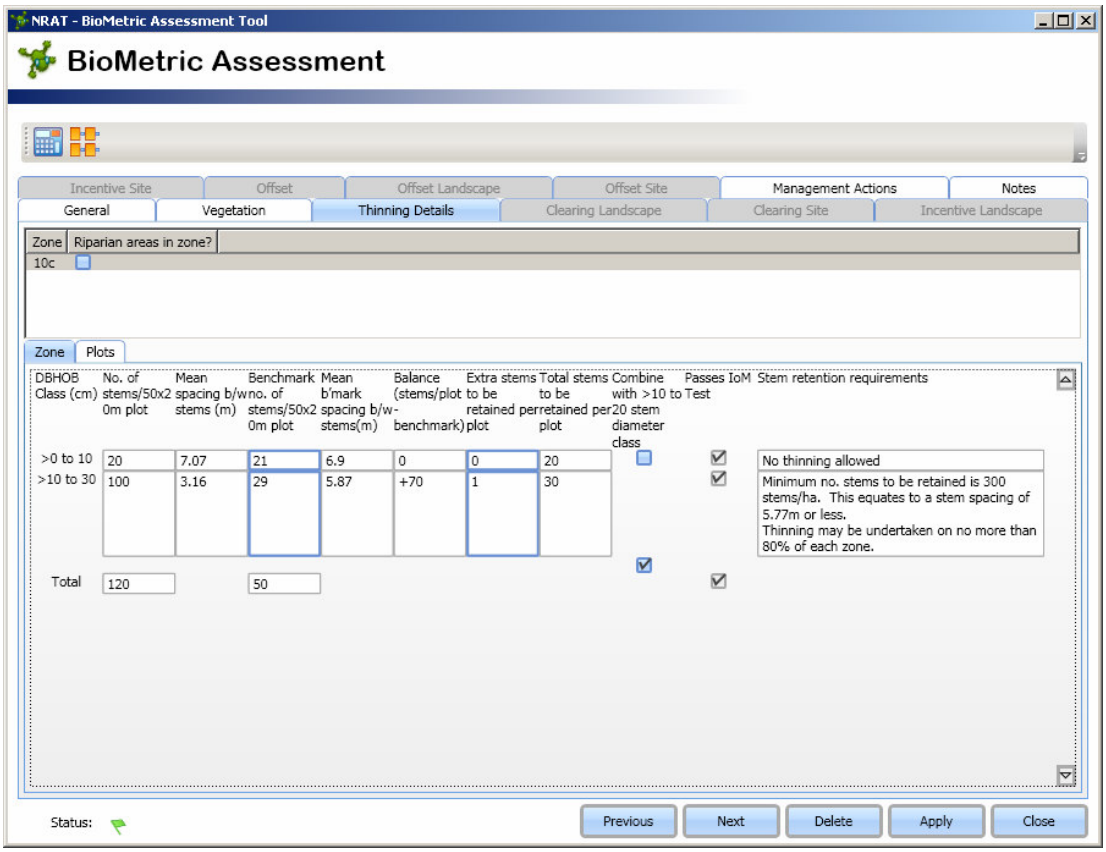
5. Thinning cannot proceed if the Total number of stems is not greater than the Total Benchmark number of stems.



6. Where stems are already below benchmark in a particular diameter class, additional stems must be retained in a larger or smaller diameter class to account for this shortfall. Record the number of additional stems to be retained in the "Extra stems to be retained per plot" field. If possible, stems should be retained in the next larger category before being retained in the next smaller category.



7. If two or more stem diameter classes (≤30cm DBHOB) are in the same age cohort, then one stem density benchmark for the combined classes can be calculated by summing the benchmarks for the individual classes, and entered into *BioMetric*. Similarly, combined counts of stem numbers can be assessed in the assessment plots. Tick the box(es) to combine the relevant DBHOB classes. Both boxes may be ticked to combine all stem diameter classes, if appropriate. In the field, record counts separately for each DBHOB class and then combine the data (if relevant) within *BioMetric.*

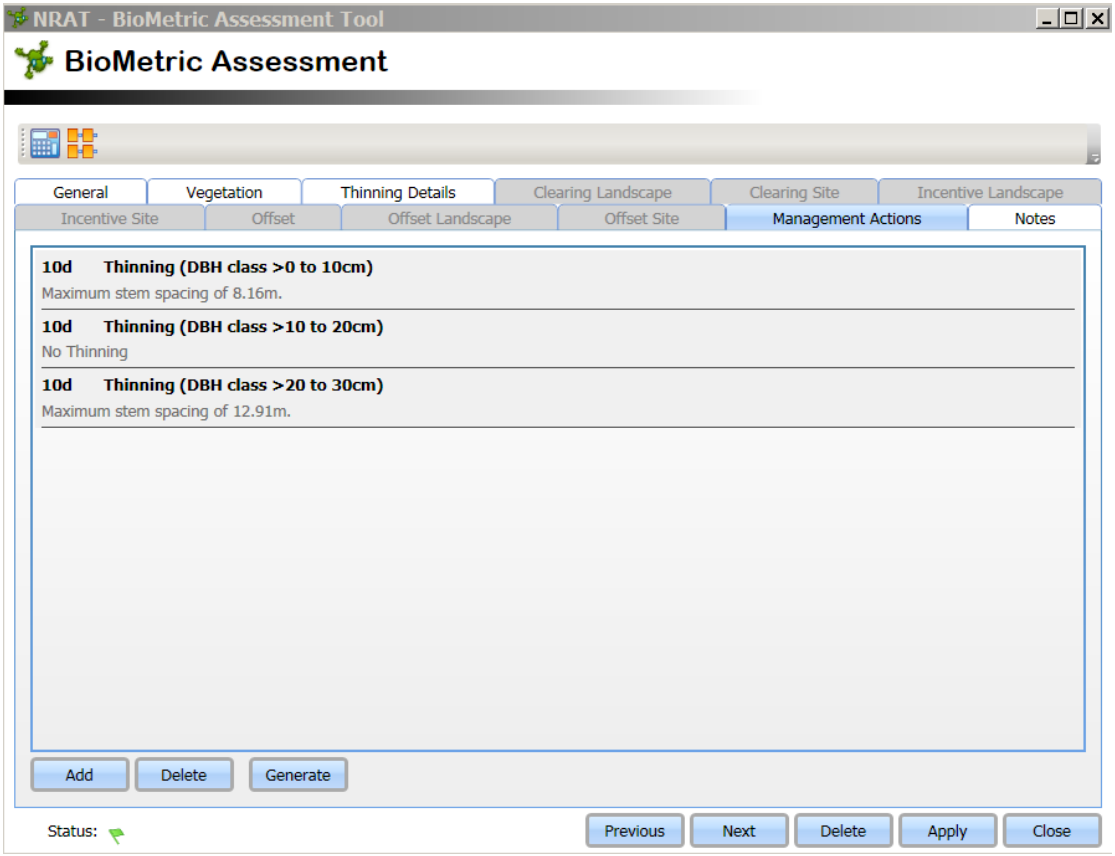


Thinning assessment can proceed to Management Actions tab if all boxes are ticked for ‘Passes IoM’ for all stem diameter classes as well as the Total.

4.3 Management Actions Tab

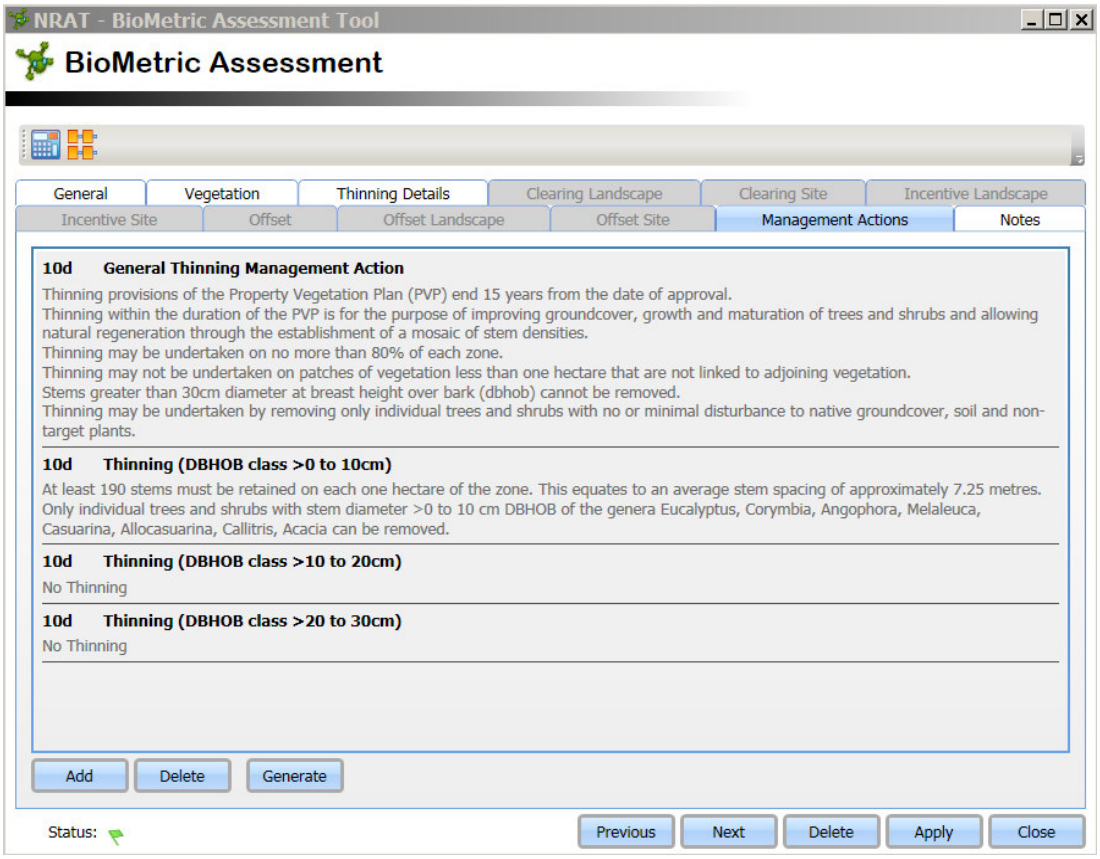
The final step is to generate and develop the agreed detailed management actions.

When you first click on the Management Actions tab, the following screen will be displayed.



4.3.1 Generating Management Actions

The assessor needs to click 'Generate' to generate the management actions that have previously been specified on the Thinning Details tab. The management actions will be displayed as follows:



General management actions that apply to all thinning zones are listed by zone. These are:

- Thinning provisions of the Property Vegetation Plan (PVP) end <duration> years from the date of approval.
- Thinning within the duration of the PVP is for the purpose of improving groundcover, growth and maturation of trees and shrubs and allowing natural regeneration through the establishment of a mosaic of stem densities.
- Thinning may be undertaken on no more than 80% of each zone.
- Thinning may be undertaken by removing only individual trees and shrubs with no or minimal disturbance to native groundcover, soil and non-target plants.
- Thinning may not be undertaken on patches of vegetation less than one hectare that are not linked to adjoining vegetation.
- Stems greater than 30cm diameter at breast height over bark (dbhob) cannot be removed.

If there are riparian areas within the zone (as indicated by the tick box) then the following management action is included:

- Thinning may be undertaken by removing only individual trees and shrubs with no or minimal disturbance to native groundcover, soil and non-target plants, except in riparian areas (including buffers) as shown on Map 1, where thinning may be undertaken by removing only individual trees and shrubs with no disturbance to native groundcover, soil and non-target plants.

For each stem diameter class the following management action will be generated:

- At least <total stems to be retained> stems must be retained on each one hectare of the zone. This equates to an average stem spacing of approximately <total stems to be retained spacing> metres.

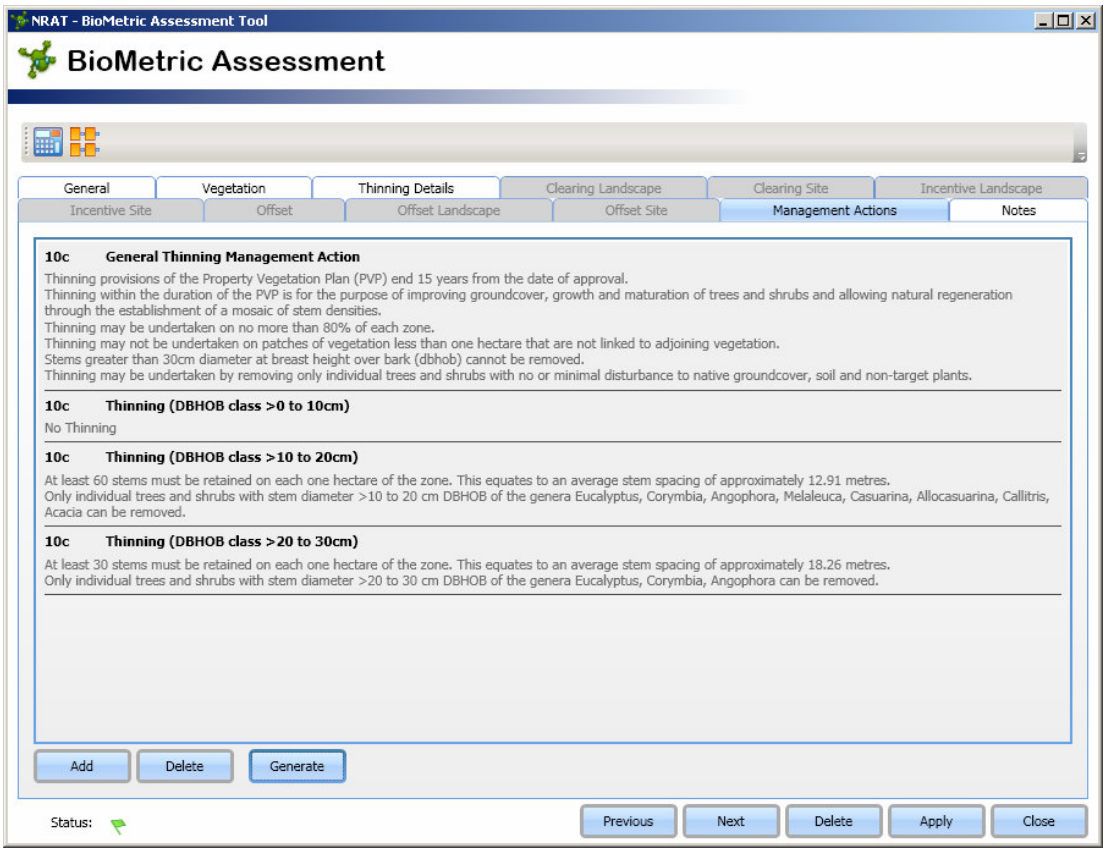
Where stem classes are combined due to being of the same age cohort, the following management action is generated for the combined stem class:

- The stem retention requirements must be met by retaining more of the larger stems and clearing more of the smaller stems in this combined stem density class.

Where the thinning is being undertaken in a coastal CMA, additional management actions are included for each stem diameter class according to the following logic:

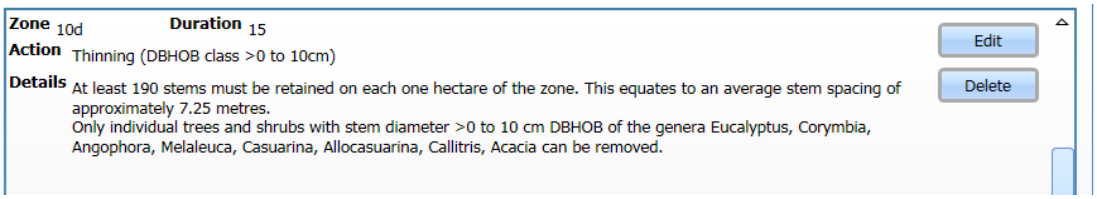
Class	**Coastal Management Action Details**
>0 – 10cm	Only individual trees and shrubs with stem diameter >0 to 10cm dbhob of the genera Eucalyptus, Corymbia, Angophora, Melaleuca, Casuarina, Allocasuarina, Callitris, Acacia can be removed.
>10 – 20cm	Only individual trees and shrubs with stem diameter >10 to 20cm dbhob of the genera Eucalyptus, Corymbia, Angophora, Melaleuca, Casuarina, Allocasuarina, Callitris, Acacia can be removed.
>20 – 30cm	Only individual trees and shrubs with stem diameter >20 to 30cm dbhob of the genera Eucalyptus, Corymbia, Angophora can be removed.
>0 – 20cm	Only individual trees and shrubs with stem diameter >0 to 20cm dbhob of the genera Eucalyptus, Corymbia, Angophora, Melaleuca, Casuarina, Allocasuarina, Callitris, Acacia can be removed.
>10 – 30cm	Only individual trees and shrubs with stem diameter >10 to 20cm dbhob of the genera Melaleuca, Casuarina, Allocasuarina, Callitris, Acacia can be removed. Only individual trees and shrubs with stem diameter >10 to 30cm dbhob of the genera Eucalyptus, Corymbia, Angophora can be removed.
>0 – 30cm	Only individual trees and shrubs with stem diameter >0 to 20cm dbhob of the genera Melaleuca, Casuarina, Allocasuarina, Callitris, Acacia can be removed. Only individual trees and shrubs with stem diameter >0 to 30cm dbhob of the genera Eucalyptus, Corymbia, Angophora can be removed.

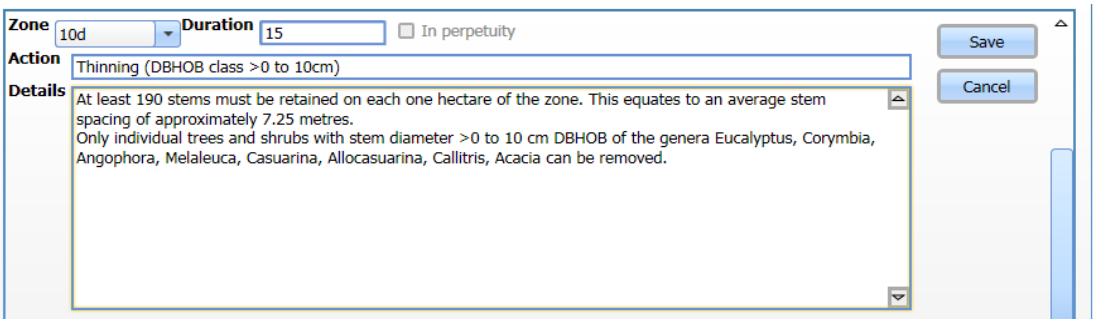
A sample Thinning Management Action Tab is shown below:



4.3.2 Editing Management Actions

To edit a management action, click on the management action that you want to edit and then click the 'Edit' button





4.3.3 Duration

The duration of management actions for thinning zones is limited to a maximum of 15 years, shorter timeframes can be specified.

4.3.4 Description of management actions

The assessor provides a description of each action within each zone. The description of each management action should include:

1. who is responsible (generally the landholder);
2. what they are to do or what outcome they are expected to achieve;
3. where this action is to be done (usually a Map Zone);
4. when it should be done (e.g. a date or event);
5. how long it should continue (e.g. “at all times” or until a specified date);
6. the purpose of the action (e.g. to achieve a specific outcome)

Principles for developing management agreements are provided in separate PVP documentation. These can be accessed via the Native Vegetation Community of Practice website (http://deccnet/natcon/NvCoP/ResManAction.htm).

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6 Glossary

Age cohort. Trees or shrubs in a vegetation community that recruited within the same recruitment event. An age cohort may fall within one or more stem diameter classes under Section 5.4.2 of the EOAM.

Benchmarks or benchmark value or vegetation benchmark. Benchmarks are quantitative measures of the range of variability in vegetation with relatively little evidence of modification by humans since European settlement (post 1750). Benchmarks are defined for the 10 condition variables used to calculate Site Value by vegetation community (predominantly Vegetation Class *sensu* Keith 2004, or Vegetation type) at the scale of the stand or patch. Vegetation with relatively little evidence of modification generally has minimal timber harvesting (few stumps, coppicing, cut logs), minimal firewood collection, minimal exotic weed cover, minimal grazing and trampling by introduced or over abundant native herbivores, minimal soil disturbance, minimal canopy dieback, no evidence of recent fire or flood, not subject to high frequency burning, and evidence of recruitment of native species. Benchmarks are used in *BioMetric* as yardsticks against which to assess the current and predicted future condition of native vegetation for clearing (including thinning), offset and incentive proposals. Benchmarks are currently available at http://www.environment.nsw.gov.au/projects/BiometricTool.htm. or may be obtained from reference sites, scientific literature or expert knowledge provided that the data has been certified by an accredited expert as set out in section 2.4.3 of the EOAM.

Broadscale clearing. Clearing of remnant native vegetation or protected regrowth (as defined in the NSW *Native Vegetation Act 2003*).

Connectivity value. A measure of the extent to which native vegetation is linked to native vegetation that is not in low condition. Assessed according to section 3.3.1.3. and Appendix 3.

Crown cover or percent crown cover. The percentage of the sample site within the vertical projection of the periphery of the crowns, i.e. the crowns are treated as opaque (Walker and Hopkins 1998). Crown cover is not used in *BioMetric*, however it can be used to calculate percent foliage cover for over-storey and mid-storey strata (see Appendix 4).

Database. See Chapter Section 2.4.1 of the EOAM.

Derived vegetation type. A vegetation type modified substantially since European Settlement and with no relatively unmodified analogue. Further defined in section 3.2.6.1. Also refer to more detailed information at http://www.environment.nsw.gov.au/projects/BiometricTool.htm.

Development. Clearing or thinning native vegetation.

DBHOB. Stem Diameter at Breast Height (i.e. at 1.3 metres above the ground), measured Over Bark.

Ecological thinning. Means thinning (clearing that comprises only the removal of individual trees or shrubs to benchmark numbers or greater) to reduce competition between tress or shrubs to allow growth and maturation of the remaining trees and shrubs, and growth of groundcover. Ecological thinning allows natural regeneration and subsequent growth of native trees, shrubs and groundcover, thus improving or maintaining vegetation composition and structure. Ecological thinning as defined here improves or maintains environmental outcomes for biodiversity in its own right (no offset is required). Thinning to below benchmark levels for stem numbers is assessed as other clearing generally requires offsets to improve or maintain

environmental outcomes for biodiversity, or is assessed as invasive native scrub if appropriate.

Effective Clearing Area. The clearing area assessed as if the vegetation is just below 25% of lower benchmark for the percent foliage cover of the over-storey, using the NVAT Scattered Paddock Tree Tool.

Fallow. Land that is normally ploughed and cropped but does not contain a crop at the time of assessment. The land must have been ploughed and cropped within the last three years.

Grassland vegetation. Herbaceous native vegetation in the Grasslands vegetation formation described in Keith (2004).

Groundcover. Any type of herbaceous vegetation as defined in the *Native Vegetation Act 2003*.

Ground stratum. All native vegetation below one metre in height.

Ground stratum cover. Percent foliage cover of the relevant category of ground stratum native vegetation (grasses, shrubs, other).

Herbfield vegetation. Herbaceous native vegetation that does not contain an over-storey or mid-storey and where the ground cover is dominated by non-grass species.

Landscape Value. Measure of native vegetation cover, connectivity and adjacency of native vegetation. On offset sites Landscape Value may also include riparian areas and any additional Site Value contribution.

Low condition vegetation. Defined in Box 2 in section 3.2.2.

Listed ecological community. Critically endangered or endangered ecological community listed under the NSW *Threatened Species Conservation Act 1995*, or critically endangered or endangered or vulnerable ecological community listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999.

Management actions. Actions that lead to increases (or occasionally decreases) in Site Value. Gains in Site Value on offset sites to offset loss in biodiversity from clearing are derived from increases in condition of site variables predicted to occur with management actions. Management actions fall under ten broad headings - stock grazing exclusion, strategic stock grazing, planting or direct seeding of native vegetation, weed control, erosion control, feral and/or over-abundant native herbivore control, retention of all dead timber, retention of all regrowth (regrowth as defined in the NSW *Native Vegetation Act 2003*), provide artificial hollows, cease fertiliser addition. Management actions other than the ten actions above may be required in combination with one or more of the ten actions to improve the condition variables. The additional management actions include controlling human disturbance, ecological burning, ecological thinning, and reducing water extraction from wetlands.

Mitchell Landscape. NSW is divided into 580 relatively homogeneous landscape units in terms of geomorphology, soils and broad vegetation types mapped at a scale of 1:250,000 (Mitchell 2002, 2003), which are colloquially termed “Mitchell Landscapes” after their author. These Landscapes are used in parts of the assessment in *BioMetric*.

Non-woody vegetation. Herbaceous vegetation that is grassland, wetland or herbfield vegetation.

NVAT. Native Vegetation Assessment Tool.

Offset. An area (or areas) of vegetation to which specified management actions are applied in perpetuity to achieve gains in biodiversity, in order to balance losses in biodiversity associated with clearing on another site(s).

Over-abundant native herbivore. Native herbivores that are in densities or numbers likely to cause detrimental effects on vegetation condition.

Overcleared landscape. A Mitchell Landscape in which more than 70% native vegetation cover has been cleared.

Overcleared vegetation type. A vegetation type of which more than 70% has been cleared in the Catchment Management Authority Area.

PADACS. PVPs, Agreements, Data and Customer Service – the database of PVP information used by CMAs.

Paddock trees: defined in section 5.6 of the EOAM as: "native vegetation having an over-storey percent foliage cover less than 25% of the lower percent foliage cover benchmark for the vegetation type and the ground cover is either crop, ploughed fallow or almost exclusively perennial or annual exotic pasture (90% or more of cover is exotic species)". For comparison - see Scattered trees.

Percent foliage cover. The percentage of the sample site occupied by the vertical projection of foliage and branches (Walker and Hopkins 1998). Equivalent to the amount of shadow that would be cast on the ground if there were a light source directly overhead. Also referred to as "canopy cover".

Plot. Area in which the assessment of individual site condition variables that make up the Site Value score are is undertaken; usually 0.1 hectare or 0.04 hectare depending on the condition variable being measured.

Ploughed. Cultivation of soil in preparation for sowing seed or planting.

Projective foliage cover. The percentage of the sample site occupied by the vertical projection of foliage only (Walker and Hopkins 1998). Projective foliage cover is not used in *BioMetric.*

Proposal. The proposed clearing and offset zones with the management actions (including clearing) put forward for assessment by a landholder. Includes clearing, offset, and thinning proposals. Incentive proposals are not included in this Manual.

Reference site. Sites with relatively unmodified vegetation used to obtain benchmark information where the benchmarks are not already available for a vegetation type, or where local benchmarks are more appropriate. Refer to Appendix 5 for more information.

Regional Value. A measure of the conservation significance of the vegetation type at the regional scale. Measured in *BioMetric* as the percentage of the original extent that a vegetation type has been cleared in the CMA, adjusted according to a generic species-area relationship and proportion of the proposal that the vegetation type makes up. Generally, the greater the percentage of the original extent of a vegetation type that has been cleared the higher is its Regional Value.

Regrowth. Any native vegetation that has regrown since 1983 in the Western Division or 1990 in the case of other land or since the date specified in a PVP (see Section 9 of *NV Act*) that has been previously lawfully cleared.

Riparian area. As defined in Appendix 6.

Scattered trees: Vegetation where trees are sparse, and hence the measurement of condition estimates from plots are not practical. Scattered trees are usually, but not always, in low condition. Scattered trees may include paddock trees (sensu section 5.6 of the EOAM) and scattered trees with native understorey. Zones comprising scattered trees can be assessed using the NVAT Scattered Paddock Tree Tool to obtain estimates of percent foliage cover, status according to the 'low condition' definition, numbers of trees with hollows, and effective clearing area.

Site Value. Quantitative measure of structural, compositional and functional condition of native vegetation (measured by site attributes) multiplied by the area of the zone. Determined by assessing the ten condition variables against the corresponding benchmarks.

Stem density. Number of tree stems per hectare, measured in plots or by plotless methods. Where a single tree has multiple stems, only the largest stem is counted.

Total adjacent remnant area. The total remnant area of which the proposal is a part. Assessed as extra large, very large, large, medium or small using criteria according to Table 4 in Section 3.3.1.2.

Vegetation class. An intermediate level of vegetation classification as defined in Keith (2004) as 'groups of vegetation defined mainly by overall floristic similarities (i.e. shared species), although they may also share structural and habitat characteristics'. There are 99 Vegetation Classes across NSW. Each Vegetation Class encompasses one to many Vegetation types within each CMA area.

Vegetation condition benchmark. See Benchmark.

Vegetation formation. A broad level of vegetation classification as defined in Keith (2004). There are 12 Vegetation Formations (16 including subformations) across NSW. Each Vegetation Formation encompasses one or more Vegetation Classes within each CMA area.

Vegetation type. The finest level of vegetation classification employed in *BioMetric*. Typologies were obtained from a number of sources across NSW, so vary in the way they were defined, but are generally at the classification level of association as defined in the Native Vegetation Information System (National Land and Water Resources Audit 2000).

Vegetation zone. See Zone.

Wetland vegetation. Herbaceous native vegetation in the Freshwater Wetland vegetation formation described in Keith (2004), and is consistent with the definition of wetland in the *Native Vegetation Act 2003.*

Woody native vegetation. Native vegetation that contains an over-storey and sometimes a mid-storey that predominately consist of trees and/or shrubs.

Zone. A relatively homogenous unit within a proposal area (clearing, offset, thinning, or incentive) that is the same vegetation type and broad condition state. Separate zones can also be identified based on different management actions. A single zone must not contain a mix of vegetation in low condition and not in low condition. A vegetation zone may comprise one or more discontinuous areas. Refer to Appendix 1 for more information.

Appendix 1 - How to map vegetation zones

Proposals must be divided into relatively homogenous or discrete zones for assessment for assessment in *BioMetric*. Each zone should represent a distinct vegetation type (according to the vegetation types provided in *BioMetric*) and broad condition state (vegetation in 'low condition' must always form a separate zone to vegetation not in 'low condition'). Areas of the same vegetation type and broad condition state that are to be managed differently should also be identified as separate zones. Zones within proposals do not need to be continuous (i.e. a single zone could occupy two or more discrete areas). Each zone must be ≥0.25ha in area (equivalent to 50mx50m). Thus a smaller vegetation patch (<0.25ha) of distinctly different vegetation type, condition and/or proposed management from that surrounding it is incorporated into and assessed as part of the surrounding zone.

All zones should be digitized and labelled using the NVAT Mapper. The zone labels will be transferred into *BioMetric* automatically. An example of a clearing proposal divided into zones is provided in Figure 1.

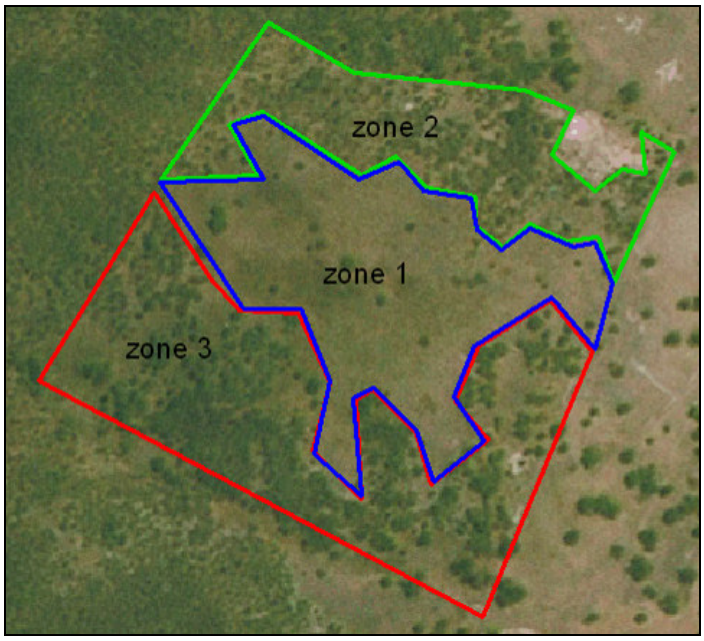
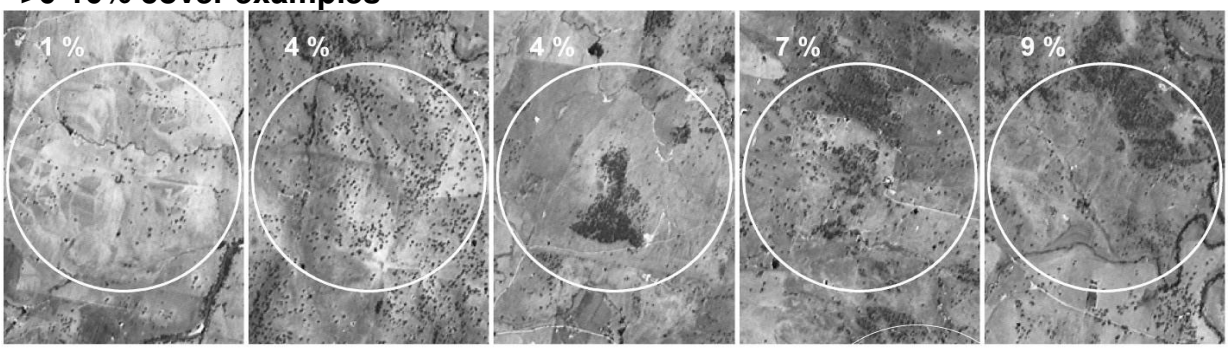


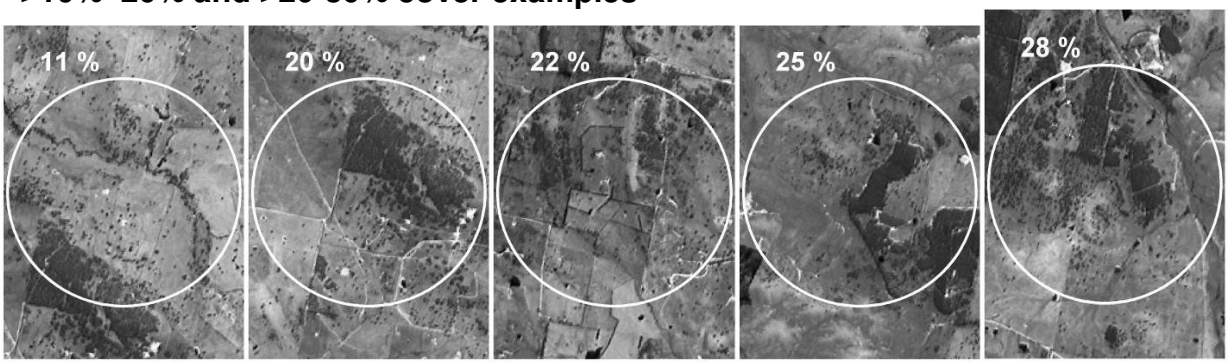
Figure 1. An example of how an area proposed for clearing (proposal area) should be broken into relatively homogeneous vegetation zones before commencing the assessment. This proposal has been broken into three zones: Zone 1, the middle zone bounded by blue, is essentially cleared and was determined to be a single vegetation type; Zone 2, the top zone bounded by green, appears to be a distinct vegetation type that is in a broadly uniform condition state; and Zone 3, the bottom zone bounded by red, is the same vegetation type as in Zone 1, but is in a different condition state.

Appendix 2 - Percent cover of native vegetation at the landscape scale

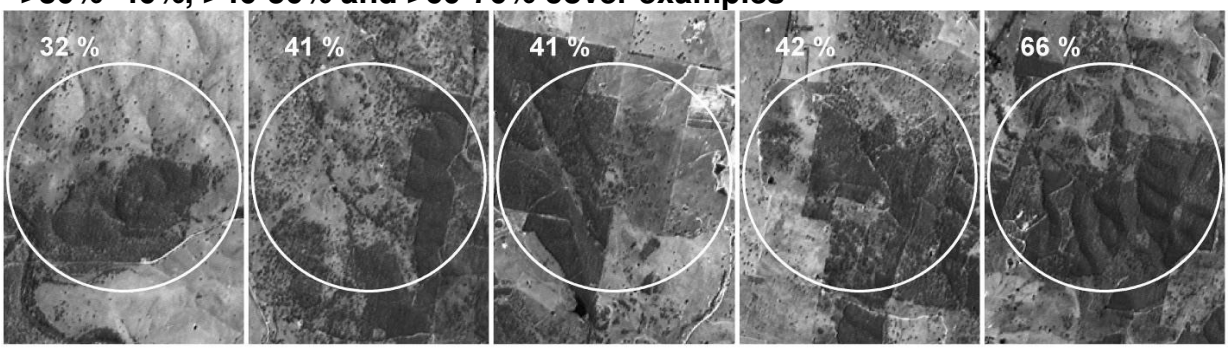
>0-10% cover examples



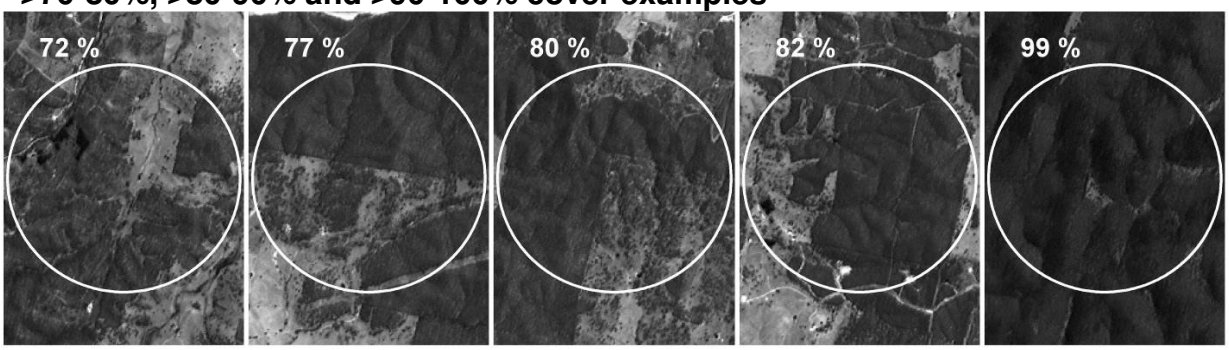
>10%–20% and >20-30% cover examples



>30%–40%, >40-50% and >60-70% cover examples



>70-80%, >80-90% and >90-100% cover examples



Appendix 3 – Assessing Connectivity in the Landscape

Connectivity and linkages in the landscape

At the landscape scale, connectivity has been defined as "the degree to which the landscape facilitates or impedes movement among resource patches (Taylor *et al.* 1993). There are two components to connectivity; structural and behavioural (or functional). Structural connectivity is anything that physically links separate populations and may consist of just about any kind of habitat in between occupied patches of habitat, e.g. corridors, partially vegetated drainage lines or fence lines. More subtle elements include scattered trees or shrubs, rocky outcrops, coarse woody debris etc. These are all known as "stepping stones" because of their scattered, non-linear structure (Doerr *et al.* 2010). Behavioural or functional connectivity relates to the behavioural response of individuals and species to the physical structure of the landscape (Bennett 1998, 2003).

In *BioMetric*, we are largely concerned with the structural component of connectivity, since we are looking at the effects upon a range of biota. The Threatened Species assessment takes the behavioural component of connectivity into account when assessing the affects of clearing and/or management actions on individual species.

Connectivity measures linkage between habitats for biota (animals and plants) in the landscape. Animals and plants and their propagules operate at different scales. Changes in connectivity in *BioMetric* with clearing and management actions measure losses and gains in linkage between habitats at the scale of metres to kilometres, with particular emphasis on the 100 metre scale as the scale of relevance to many vertebrates (see Gibbons *et al.* 2009; Doerr *et al.* 2010; Doerr *et al.* in press). Figure 1 illustrates how an individual Brown Treecreeper moves around the landscape using habitat linkages.

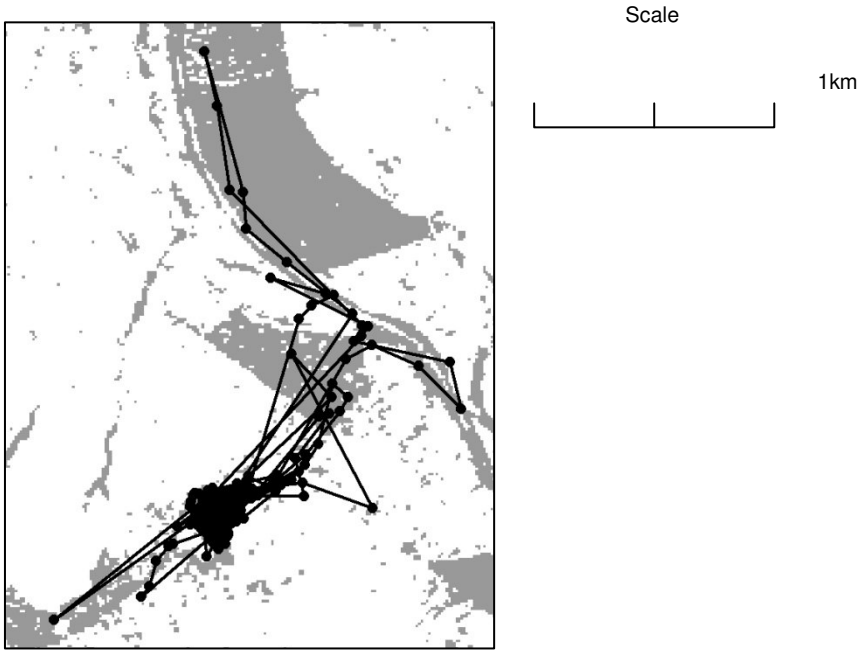


Figure 1. Movements of a Brown Treecreeper. Source - Doerr *et al.* (in press).

BioMetric assesses loss and gain in connectivity arising from loss and gain in linkages due to the clearing or offset (see Figures 3 and 10 for examples of linkages). Linkages link two areas of vegetation, often through a corridor (see below). The impacts of clearing at the clearing site and of management actions at the offset site on the connectivity of the sites to adjoining vegetation are assessed in *BioMetric* by

assessing change in the average width and condition of the primary linkage of the clearing or offset site to the adjoining vegetation. The linkage can include vegetation on and/or off the clearing or offset site.

In *BioMetric* the *average* width of the connecting linkage is assessed, whereas in BioBanking the *most limiting* width, ie, the narrowest width, of the connecting linkage is assessed. There are ecological arguments for and against both approaches. The average condition of the linkage is assessed in both *BioMetric* and in BioBanking.

Where there is more than one linkage from the clearing or offset site to the adjoining vegetation, the linkage with the highest combination of current linkage width class and current linkage condition class, i.e., the primary connecting linkage, is used to determine the connectivity value score. See Figure 2 for example.

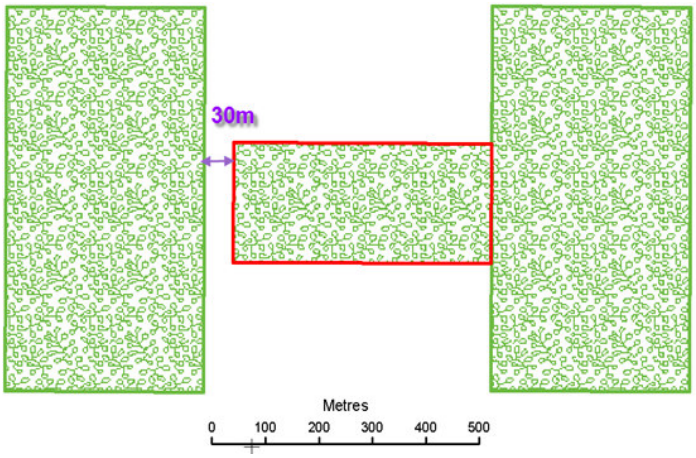
Figure 2. The area bounded by the black line is the clearing area. In this situation, loss in connectivity is assessed for the linkage towards the bottom, because this is the linkage with the higher combination of width and condition. Assessment of loss in connectivity in this example assumes that the linkage is connected to adjoining vegetation to the right of the photo.

In assessing connectivity, first determine whether or not a link or linkage exists. A link or linkage is a general term referring to areas of habitat that enhance the movement of animals or the continuity of ecological processes through the landscape (Bennett 1998, 2003). In *BioMetric*, linkages are measured as native vegetation using the following criteria.

Under the EOAM, a link or linkage exists between the clearing or offset site to adjoining vegetation where the adjoining vegetation:

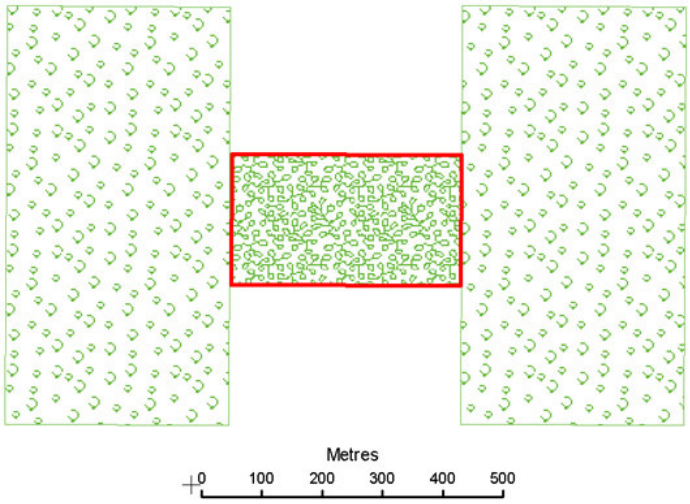
- is not in low condition; and
- has a patch size greater than 1 ha; and
- is 100 metres or closer for woody vegetation or 30 metres or closer for non-woody vegetation to the site; and
- is not separated from the site by a barrier such as a dual-lane or wider highway.

Where a linkage is changed by clearing (on the clearing site) or by management actions (on the offset site), but the linkage is connected to only one adjoining patch of vegetation, then connectivity will generally remain unchanged. This situation is an example of total adjacent remnant area and is considered as a separate component of Landscape Value. See Figures 3, 4 & 5 for examples of linkages.



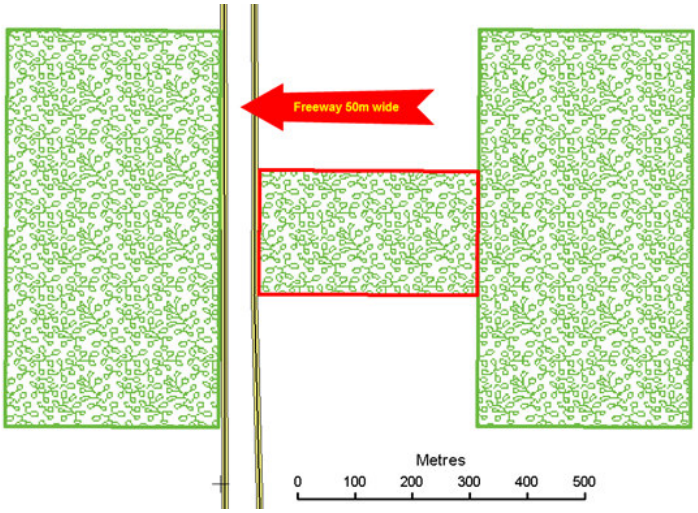
Site is linked as adjoining vegetation:
- Is NOT in low condition
- Is >1ha
- Is 100m or closer (or 30m or closer)
- Is NOT separated by a hostile barrier

Figure 3. Clearing site (red rectangle) is linked to adjoining vegetation and connectivity would be affected by clearing.



Site is NOT linked as adjoining vegetation:
- Is in low condition

Figure 4. Clearing site (red rectangle) is not linked to adjoining as both patches of adjoining vegetation are in low condition.



Site is NOT linked as adjoining vegetation:
- Is separated by a hostile barrier

Figure 5. Whilst the clearing site (red rectangle) is linked to adjoining vegetation to the right, it is NOT linked to the vegetation to the left as a hostile barrier (freeway) exists and therefore connectivity would not be affected by clearing.

Assessing loss and gain in connectivity: determining the connectivity value score

Connectivity value is determined according to the three steps below. The same process is used to determine the loss in connectivity at the clearing site and the gain in connectivity at the offset site. The effect of management actions on connectivity at the offset site is assessed as though the clearing has taken place.

Judgement needs to be applied in several ways when assessing connectivity:

a. Determining linkage condition. In woody vegetation types, the assessor needs to decide whether the mid-storey or the ground cover is the more important component for movement of biota in that linkage.

b. Considering effects of adjacent land use. The assessor needs to consider whether adjacent land use affects the width and/or condition of the linkage for biota, e.g., next to a housing development, mining site with 24 hour movement of heavy vehicles, lights etc.

c. Taking into account the importance of the linkage on connectivity at the landscape scale. There is usually no loss in connectivity with clearing or gain in connectivity with management actions in landscapes with 70% or more native vegetation remaining because such landscapes are intrinsically connected (see Figures 6 & 7). No change in connectivity with clearing or with management actions is usually scored in such landscapes.

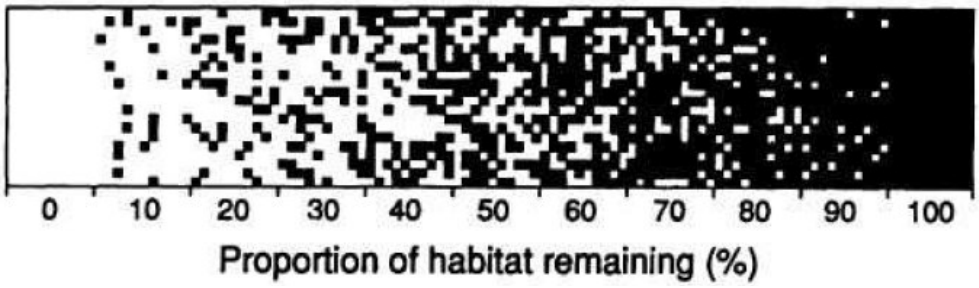


Figure 6. Relationship between connectivity and amount of habitat (native vegetation) remaining at landscape scale. Landscapes with 70% or more habitat (native vegetation) are usually intrinsically connected. Source - Andren (1994)

Figure 7. The area bounded by the red line is the clearing area. In this situation, there is no loss of connectivity with clearing because the landscape is fully connected prior to clearing, and remains fully connected following clearing. If the area bounded by the red line was the offset site, there would not be any gain in connectivity with management actions because the landscape is fully connected prior to the management actions on the offset site.

d. Where the clearing or offset site comprises part of the linkage, the connectivity value score is determined from the loss or gain in connectivity with the closest adjoining vegetation. See Figure 8 for example.

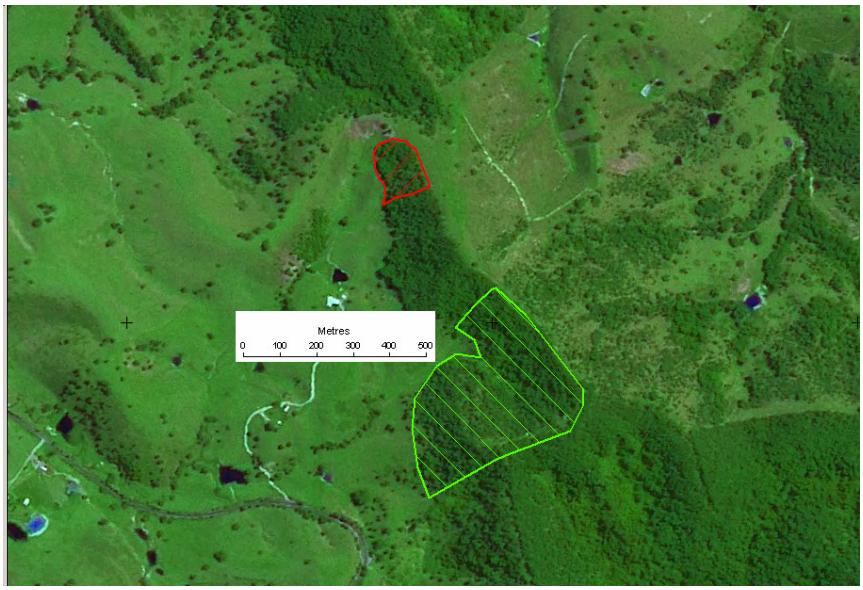


Figure 8. The area bounded by the red line is the clearing site. In this situation, the loss in connectivity is calculated as the loss in connectivity with the adjoining vegetation to the north, because the adjoining vegetation to the north is the closest adjoining vegetation to the linkage. The loss in connectivity is the average width and condition of the area of vegetation bounded by the red line plus the small (brown) area of vegetation to the north of this area that forms the linkage with the nearest adjoining vegetation. Notes: (i) The area bounded by the green line is not relevant to this example. (ii) The small brown area is assumed to be native vegetation for the example.

e. Where a linkage is changed by clearing on the clearing site or management actions on the offset site, but the linkage is connected to only one adjoining patch of vegetation and that vegetation is not linked to anything else, then judgement should be used to determine whether connectivity changes with clearing on the clearing site or management actions on the offset site. In most of these situations, connectivity does not change. The adjoining vegetation in such situations is not linked to any other vegetation. So, there is no loss or gain in connectivity. See Figure 9 for illustration.

Judgement is required to determine when to score no loss or no gain in connectivity when the linkage is connected to only one adjoining patch of vegetation and that vegetation is not linked to anything else. Take into account the area of the linked adjoining vegetation (or the area of the linked adjoining vegetation plus the next linked area of adjoining vegetation, if more than one patch is sequentially linked to clearing or offset site) in relation to the percent cleared of the landscape. Table 5.4 in the EOAM and Table 4 (section 3.3.1.2) in the Operational Manual can be used to provide guidance.

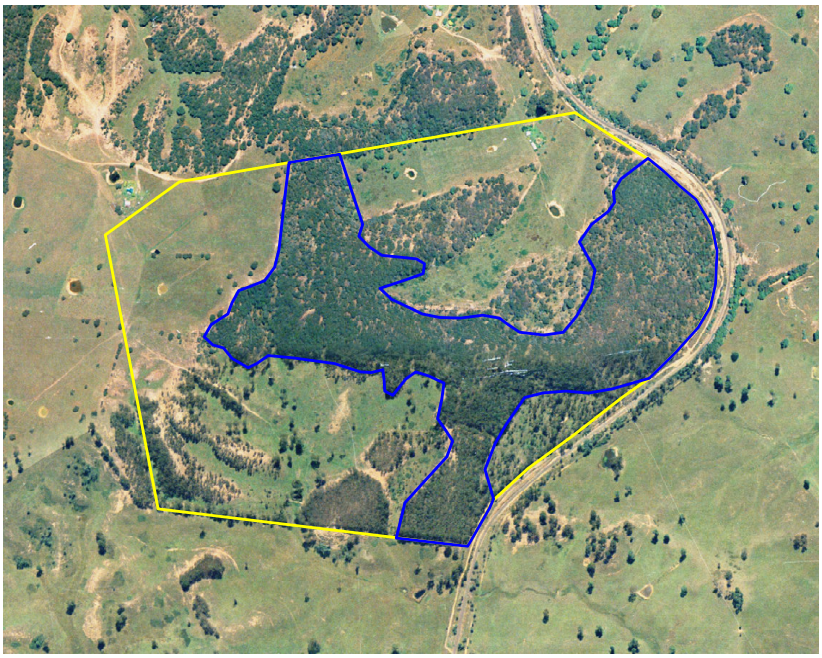


Figure 9. Example of adjoining vegetation not connected to any other adjoining vegetation. The area bounded by the blue line is the clearing area. In this situation, there is no loss in connectivity with clearing because the small area of adjoining vegetation to the lower right of the clearing site is not linked to any other adjoining vegetation. If the area bounded by the blue line was the offset site, there would not be any gain in connectivity with management actions for the same reason.

Steps to determine the connectivity value score

Step 1: From Table 1 below, determine the current linkage width class and the future linkage width class with clearing (clearing site) or with management actions (offset site), and then determine the number of linkage width thresholds crossed. The number of linkage width class thresholds that are crossed in going from the current linkage width class to the future linkage width class (with clearing or with management actions) is measured as the number of thresholds crossed, i.e., the number of vertical lines, crossed in Table 1. Enter the current and future width classes for the primary linkage into *BioMetric,* and the number of thresholds crossed will be determined automatically.

The linkage width is the average width of the area of vegetation that links the clearing or offset site with the adjoining vegetation, including vegetation on and off the clearing and offset sites. See Figures 10, 11 & 12 for examples.

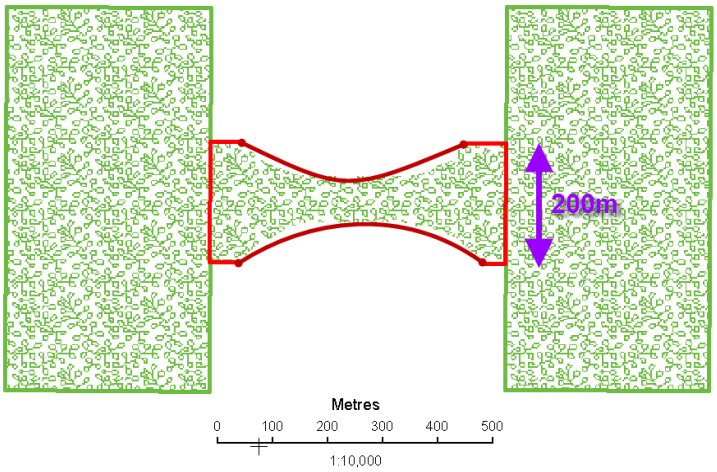


Figure 10. Average linkage width is determined by "dividing" the linkage into lengths of approximately similar widths, and then weighting these widths by the proportion of the length of the linkage they comprise. In this example, approximately 20% of the length of the linkage is 200 metres wide, approximately 20% is 100 metres wide, and approximately 60% is 150 metres wide. This provides an average width of 150 metres, ie, linkage width class "Wide". The calculations can be very approximate, unless the result affects the linkage width class. Note: The above figure is diagrammatic only, and is not drawn to accurate scale.

Figure 11. The area bounded by the red line is the clearing site. The clearing reduces the average linkage width from Wide to Narrow and does not change the average linkage condition class. Judgement is needed in this example to assess whether a change in land use following clearing will affect the future condition of the remaining linkage.

Figure 12. The area bounded by the red line is the clearing site. The clearing reduces the average linkage width from Moderate to Very Narrow and the average linkage condition class from Moderate to Nil. The black lines indicate the vegetation that comprises the linkage, although judgement could be used to place the linkage between the upper black line and the lower boundary of the clearing site (the lower red line).

Table 1. Linkage width classes and thresholds

Linkage widths (metres)				
0 – 5	>5 – 30	>30 – 100	>100 – 500	>500
Very Narrow	Narrow	Moderate	Wide	Very Wide

Enter the 'Current' linkage width class into *BioMetric*. Then calculate the linkage width class with the clearing, and with the management actions on the offset site. Enter the 'With Clearing' and the 'With Offset' linkage width classes into *BioMetric*.

The number of linkage width class thresholds that are crossed by reducing/improving connectivity of the primary connecting linkage of the site with the adjoining vegetation are scored as 0, 1, 2, 3 or 4 in *BioMetric*.

Step 2: Determine the current condition class, the future condition class with clearing (clearing site) or with management actions (offset site), and then determine the number of linkage condition thresholds crossed. The number of linkage condition class thresholds that are crossed in going from the current linkage condition class to the future linkage condition class according the number of thresholds is the number of vertical and horizontal lines crossed in Table 2a or 2b below. *BioMetric* calculates this.

The condition of the vegetation that forms the connecting linkage, including vegetation on and off the clearing and offset sites, is assessed for its average condition class over the area of the current linkage and the area of the future linkage. See Figures 13, 14 & 15 for examples.

The linkage condition classes for woody vegetation are determined by assessing either: i) over-storey cover and mid-storey cover or ii) over-storey cover and ground stratum cover, according to Table 2a. The linkage condition assessment for woody vegetation types uses over-storey cover, and either mid-storey cover or ground cover, depending on which stratum is most relevant to the vegetation. Woody vegetation contains over-storey and sometimes mid-storey that predominantly consist of trees and/or shrubs.

The linkage condition classes for non-woody vegetation are determined according to Table 2b. Non-woody vegetation is herbaceous vegetation that is grassland, wetland or herbfield vegetation. Only ground cover is assessed for non-woody vegetation.

Enter the 'Current' linkage condition class into *BioMetric* for whichever vegetation structure is appropriate. Then, determine the linkage condition class that will result from the clearing (clearing site) and from the management actions (offset site) according to Table 2a or 2b. At the clearing site, consider the effect the clearing will have on the condition of the remaining linkage. At the offset site, consider the effect the management actions will have on the condition of the future linkage. Enter the 'With Clearing' and the 'With Offset' linkage condition classes into *BioMetric*. *BioMetric* will determine the number of linkage condition class thresholds that have been crossed.

The number of linkage condition class thresholds that are crossed by reducing/ improving connectivity in the primary connecting linkage to the site are scored as 0, 1, 2, 3, 4, 5 or 6 in *BioMetric*. When clearing or management actions take the connectivity condition of non-woody vegetation from one class to another, this is counted as crossing *two* thresholds.

Note: For the purposes of assessing connectivity, shrubland vegetation <1m tall with no over-storey (i.e. the over-storey benchmark is zero) is assessed as non-woody vegetation (using Table 2b). Non-woody vegetation such as sedges, rushes or bulrushes ≥1m tall is assessed as for woody vegetation (i.e. both over-storey and ground stratum are assessed) using Table 2a.

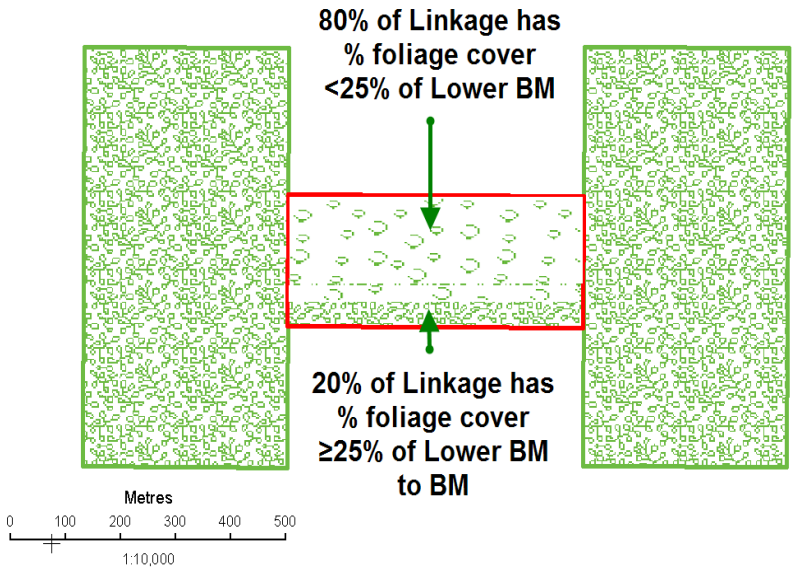


Figure 13. Average condition is determined by apportioning the linkage into areas of approximately similar condition, and then weighting the condition of these areas by the approximate area of the linkage they comprise. In this example, 80% of the linkage is in over-storey condition class <25% of lower benchmark and 20% of the linkage is in over-storey condition class ≥25% of lower benchmark to benchmark condition. This provides an average over-storey condition class of <25% of lower benchmark. The calculations can be very approximate, unless the result affects the class of the linkage width class. Note: The above figure is diagrammatic only, and is not drawn to accurate scale.

Note: For the purposes of assessing connectivity, shrubland vegetation that is less than one metre high without an over-storey (i.e. the over-storey benchmark is zero) is assessed as non-woody vegetation. Non-woody vegetation such as sedges, rushes

or bulrushes that is one metre or greater in height is assessed as for woody vegetation, i.e. both the over-storey and the ground stratum cover are assessed.

Table 2a. Linkage condition classes (woody vegetation)

		Over-storey condition			
		No native over-storey OR Exotic vegetation with similar structure to the proposal	% foliage cover <25% of lower benchmark OR Exotic vegetation with similar structure to the proposal	% foliage cover ≥25% of lower benchmark to lower benchmark	% foliage cover within benchmark
Mid-storey or ground stratum condition	No mid-storey or ground stratum cover OR Exotic vegetation with similar structure to the proposal	Nil	Nil-Low	Low	Low-Mod
	% foliage cover of mid-storey or ground stratum cover <25% of lower benchmark OR Exotic vegetation with similar structure to the proposal	Nil-Low	Low	Low-Mod	Moderate
	% foliage cover of mid-storey or ground stratum cover ≥25% of lower benchmark to lower benchmark	Low	Low-Mod	Moderate	Mod-High
	% foliage cover of mid-storey or ground stratum cover within benchmark	Low-Mod	Moderate	Mod-High	High

Table 2b. Linkage condition classes (non-woody vegetation)

Linkage Condition Class	Vegetation condition
Nil	Meets none of the definitions below
Low	Percent foliage cover is less than 25% of lower benchmark in native grassland, wetland or herbfield OR exotic vegetation with similar structure to the proposal.
Moderate	Percent foliage cover is greater than or equal to 25% of lower benchmark and less than lower benchmark in native grassland, wetland or herbfield
High	Percent foliage cover is within benchmark in native grassland, wetland or herbfield

Step 3: The final connectivity value scores for the clearing site(s) and for the offset site(s) are then calculated from the number of linkage width class thresholds and the number of linkage condition class thresholds that are crossed as a result of the loss of connectivity from clearing on the clearing site, and from the gain in connectivity from management actions on the offset site, using Table 3 below.

Note: In the rare circumstances in which connectivity is improved on the clearing site or reduced on the offset site, the number of linkage width thresholds and/or the number of linkage condition thresholds that are crossed are scored as negative numbers.

Table 3. Scores for loss/gain of connectivity value based on number of thresholds crossed

		Number of linkage width thresholds crossed			
		0	1	2	3 or 4
Number of linkage condition thresholds crossed	0	0	2	4	6
	1	1	3	5	7
	2	2	4	6	8
	3	3	5	7	9
	4	4	6	8	10
	5	5	7	9	11
	6	6	8	10	12

References (for Appendix 3)

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Appendix 4 - Field methodology for measuring condition variables for Site Value and at Reference Sites

Suggested plot and transect layout

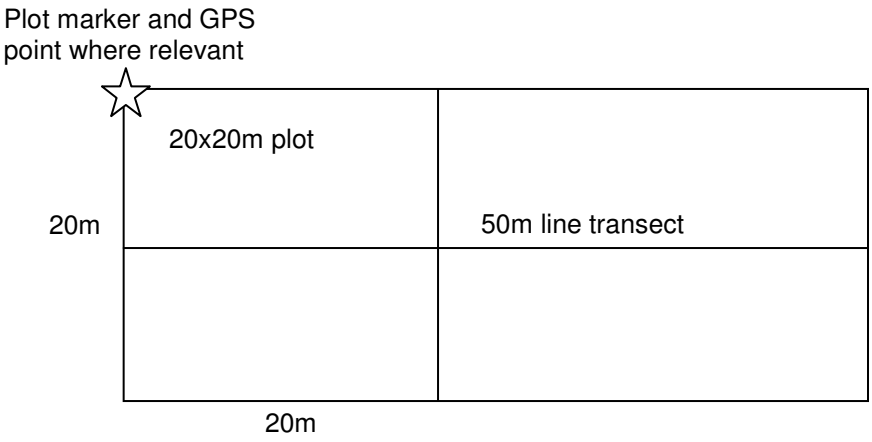

Figure 1. Layout of nested 20x50m and 20x20m plots and transects used to assess vegetation condition variables.

Field methodology

Table 1: Field methods for measuring the vegetation condition variables for Site Value and at reference sites. An asterisk indicates that an alternative method is provided for proposals where tree density is very low (e.g. scattered or paddock trees). Note, all cover attributes are assessed as percent foliage cover (see Glossary).

Variable	Plot or transect type	Method
a. Native plant species richness	20mx20m plots	Native plant species refers to indigenous vascular species local to the area and, if planted, which come from a local seed source. Systematically walk the plot counting the number of indigenous plant species for all vascular plants (i.e. the species do not have to be identified).

Variable	Plot or transect type	Method
b. Native over-storey cover	At 10 points along 50m transects OR CSR technique with zig-zag along 50m transects OR Whole-of-zone method	Native over-storey is the tallest woody stratum present (including emergents) that is 1m and higher and includes all species native to New South Wales (i.e. native species not local to the area can contribute to over-storey). In a woodland community the over-storey is the tree layer, and in a shrubland community the over-storey is the tallest shrub layer. Some vegetation types (e.g. grasslands <1m) may not have an over-storey. Over-storey cover is estimated as percent foliage cover, which is equivalent to the amount of shadow that would be cast on the ground if there were a light source directly overhead. Percent foliage cover of over-storey can be estimated using one of three methods: 1. At 10 points (i.e. every 5m) along the 50m transects (see Figure 1) estimate percent foliage cover directly overhead using the images provided in Figure 3. Divide the total by the number of points (i.e. 30) measured along the transects (e.g. 50%, 0%, 0%, 40%, 0%, 45%, 50%, 55%, 0%, 0% = 240/10 =24% percent foliage cover for guidance). Multiple transects are usually required to sufficiently encompass over-storey heterogeneity. 2. Using the Crown Separation Ratio (CSR) technique – see methodology at end of this Appendix. 3. Where the over-storey cover is very sparse (e.g. scattered or paddock trees), percent foliage cover can be estimated across the zone using the NVAT Scattered Paddock Tree Tool (accessible via the NVAT Mapper).
c. Native mid-storey cover	At 10 points along each of three 50m transects OR CSR technique with zig-zag along 50m transect OR 20mx20m plot	The mid-storey contains all vegetation between the over-storey stratum and 1m in height (typically tall shrubs, under-storey trees and tree regeneration) and includes all species native to New South Wales (i.e. native species not local to the area can contribute to mid-storey structure). Mid-storey cover is estimated as percent foliage cover and can be measured using one of three methods: (1) At 10 points (i.e. every 5m) along 50m transects – as for Native over-storey cover (see above) using images in Figure 3, except foliage is not necessarily overhead. Multiple transects are usually required to sufficiently encompass mid-storey heterogeneity. (2) CSR technique – as for Native over-storey cover (see above); (3) Visually estimate percent foliage cover in 20mx20m plots. The accuracy of the estimate can be improved if the assessment is conducted separately in each of the four 10mx10m quarters that make up the 20mx20m plot. 1m^2 of 100% foliage cover in a 10mx10m sub-plot is equal to 1% foliage cover for the plot (in a 20mx20m plot 4 m^2 of 100% foliage cover is 1% foliage cover for the plot). Either add the total m^2 of 100% foliage cover for each of the four 10mx10m sub-plots, or average the percent foliage cover in each sub-plot, to estimate percent foliage cover for the entire 20mx20m plot.

Variable	Plot or transect type	Method
d. Native ground stratum cover (grasses)	At 50 points along 50m transects OR 20mx20m plots	The ground stratum contains all native vegetation below 1m in height and includes all species native to New South Wales (i.e. is not confined to species indigenous to the area). The ground stratum (grasses) refers to native grasses (i.e. plants belonging to the family Poaceae). Cover of the ground stratum (grasses) is expressed as percent foliage cover and can be measured using one of two methods: (1) At 50 points (i.e. every 1m) along 50m transects (see Figure 1) record whether native grass intersects that point. Note, multiple 'hits' (i.e. multiple grasses) at a point count as one hit only. Divide the total of 'hits' by the number of points measured along the transects (i.e. 150). Multiple transects are usually required to sufficiently encompass ground stratum cover heterogeneity. (2) Visually estimate foliage cover (percent) in 20mx20m plots as described for native mid-storey cover.
e. Native ground stratum cover (shrubs)	At 50 points along 50m transects OR 20mx20m plots	The ground stratum contains all native vegetation below 1m in height and includes all species native to New South Wales (i.e. is not confined to species indigenous to the area). The ground stratum (shrubs) refers to native woody vegetation <1m. It is measured in the same way as for native ground stratum cover (grasses).
f. Native ground stratum cover (other)	At 50 points along each of three 50m transects OR 20mx20m plots	The ground stratum contains all native vegetation below 1m in height and includes all species native to New South Wales (i.e. is not confined to species indigenous to the area). The ground stratum (other) refers to non-woody native vegetation (vascular plants only) <1m that is not grass (e.g. forbs, herbs, ferns). It is measured in the same way as for native ground stratum cover (grasses)
g. Exotic plant cover	20mx20m plot OR at 50 points along each of three 50m transects	Exotic plants are vascular plants not native to Australia. Exotic plant cover is measured as total percent foliage cover of all exotic plants in all strata - this calculation is done automatically within *BioMetric*. If the exotics are in the over-storey, then measure using the same method as native over-storey cover, if exotics are in the mid-storey then measure using the same method as native mid-storey cover and if exotics are in the ground stratum then measure using the same method as described for native ground stratum cover.

Variable	Plot or transect type	Method
h. Number of trees with hollows	50mx20m plot OR Whole-of-zone method	Number of trees with hollows is a count of the number of living and dead trees within a 50mx20m plot with at least one hollow (the hollows do not have to be within the plot). A hollow is only recorded if: (a) the entrance can be seen; (b) the minimum entrance width is at least 5cm across; (c) the hollow appears to have depth (i.e. you cannot see solid wood beyond the entrance); (d) the hollow is at least 1m above the ground (this omits hollows in cut stumps or at the base of trees); and (e) the centre of the tree is within the plot. Trees should be examined from all angles. In proposals where trees occur in very low densities (e.g. paddock trees), the number of trees with hollows in the zone can be estimated across the zone using the NVAT Scattered Paddock Tree Tool (accessible via the NVAT Mapper). The number of trees with hollows per zone needs to be converted to the number of trees with hollows per 0.1ha (equivalent to the area of a 50x20m plot) for comparison with benchmarks.
i. Regeneration	Entire zone	Regeneration is measured as the proportion of the over-storey species at the site that are regenerating (i.e. with DBH $\leq$ 5cm). For example if there are three tree species present at the site but only one of these species is regenerating, then the value is 0.33. The maximum value for this measure is 1.
j. Total length of fallen logs	50mx20m plot	This is the total length of logs at least 10cm diameter and at least 0.5m long. The diameter is estimated with a measuring tape (or callipers if available) held horizontally immediately above the log and the length is estimated to the nearest metre by measuring with a tape, or pacing along the part of the log that is at least 10cm diameter. If estimating length by pacing then the actual length of a sample of logs should be measured regularly with a tape so the assessor can calibrate their own estimate derived from pacing. Only those parts of logs lying within the plot are measured.
Number of stems in specified diameter classes: • **>0-10cm** • **>10-20cm** • **>20-30cm**	50mx20m plot	This is a count of the number of stems of tree and/or shrub species within the specified dbhob classes (diameter classes). Dbhob is stem diameter at breast height (i.e. at 1.3 metres above the ground), measured over bark. Record only those trees or shrubs in which the centre of the stem is within the plot. Record only the largest stem for multi-stemmed trees and shrubs.

Calculation of percent foliage cover from crown separation ratio

The most consistent method for the assessment of cover is the crown separation ratio (CSR) technique, which can be used to calculate percent crown cover. Percent crown cover can, in turn, be converted to percent foliage cover. Use the field data sheet in Appendix 9 to record Crown Separation Ratio measurements.

Percent foliage cover is assessed from crown separation ratio as follows (source: Walker and Hopkins 1998). CSR is assessed separately for the over-storey (termed trees here for simplicity) and the mid-storey (termed shrubs here for simplicity):

1. Determine the distance between the crowns of each sequential tree and each sequential shrub closest to the transect, along a zig-zag line following the 50m transect, as shown in Figure 2. The 50m transect is down the centre of the 50x20m plot (shown as PQ in Figure 2). Start at the tree and the shrub closest to P and select the next tree and the next shrub closest to the transect line (regardless of which side of the transect line the tree/shrub occurs on), walking in the direction P → Q. Continue to sequentially select each nearest tree and shrub to the transect (on either side of the transect) forming the zig-zag lines in Figure 2. Undertake the assessment separately for trees and shrubs.

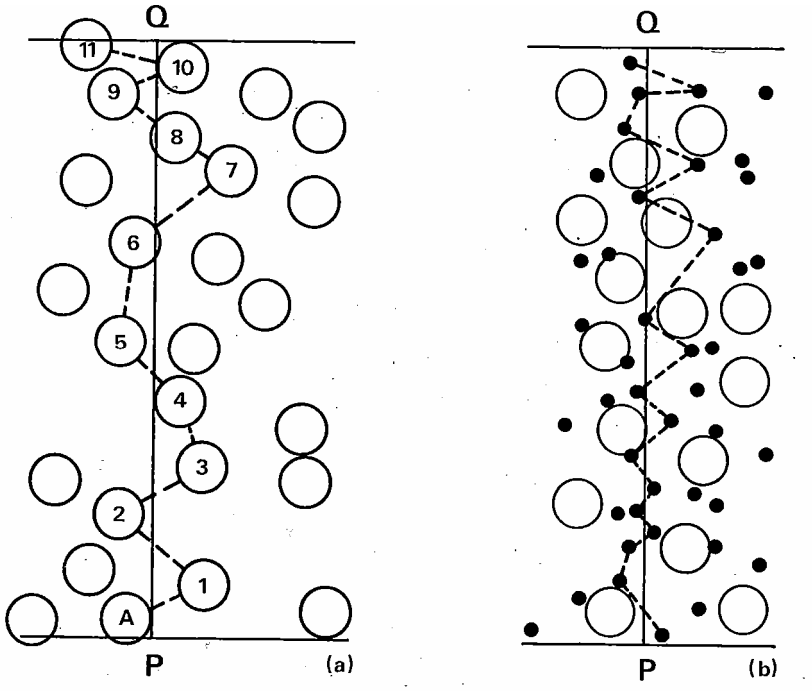

Figure 2. The zig-zag procedure is used for (a) the over-storey and (b) the mid-storey (see Walker and Hopkins 1998).

2. Measure the following for each selected tree and shrub, regardless of species:
    a. crown widths (m)
    b. crown gaps (m), and
    c. crown type (degree of openness, percent foliage cover of the crown), by matching the actual tree or shrub crowns with the photographs in Figure 3.

- A mean of 12 measurements of trees and of shrubs (i.e. 12 widths and 12 gaps) is usually sufficient to measure over-storey and mid-storey. Note, in

more open vegetation types the transect PQ will be considerably longer than 50m.

- Record data in the appropriate field data sheet:
    i. Site Value (zones) – plot data sheet
    ii. Site Value (reference sites) – plot data sheet
    iii. Step point transect tally tables – plot data sheet
- Where crown overlap occurs, the crown gap has a negative value. The greater the overlap, the larger the negative value. For example, for two crowns that overlap by 3m, the gap is -3.

3. Percent foliage cover is calculated as follows:
    a. CSR = mean gap/mean crown width.
    b. Percent crown cover = k/(1+CSR), where the constant k = 80.6 for samples taken along the zig-zag transect shown in Figure 2. A conversion table for a range of CSR and cover values is given in Table 2 for guidance.
    c. Percent foliage cover = percent crown cover x mean crown type (percent, see figure 3).
4. Enter percent foliage cover for over-storey and mid-storey into *BioMetric* for the appropriate zone and plots (i.e., for the zig-zag transects).

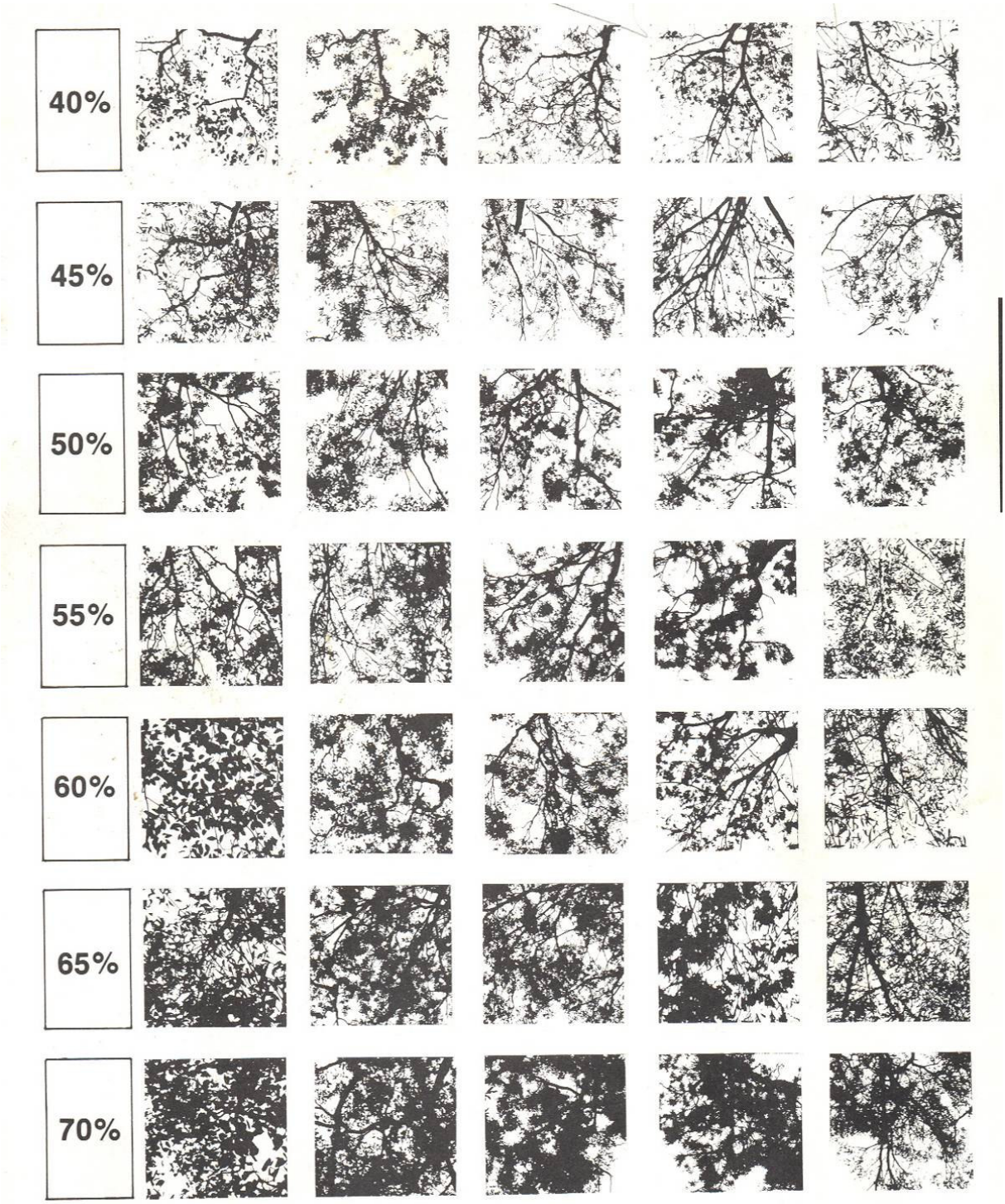

Figure 5 Crown types. Estimate the openness of individual tree or shrub crowns by matching the crown with a photograph. The rows show similar crown types for different leaf sizes (large to small, left to right); *Acacia* phyllodes are in the right hand row. Most Australian woody plants are in the range 40 per cent to 70 per cent.

Figure 3. Crown type images to assist with estimates of percent foliage cover of individual tree or shrub crowns. (Walker and Hopkins 1998).

Table 2: Conversion of crown separation ratios (crown gap: crown size) to percent crown cover. To be used for guidance only.

Broad description	Crown separation ratio	Crown cover (percent)
Crowns overlap	-0.1	100
	-0.05	89
	-0.02	84
Crowns touching	0	81
Crowns separate	0.05	73
	0.1	67
	0.15	60
	0.2	56
	0.25	52
	0.3	48
	0.4	41
	0.5	34
	0.6	31
	0.75	26
	1.0	20
	1.25	16
	1.5	13
	2.0	9
	3	5
	4	3
	8	1
	10	0.6
	15	0.3
	20	0.2
	30	0.1

Appendix 5 - Obtaining benchmarks from reference sites

The Site Value score in *BioMetric* is based on a comparison between measurements of several variables on the proposal area and a benchmark for each of these variables. Benchmarks are quantitative measures of the range of variability in vegetation with relatively little evidence of modification by humans since European settlement. Benchmarks are defined for specified variables by vegetation community at the scale of the stand or patch. Benchmarks derived from quantitative data and expert knowledge are available for most vegetation classes across NSW at http://www.environment.nsw.gov.au/projecys/BiometricTool.htm. However, where benchmarks do not exist for a vegetation type, or where local benchmarks are more appropriate, they can be derived from measurements taken in reference sites, that is, sites measured in the same vegetation type in relatively unmodified condition.

Locating reference sites

Reference sites have little modification relative to other vegetation in the region as indicated by: minimal timber harvesting (few stumps, coppicing, cut logs), minimal firewood collection, minimal exotic weed cover, minimal grazing and trampling by introduced or over abundant native herbivores, minimal soil disturbance, dieback not in excess of normal senescence, no evidence of very recent major perturbation such as fire or flood, not subject to high frequency burning, and evidence of recruitment of native species.

It may be difficult to find totally unmodified sites in a landscape, particularly in highly cleared regions. Vegetation in relatively unmodified condition can be found in some travelling stock routes and reserves, national parks and nature reserves, state forests (especially Flora Reserves), cemeteries, roadsides and commons. Appropriate reference sites may exist on the assessment property. Reference sites can occur in small remnants, such as narrow roadsides and cemeteries. Sources of local knowledge regarding the potential location of reference sites include field-based staff from: CMAs, DECCW, Department of Industry and Investment (including Forests NSW), Livestock Health and Pest Authorities, Greening Australia, Landcare Coordinators, field naturalist clubs and landholders. Individuals who undertook the surveys underpinning the vegetation types listed in *BioMetric* (these sources are listed with the definitions of each vegetation type) may be another potential source of information regarding potential reference site locations.

Numbers of reference plots/transects

To encompass the variation in condition variables, a minimum of three reference plots for each variable should be measured for each vegetation type with more plots/transects being desirable. This may require the collection of data from more than three plots, especially true where some of the condition variables on a reference plot/transect are clearly in a modified condition (e.g. where coarse woody debris has been 'tidied up', or previous thinning or coppicing has occurred in an otherwise intact remnant).

Field methods for measuring vegetation condition variables on reference sites

The methods for recording data from reference plots/transects are identical to the methods for recording data for Site Value in PVPs as outlined in Appendix 4. Field datasheets for reference plots/transects are available in Appendix 9 or on the Native Vegetation Community of Practice.

Data entry

The data from all reference plots/transects for a specific PVP assessment need to be entered into the "Data entry - Benchmarks" worksheet, accessible via the Native Vegetation Community of Practice website. This worksheet automatically calculates benchmark values, which then need to be transcribed into the Plot tab for the relevant proposal type (development, offset, thinning or incentive) in *BioMetric* for the Site Value assessment.

Provision of reference site data for incorporation into benchmarks

Reference site data collected for assessment of individual PVPs can be contributed to the pool of data used to calculate the benchmarks in the Vegetation benchmarks database on the *BioMetric* website (http://www.environment.nsw.gov.au/projects/BiometricTool.htm). Please email copes of all field data sheets from reference site to the PVP Service Centre: pvpservicecentre@dnr.nsw.gov.au

Appendix 6 - Riparian areas - definitions

The Landscape Value score for offset proposals includes the attribute “percent within riparian buffer”, wherein an additional score is awarded to offsets in riparian areas, as defined below (see section 3.6.1.1 for scoring details).

Widths of riparian areas are in Table 1. Note that riparian areas in this table are the same riparian buffer distances as in Table 3.1 in the EOAM, defined in Chapter 3 of the EOAM. Riparian areas for streams are measured on both sides of the stream from the top of bank if this is defined, otherwise from the centre of the stream. Where a stream has more than one bank on either side, the bank closest to the main channel should be used, to protect vegetation on and within the stream banks.

Riparian areas for wetlands are measured from the wetland limit. Where a wetland has more than one bank, the bank closest to the wetland area should be used.

Table 1. Definition of riparian areas (width of riparian areas).

Location	**Size of stream/wetland**			
	Minor watercourses, flood runners and effluents	Minor creeks and lagoons	Minor rivers, wetlands and major creeks	Major rivers and important wetlands
Coast & tablelands	10m	20m	30m	40m
Western slopes and plains	20m	40m	60m	100m
Estuarine areas	50m from the astronomical high tide mark (where no obvious bank).			

Appendix 7 - Guidelines for assessing change in Site Value variables with management actions

Site Value comprises ten condition variables: native species richness, over-storey cover, mid-storey cover, ground stratum cover (grasses, shrubs, other), exotic plant cover, trees with hollows, length of fallen logs and over-storey regeneration. A score between 0 and 3 is allocated to each variable based on the difference between the observed value and the benchmark value, to determine 'Current' Site Value of a clearing or offset zone.

The assessor predicts the loss (occasionally the gain) in each condition variable with clearing, and the gain (occasionally loss) in each condition variable with proposed management actions, to determine the future Site Value of a clearing or offset zone, using informed judgement. This appendix provides guidelines for assessing change in Site Value with proposed clearing and with proposed management actions to support the informed judgement of the assessor.

Change in Site Value variables with clearing

The impacts of clearing vary. Clearing intact woodland (e.g. to establish a crop) will generally take all ten condition variables down to zero (i.e. cropping does not generally include the permanent retention of any components of native vegetation). Partially clearing the over-storey to encourage ground cover for grazing (i.e. where some trees will be retained) will take the over-storey cover down one or two points according to the amount of over-storey removal.

If the benchmark for over-storey is 20-30% cover and the site currently has 25% over-storey cover then the current score for over-storey is 3. If the over-storey cover is cleared down to 5% then the score with the proposal would be 1 (i.e. the clearing results in over-storey cover that is within >10-<50% of the lower benchmark), but if the clearing were to result in only few scattered trees, or an over-storey cover of 1% then the score with the clearing would be 0 (i.e. 0-10% of the lower benchmark).

Some impacts of clearing can be positive. For example, removing over-storey and/or mid-storey down to benchmark levels without damage to native ground cover can stimulate increased ground cover.

Change in Site Value variables with management actions

The EOAM lists the ten management actions that can be applied to increase the condition of the vegetation within the offset area. Additional management actions, including controlling human disturbance, ecological burning, ecological thinning, and reducing water extraction from wetlands, may be required in combination with one or more of the ten actions below to improve the condition variables.

Table 1. Definitions for management actions in *BioMetric*. More than one management action may be applied (except Grazing exclusion and Strategic grazing, which are mutually exclusive) to improve the Site Value condition variables (see Table 4).

Management action	Definition
Grazing exclusion	The complete and permanent removal of grazing by all domestic stock at the site.
Strategic grazing	The implementation of an adaptive stock grazing regime for enhancing biodiversity, such as for controlling exotic weeds or vegetation biomass and/or enhancing competitiveness of native perennial species. Typically involves short periods of intensive grazing between long periods of little or no grazing. Strategic grazing strategies differ with management goals, seasonal conditions and regions.
Feral and/or over-abundant native herbivore control	Control feral and native herbivores to minimise total grazing pressures and reduce/eliminate damage to native vegetation and soil. Feral herbivore species include rabbits, goats, pigs, horses, escaped domestic stock and deer.
Planting/direct seeding	The direct establishment of tree, shrub or ground layer species that are likely to have existed at the site, using species and seed sources suitable for the vegetation type and region.
Weed control	Reducing the number or cover of exotic plants using herbicides, manual or mechanical control. Stock grazing for weed management is covered by the management action 'Strategic grazing'. Landholders are required by law to manage noxious weeds and hence management of such species is therefore outside the definition of this management action. Landholders should check with their local council for weeds listed under the *Noxious Weeds Act 1993,* alternatively visit www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/noxweed. There may also be a number of environmental weeds that need to be controlled on the site.
Erosion control	Mitigation of the mass movement of soil. It can be achieved using engineering solutions, soil amelioration, management of grazing and/or revegetation.
Retain dead timber	Means that no dead timber (i.e. logs and litter on the ground and standing dead trees) is removed from a site.
Retain regrowth	Not clearing native vegetation (as defined by the *Native Vegetation Act 2003*) that has regrown since 1 January 1983 in the Western Division and 1 January 1990 in the case of other land.
Provide artificial hollows	The provision and ongoing maintenance of artificial hollows (see Appendix 8). Suggested density and types of artificial hollows (including nest boxes) are one hollow or box per hectare for each of the following four species (see Appendix 8): large arboreal mammal, microbat, small bird and parrot/owl.
Exclude fertiliser	Cessation of fertiliser application in and immediately adjacent to the zone. Aims to reduce cover of exotic species and increase native species richness and cover.

Additional management actions can be used in conjunction with the above management actions to improve condition variables with management, where appropriate. These additional management actions include, but are not limited to, controlling human disturbance, ecological burning, ecological thinning, and reducing water extraction from wetlands. These additional management actions would be

specified within the conditions of the PVP but cannot improve condition variables on their own.

Changes in scores for the condition variables are determined by the assessor, using his/her local knowledge and judgement. The following provides overall guidance for scoring increases in condition variables.

1. scores of each variable are usually increased by 0.5 or 1.0 point unless there is strong management intervention (e.g. planting or direct seeding of native pasture species) and a low risk of failure, in which case the increase is generally 1.5-2.0 points.
2. planting or direct seeding increases species richness if the species are indigenous to the area and the seed is sourced locally;
3. where a condition variable is currently absent from the offset site and adjacent area then an increase is not generally scored unless that variable is specifically introduced;
4. an increase should not be scored where improvement is unlikely because of characteristics of the offset site that impede improvement in condition (e.g. continuing with a continuous grazing regimes or unmanaged high weed cover).

Specific guidelines and examples for scoring increases in Site Value condition variables with management actions are in Table 4. The notes below provide guidance for using Table 4:

1. **These notes and Table 4 provide advice only. Judgement and local knowledge are required to determine how much increase in each condition variable should be scored with management actions.**
2. Assessors should consider pressures at sites when estimating improvement in the condition variables with management actions. For example, native ground cover on fertilised sites with high exotic ground cover is unlikely to increase with removal of grazing. Strategic grazing is required to reduce exotic cover in such circumstances. The information on state and transition frameworks at the end of this Appendix may help assessors predict vegetation condition with management actions, in some circumstances.
3. Management actions should be applied to take the condition variables to within benchmark. Increasing some condition variables to higher than benchmark levels gives a lower score than benchmark levels for some variables.
4. Increases in condition variables depend on their starting condition as shown below.

Table 2. Guidance on increases to scores based on starting condition.

Starting condition score:	Increase generally limited to:
0	0.5 or 1 point only
1	0.5, 1, 1.5, or 2 points
2	0.5 or 1 point
3	No increase possible (reward for past good management automatically applied by tool)

5. Condition variables with a starting score of 3 cannot increase with management actions (the tool automatically provides a reward for good management for variables with a starting condition of 3 on offset sites).

6. Condition variables are improved where the landholder agrees to continue past management actions where one or more of the condition variables has a score of 3 from applying the past management action. For example, if mid-storey cover is at benchmark levels because regrowth has been retained, and over-storey cover is at 2 then continuing to retain regrowth will improve over-storey cover to 3. Past management actions include passive actions such as not clearing regrowth, not picking up logs for non-commercial firewood, and not applying fertiliser.
7. Grazing exclusion and Strategic grazing are mutually exclusive management actions and cannot be undertaken on the same land at the same time.
8. Some of the alternatives in these notes are not mutually exclusive. This is to allow flexibility because not all management actions have equal effects on the condition variables, and to account for odd and even numbers of management actions.
9. Additional management actions, namely; controlling human disturbance, ecological burning, ecological thinning, retention of bush rock, reducing water extraction from wetlands and any other management actions required to improve the vegetation condition, can be applied to improve the condition variables. The additional management actions cannot be used alone. Judgement should be used to apply the additional management actions in combination with the ten standard management actions, when required to improve the condition variables.
10. Shading in Table 4 indicates the level of response that a condition variable will have to that particular management action. The following provides a key to using Table 4 to provide guidance for increasing Site variables with management actions:

Dark shaded:  Light shaded:  Unshaded: 

Table 3. Suggested increase in condition variable score when management actions are applied as per Table 4.

Suggested increase in condition variable score		Proportion of dark shaded management actions to be applied				
		100%	≥ 50%	>1 - <50%	1 only	None
Proportion of light shaded management actions to be applied	100%	Maximum increase	2 – 2.5	1.5 – 2	1 – 1.5	0.5 – 1
	≥ 50%	2 – 2.5	1.5 – 2	1 – 1.5	0.5 – 1	0.5
	< 50%	1.5 – 2	1 – 1.5	0.5 – 1	0 – 0.5	0

Note: since Grazing exclusion and Strategic grazing are mutually exclusive management actions, they are counted as <u>one</u> possible management action for a condition variable.

Examples have been included after the table to indicate how these guidelines should be applied.

Table 4. Guide for scoring increase in Site Value variables (Site condition variables) with management actions.

Site variable	Grazing exclusion	Strategic grazing	Planting/ direct seeding	Weed control	Erosion control	Feral/over-abundant native herbivore control	Retain dead timber	Retain regrowth	Provide artificial hollows	Cease fertiliser addition	Additional management actions
Native plant species richness											
Native over-storey cover											
Native mid-storey cover											
Native ground cover								*			
Exotic plant cover											
No. trees with hollows											
Over-storey regen.											
Length fallen logs											

* If regrowth vegetation is a non-woody type, then treat as a dark shaded square. If regrowth vegetation is a woody type, then treat as an unshaded square.

Example 1.

The landholder agrees to apply the following management actions:

- strategic grazing,
- weed control,
- feral herbivore control, and
- cease applying fertiliser.

The following table shows the current condition score and suggested increase in score to give final score with management actions for all condition variables.

In the first example for condition variable, Native plant species, there are a total of 5 darkly shaded boxes (grazing exclusion and strategic grazing count as 1 as they are mutually exclusive). In this instance, only 4 management actions were agreed to with the landholder so the proportion for the darkly shaded boxes was 4/5 or 80%.

Condition Variable	**Current score**	**Proportion of dark shaded MAs being applied**	**Proportion of light shaded MAs being applied**	**Suggested increase in score (suggested range in brackets, from Table 3)**	**Score with Offset**
Native plant species	1	4/5	0/4	1.5 (1-1.5)	2.5
Native over-storey cover	1	2/4	2/5	1 (1-1.5)	2
Native mid-storey cover	1	2/4	2/5	1 (1-1.5)	2
Native ground stratum cover (grasses)	1	4/6	0/2	1.5 (1-1.5)	2.5
Native ground stratum cover (shrubs)	1	4/6	0/2	1.5 (1-1.5)	2.5
Native ground stratum cover (other)	1	4/6	0/2	1.5 (1-1.5)	2.5
Lack of exotic plant cover	1	4/5	0/2	1.5 (1-1.5)	2.5
Number of trees with hollows	1	0/1	3/7	0 (0)	1
Over-storey regeneration	1	2/4	2/5	1 (1-1.5)	2
Total length of fallen logs	1	0/1	0/3	0 (0)	1

If the current condition of the three ground stratum cover variables was 0, then the maximum increases in the variables that can improve (ie, species richness, ground cover, exotic cover and regeneration) would be 0.5, because the site would be in an alternative stable state (see below) due to high exotic cover and no regeneration. Improvement in condition on such sites is slow and uncertain.

Example 2.

The landholder agrees to apply the following management actions:

- strategic grazing,
- feral herbivore control,
- provide artificial hollows, and
- undertake ecological thinning.

The following table shows the current condition score and suggested increase in score to give final score with management actions for all condition variables.

Condition Variable	Current score	Proportion of dark shaded MAs being applied	Proportion of light shaded MAs being applied	Suggested increase in score (suggested range in brackets, from Table 3)	Score with Offset
Native plant species	1	2/5	1/4	1 (0.5-1)	2
Native over-storey cover	1	2/4	1/5	1 (1-1.5)	2
Native mid-storey cover	1	2/4	1/5	1 (1-1.5)	2
Native ground stratum cover (grasses)	1	2/6	1/2	1 (1-1.5)	2
Native ground stratum cover (shrubs)	1	2/6	1/2	1 (1-1.5)	2
Native ground stratum cover (other)	1	2/6	1/2	1 (1-1.5)	2
Lack of exotic plant cover	1	2/5	1/2	1 (1-1.5)	2
Number of trees with hollows	1	1/1	2/7	1.5 (1.5-2)	2.5
Over-storey regeneration	1	2/4	1/5	1 (1-1.5)	2
Total length of fallen logs	1	0/1	1/3	0 (0)	1

If the current condition of one or more variables was 0, then the maximum increases in the variables would be 0.5, except for hollows which would be 1.

Example 3.

The landholder agrees to apply the following management actions:

- retain regrowth, and
- retain dead timber.

The following table shows the current condition score and suggested increase in score to give final score with management actions for all condition variables.

Condition Variable	Current score	Proportion of dark shaded MAs being applied	Proportion of light shaded MAs being applied	Suggested increase in score (suggested range in brackets, from Table 3)	Score with Offset
Native plant species	1	0/5	2/4	0 (0-0.5)	1
Native over-storey cover	1	1/4	1/5	0 (0-0.5)	1
Native mid-storey cover	1	1/4	1/5	0 (0-0.5)	1
Native ground stratum cover (grasses)	1	0/6	1/2	0 (0-0.5)	1
Native ground stratum cover (shrubs)	1	0/6	1/2	0 (0-0.5)	1
Native ground stratum cover (other)	1	0/6	1/2	0 (0-0.5)	1
Lack of exotic plant cover	1	0/5	0/2	0 (0)	1
Number of trees with hollows	1	0/1	1/7	0 (0)	1
Over-storey regeneration	1	1/4	1/5	0.5 (0-0.5)	1.5
Total length of fallen logs	1	1/1	1/3	1 (1.5-2)	2

If the current condition for all variables was 0, then the increase in over-storey regeneration is 0.5, and the increase in fallen logs is 0.5 (1 if the thinned material is left in situ). If the starting condition for all variables was 2, then the increase in over-storey regeneration is 1 and the increase in fallen logs is 1.

State and Transition framework to assist in the prediction of future vegetation condition

State and transition framework

Originally developed to predict the response of rangelands to disturbance as an alternative to classical succession (Westoby *et al.* 1989), state and transition (S&T) models are now used to describe the dynamics of a variety of vegetation communities. 'Pristine' states rarely exist and, instead, multiple stable states occur as a consequence of interactions between climate, soils, natural disturbance attributes, grazing history and other management practices. A state and transition model framework (Figure 1) may be useful for assessors to determine likely increases in condition variables with management actions in some vegetation types, and thus to score improvement in vegetation condition with management actions.

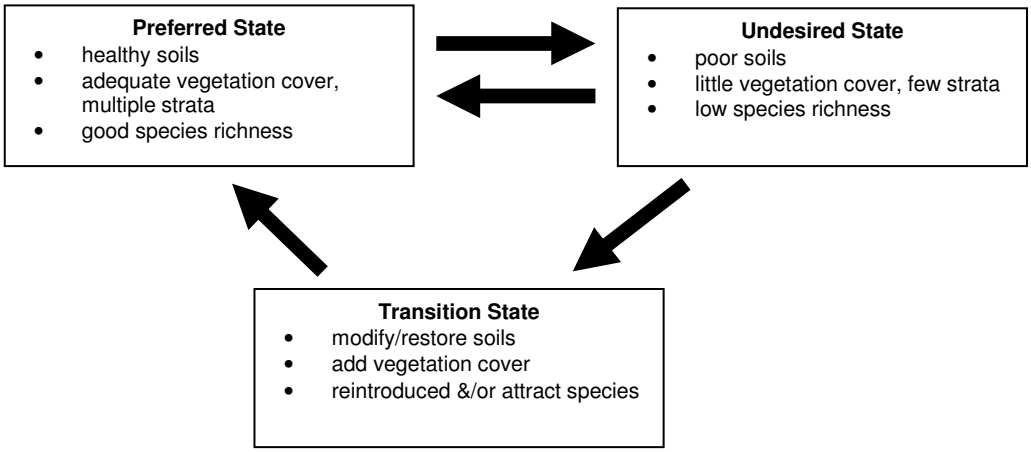

Figure 1. Simple representation of the State and Transition model framework (*sensu* Westoby *et al.* 1989). Note reference to soils, cover and species richness to represent basic function-structure-composition definition of biodiversity (*sensu* Noss 1990), which underpins the *BioMetric* assessment methodology. Restoration of 'good' species richness may not be achievable until more fundamental attributes are adequately restored (for example, reduce soil nutrient status, re-establish soil seed banks).

States

In applying the S&T framework to a specific scenario (e.g. an offset zone), assessors can think about the states in one of two ways:

- condition states of the vegetation type
- land use states

These can be thought of individually or in combination. For example, condition of the ground stratum, grazing history and present grazing pressure and fertility levels are the key attributes that define the condition states in the S&T model developed by McIntyre and Lavorel (2007) for the herbaceous vegetation in temperate eucalypt grassy woodlands of south-eastern Australia (see Figure 2).

Transitions

Transitions are best thought of in terms of the key processes that are likely to maintain sites within states and/or trigger transitions to other states. For example, McIntyre and Lavorel (2007) identified combinations of the following key processes for transitions in herbaceous vegetation in grassy woodlands (see Figure 2):

- grazing by native and introduced herbivores
- fertilizer applications (timing and rate)

- cultivation
- sowing of exotic species.

Realistic restoration goals, management actions and adaptive management
Setting clear goals and objectives is fundamental to achieving improved vegetation condition and thus biodiversity. Improving vegetation condition (and biodiversity) requires understanding of the current state, the future desired state and how to make the transition from the former to the latter. Transition from one alternative stable state (such as fertilised pasture dominated by exotic plants) is usually very slow and requires active management actions such as strategic grazing as well as passive management actions, such as stopping fertiliser use).

The broad restoration goal for each zone should be established with reference to the ecological and technical feasibility of achieving the transition required. Ecologically desirable transitions improve the condition of a site in relation to benchmark condition, while non-desirable transitions are those that result in the degradation or loss of ecological condition.

Assessors need to consider the technical feasibility of achieving transitions from the starting state for each zone, taking into account disturbance history of the site. Past and present disturbance pressures (including severity, frequency and age of each) can be considered by the assessor in conjunction with the current zone condition for each variable, along with the proposed management actions for that zone. This can inform the prediction of potential future condition, determining realistic restoration goals, timeframes and providing an adaptive management strategy for zones depending on their starting state.

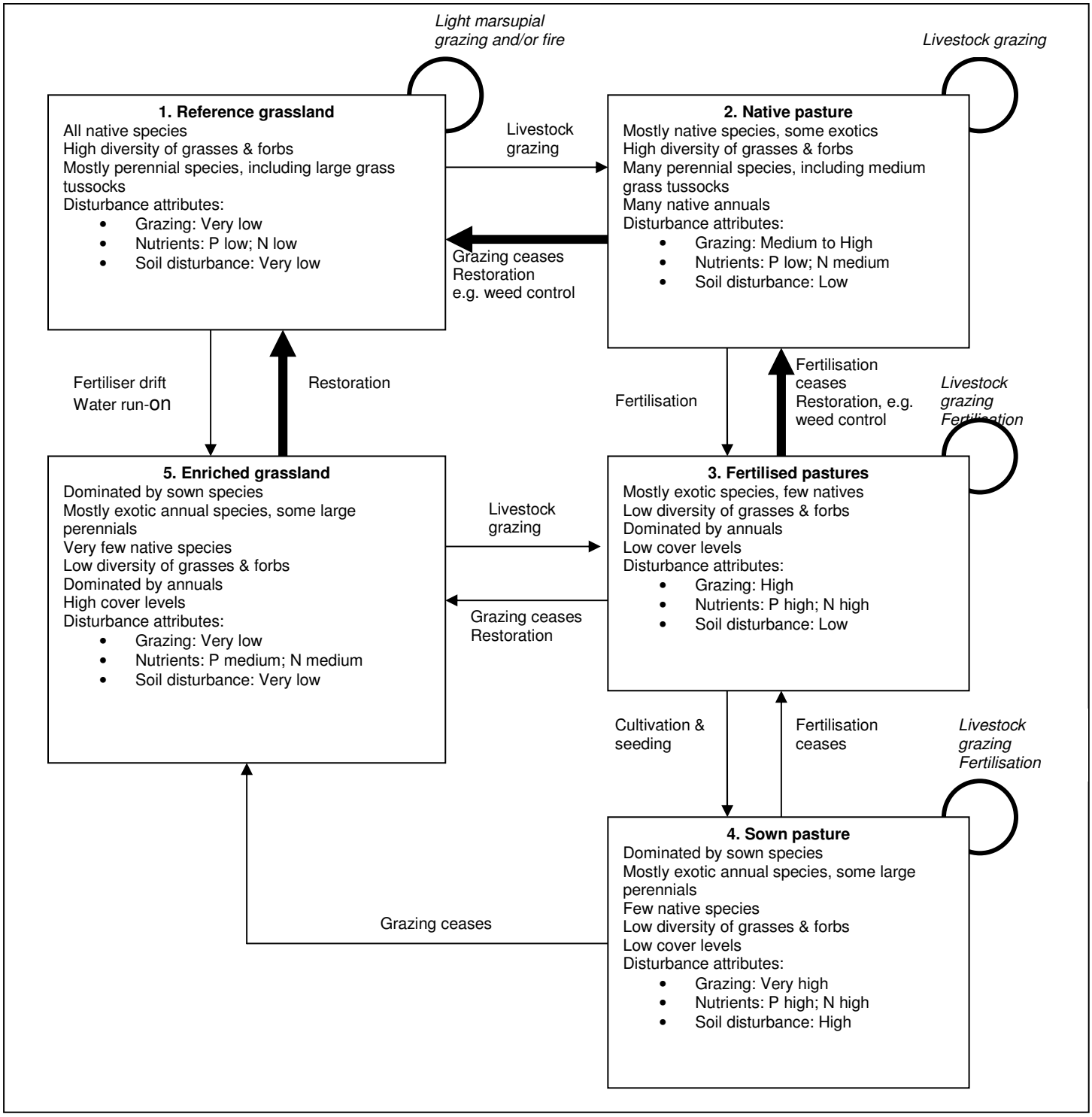

Figure 2. Modified S&T model for the ground cover stratum in temperate eucalypt grassy woodlands of south-eastern Australia. Five alternative states are shown. The boxes contain descriptions of the states, with a brief statement about each of their attributes (general levels of grazing, soil disturbance and soil fertility). Arrows between boxes describe the key management inputs that drive transitions between states and the ease (thin arrows) or difficulty (thick arrows) of these transitions. Curly arrows indicate the management inputs required to maintain a site in a particular state. Sources: McIntyre and Lavorel (2007) and McIntyre (2008).

Appendix 8 - Guidelines for the design, construction and placement of nest-boxes

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Nest-boxes have been used in a range of research, management and population recovery programs for hollow-using species. Nest-box design, materials and location influence the rate at which they are occupied and the species using them. They should not be viewed as a complete replacement to natural hollows, because they do not reflect the abundance and diversity of natural hollows (Gibbons and Lindenmayer, 2002).

The following is a guide for the design and construction of nest boxes compiled from a number of sources.

1. Design

- Different species require different nest-box dimensions and entrance sizes. An entrance hole should be no bigger than that necessary for the target animal (DNRE, 1999). Species-specific nest-box dimensions can be obtained from a range of sources, including Grant (1997) and Franks and Franks (2003) and Table 2 in this document;
- Entrance holes should be placed toward the top of the nest box to ensure the inside of the box is dark (DNRE, 1999);
- An access point at the top of the box should be built into the design (hinged lid) to allow access for maintenance. Nest-boxes should contain a sloping lid with an awning over the entrance hole. The lid should overhang the front and sides by at least 2.5cm (http://www.zoo.org.au/education/factsheets/bir-nest_boxes.pdf);
- Nest boxes should be stable. A slight lean forward will assist drainage and exit by young (DNRE, 1999);
- Nest boxes can collect water. By drilling three small holes (<10mm) in the floor, towards the front of the nest box, water is able to drain out (DNRE, 1999). Ensuring that nest-box entrances face the best aspect (see below) and do not point sky-wards minimises water accumulation.

2. Materials

- Rough sawn plantation timber is the best nest-box material, and can be roughened further with sand paper or notched using a saw. This allows animals to grip the outside of the box (DNRE, 1999);
- Up to 3cm thick, the thicker and more insulating the material the better (Birds Australia, 1997). Timber at least 3 cm thick is likely to be sufficient (Grant, 1997);
- Nest boxes should be weather proofed. After assembly, paint the outside of the box with three coats of non-toxic dark-coloured outdoor water-based acrylic paint (DNRE, 1999), or oil. Do not paint the internal surfaces of nest boxes.
- Chemical substances that prevent wood rot can harm animals and should be avoided (Mayle, 1990 in Gibbons and Lindenmayer, 2002);
- All gaps (apart from drainage holes) should be sealed;
- Sharp edges or protruding nails should be removed (http://www.longgrasssystems.com.au/Documents/Factsheet%20Building%20a%20nestbox%20for%20Brushtail%20Possums.pdf);
- Providing toe-holds on inside walls will assist the exit of young animals (DNRE, 1999);
- A 20mm deep layer of non-toxic wood shavings, decayed wood or shredded bark should be used to line the nest box floor (DNRE, 1999).

The following table provides a guide to nest box dimensions for specific fauna groups. Note, other publications specify slightly different next box dimensions for some fauna. It may be necessary therefore to trial a range of sizes. Monitoring will determine which is most effective for target fauna.

Table 1: Nest box type, dimensions and target species

Nest Box Type	Diameter (mm)	Depth/height (mm)	Entrance Diameter (mm)	Target Species
1	350	500	120	Ducks and large mammals
2	200-300	850	150x200	Cockatoos and Galah
3	150-200	450-600	75-100	Parrots and Sacred Kingfisher
4	400	750	150	Owls
5	300x150-200	600	80-120	Kookaburra
6	130-150	200-300	50-80	Small birds
			30	Pardalotes
			150	Grey Shrike-Thrush
7	300	300	35-37	Small mammals
8	70-100x150-240	200-250	12-15	Bats
			15-20	Bats
			25-35	Bats

Source: Birds Australia (1997)

3. Installation of Nest Boxes

Tree selection

The choice of tree species and size may be important if nest-boxes are to be successfully occupied by target fauna. It is advisable to imitate the natural nest site of target species as much as possible (DNRE, 1999).

The behavioural ecology of individual species also influences the placement of nest boxes, most particularly their spatial arrangement (see Gibbons and Lindenmayer, 2002 for a short summary). Some species vigorously defend a territory, attacking individuals of the same species, and occasionally destroying rival nests. Others species are more gregarious, tolerating overlapping home ranges. Understanding the individual territorial requirements of species can inform the density of nest boxes required for a given area.

The following table identifies whether some local hollow-dependent fauna are territorial in the first instance. Where they are not territorial, they are not considered further, and the spatial arrangement of nest boxes is not critical in ensuring nest box use by that species. Where they are territorial, and a breeding territory known, a minimum distance between nest boxes is suggested. The intent here is to maximise nest box use, taking into account the likelihood that species will establish a territory, and defend that territory.

Table 2: Breeding territory and distance required between nest boxes for hollow-dependant native fauna recorded, or likely to occur in the Junee area. Corresponding information should be compiled for other regions.

Common Name	Scientific Name	Territorial at any stage of life-cycle? (y/n)	Breeding territory (ha) or distance between nests (m)	Distance between nest boxes (m)	Nest box type (see Table 2)
BIRDS					
Pacific Black Duck	*Anas superciliosa*	Y[1]	Defends area near nest tree[1]	20m	1
Australian Wood Duck	*Chenonetta jubata*	Y[1]	unknown[1]	-	1
Sulphur-crested Cockatoo	*Cacatua galerita*	N[2]	-	-	2
Gang Gang Cockatoo	*Callocephalon fimbriatum*	Unknown	-	-	2
Galah	*Eolophus (Cacatua) roseicapilla*	N[2]	-	-	2
Crimson Rosella	*Platycercus elegans*	Y[2]	Unknown, but small[2]	90m	3
Eastern Rosella	*Platycercus eximius*	Y[2]	90m[2]	90m	3
Red-rumped Parrot	*Psephotus haematonotus*	Y[2]	Defends nest tree[2]	10m	3
Turquoise Parrot	*Neophema pulchella*	Y[2]	Defends nest tree[2]	10m	3
Barking Owl	*Ninox connivens*	Y[2]	<200ha[2]	1.4km	4
Southern Boobook	*Ninox novaeseelandiae*	Y[2]	37ha[2]	600m	4
Powerful Owl	*Ninox strenua*	Y[2]	1500ha[2]	3.8km	4
Barn Owl	*Tyto alba*	Y[2]	300m[2]	300m	4
Australian Owlet Nightjar	*Aegotheles cristatus*	Y[2]	<80ha[2]	750-900m	4
Laughing Kookaburra	*Dacelo novaeguineae*	Y[2]	25ha[2]	500m	5
Sacred Kingfisher	*Todiramphus sanctus*	Y[2]	4ha	200m	3
Brown Treecreeper	*Climacteris picumnus picumnus*	Y[3]	1.5ha[3]	120m	6
White-throated Treecreeper	*Cormobates leucophaeus*	Y[3]	3-7ha[3]	170-250m	6
Striated Pardalote	*Pardalotus striatus*	Y[4]	Defends nest tree[4]	10m	6*
White-browed Scrubwren	*Sericornis frontalis*	Y[4]	1.8ha[4]	135m	6
Southern Whiteface	*Aphelocephala leucopsis*	N[4]	-	-	6
Flame Robin	*Petroica phoenicea*	Y[4]	120-150m[4]	150m	6
Hooded Robin	*Melanodryas cucullata cucullata*	Y[4]	30-50ha[4]	600m	6
Grey Shrike-thrush	*Colluricincla harmonica*	Y[4]	17.4ha[4]	400m	6**
Black-faced Woodswallow	*Artamus cinereus*	Y[5]	90m[5]	90m	6
Pied Butcherbird	*Cracticus nigrogularis*	Y[5]	Unknown, but small[5]	20m	6
Tree Martin	*Petrochelidon (Hirundo) nigricans*	N	-	-	6
MAMMALS					
Sugar Glider	*Petaurus breviceps*	Unknown[6]	0.89-1.54ha[6]	100-125m	7
Squirrel Glider	*Petaurus norfolcensis*	Unknown[6]	2.5-4ha[6]	160-200m	7

Common Name	Scientific Name	Territorial at any stage of life-cycle? (y/n)	Breeding territory (ha) or distance between nests (m)	Distance between nest boxes (m)	Nest box type (see Table 2)
Common Ringtail Possum	*Pseudocheirus peregrinus*	Unknown[7]	-	-	1
Common Brushtail Possum	*Trichosurus vulpecular*	Yes[7]	0.2-4ha[7]	100m	1
Bats	Several species	Yes[7]	unknown	-	8

[1] Marchant, S. and Higgins, P.J. (Eds). 1990. *Handbook of Australian New Zealand and Antarctic Birds Volume 1: ratites to ducks.*. Oxford University Press, Melbourne.
[2] Higgins, P.J. (Ed.) 1999. *Handbook of Australian, New Zealand and Antarctic Birds Volume 4: parrots to dollarbird*. Oxford University Press, Melbourne.
[3] Higgins, P.J., J.M. Peter & W.K. Steele. (Eds) 2001. *Handbook of Australian, New Zealand and Antarctic Birds Volume 5: tyrant flycatchers to chats*. Oxford University Press, Melbourne.
[4] Higgins, P.J., & J.M. Peter (Eds) 2002. *Handbook of Australian, New Zealand and Antarctic Birds Volume 6: pardolates to shrike-thrushes*. Oxford University Press, Melbourne.
[5] Higgins, P.J., J.M. Peter & S.J. Cowling. (Eds) 2006. *Handbook of Australian, New Zealand and Antarctic Birds Volume 7: boatbill to starlings*. Oxford University Press, Melbourne.
[6] Quin, D.G. 1995. *Population Ecology of the Squirrel Glider (Petaurus norfolcensis) and the Sugar Glider (*P. breviceps*) (Marsupialia: Petauridae) at Limeburners Creek, on the Central North Coast of New South Wales*. Wildlife Research 22, pp 471-505.
[7] Strahan, R. (Ed). 1995. *The mammals of Australia*. Reed Books, Sydney.

* In the case of Pardalotes, the nest box dimensions may be the same as that for other small birds, but the entrance hole should be smaller. That is, 30mm diameter rather than 50-80mm.
** In the case of the grey shrike-thrush, the nest box dimensions may be the same as that for other small birds, but the entrance hole should be larger. That is, 150mm diameter rather than 50-80mm.

Height
Some species of arboreal mammal are indifferent to the height at which nest-boxes are erected. Others require nest-boxes above or below certain heights (see Beyer and Goldingay, 2006). Different species of bats and birds are likely to require different nest-box heights, also. Hussey, 1997 includes specifications for nest-box height for some species. A height range of between 3m and 6m above the ground may be appropriate for most species, but occupation of nest-boxes by target species should be monitored.

Aspect
Nest boxes should be placed in a southerly to easterly aspect, with entrances facing away from the direction of prevailing weather conditions (Birds Australia, 1997). Where possible, nest boxes should also be placed away from night-time lights (http://www.latrobe.edu.au/wildlife/nboxes.html). Where nest-boxes face into the tree, the mutual objective of facing entrances away from prevailing wind and weather, and away from night-time traffic/suburban lights may be satisfied. To ensure successful fauna access to tree-facing nest-boxes, a gap of approximately 100mm should be maintained between the nest-box and the tree.

Erecting Nest Boxes
A number of techniques have been developed to erect nest boxes. The most accepted and widely used technique involves using two strips of sheet galvanised steel to attach the box to the tree (DNRE, 1999). If using this method, each steel strap should be long enough to reach half way round the tree, so that growth of the

tree will not pull them apart or result in ringbarking of the branch or trunk. The straps are screwed to the nest box and hammered into the tree using non-galvanised, non coated nails (A. Moriarty *pers. comm.*). The boxes should be firmly attached so they cannot be dislodged in high winds and placed on a slight angle into the tree (base touching tree) to aid drainage and the escape of any young animals. A standard gap of 100mm between the nest box and the tree will ensure further damage to the tree is minimised as the tree continues to grow.

An alternative technique involves attaching the nest box to the tree with a nail (DNRE, 1999) in much the same way as you would hang a picture frame. This is an easier method for attaching nest-boxes to trees. However, the level of care applied in attaching the nest-box to the tree is likely to determine whether it remains attached during high wind conditions.

Bats (Smith and Agnew, 2002) and arboreal marsupials (Lindenmayer *et al*. 2003) prefer natural hollows to nest boxes where the former are abundant. This may be because natural hollows generally provide better insulation against the extremes of temperature than do nest-boxes (Calder *et al*. 1983 in Beyer and Goldingay, 2006). Accordingly, nest-boxes may remain unoccupied where natural hollows are abundant in an area.

To ensure nest-boxes remain well anchored to their tree, it is recommended they are installed on large trees either on the main trunk, or a major branch.

It is recommended that each nest box is marked on a map and a GPS reference recorded to aid in monitoring and maintenance.

Baiting Nest Boxes

Baiting of nest boxes with food to entice hollow dependent fauna to enter and use the boxes is not well researched. Experts in nest box design and use generally discourage this practice due to the possibility of encouraging ants, bees or other pests into the boxes (R. Durant *pers. comm.*), and the potential problem of encouraging parasites and diseases.

Pest and/or Predator Management

- An anti myna shield could be considered for bird boxes depending on the site and local presence of Indian mynas (see Figure 1). Effective exclusion of mynas will depend on the presence of adequate perches near, or on the nest box. A steeply sloping roof will limit perching opportunities (Birds Australia, 1997). Some native species may require a nearby perch however, particularly where juvenile animals are first emerging from the nest. Removing potential perches may therefore limit nest-box occupation. Trial and error, combined with regular monitoring is recommended;

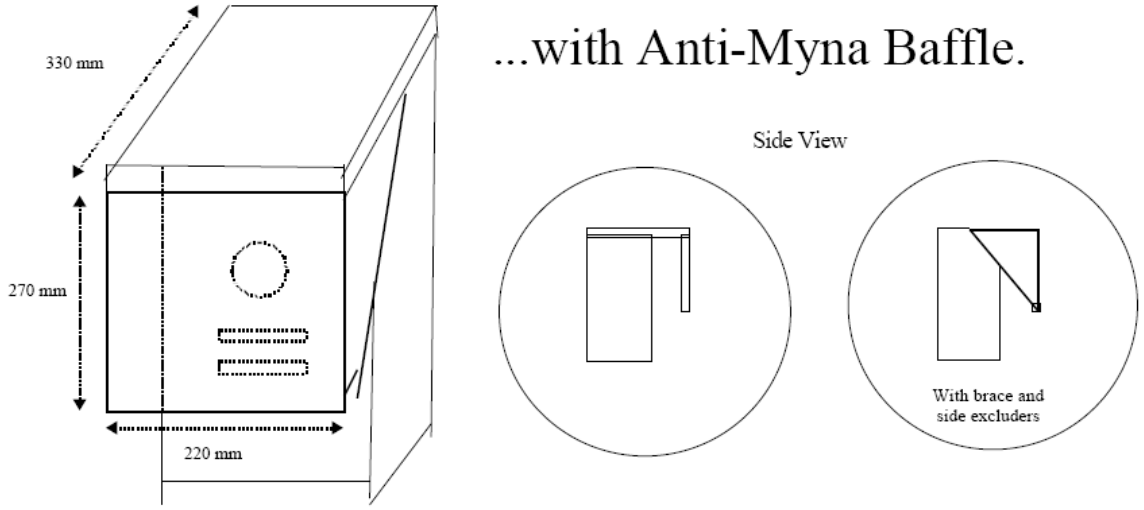

Figure 1 – The anti-predator/anti–myna baffle designed by Birds Australia (source: Birds Australia, 1997)

- Bees occasionally colonise nest-boxes (Hussey, 1997), and exclude arboreal marsupials from these structures (Beyer and Goldingay, 2006). By lining the ceiling with carpet (Franks and Franks, 2003), bees may be deterred.
- Ants are common residents in nest-boxes, but do not necessarily limit nest-box use by arboreal marsupials (Beyer and Goldingay, 2006). It is not known whether ants affect nest-box occupation for other fauna groups. If ants prove to be a problem, talcum powder applied to the entrance and edges of a nest box may effectively deter ants (Gibbons and Lindenmayer, 2002);
- Tree guards or exclusion collars on branches may be required to limit access to nest-boxes by cats or rats (Birds Australia, 1997);
- Predation by currawongs may be limited by placing a short length of PVC pipe into the entrance of nest-boxes (Krebs, 1998 in Gibbons and Lindenmayer, 2002).

If nest boxes are placed within remnant vegetation, more than 60m from the edge of the patch, they will not be used by starlings, mynas or sparrows (DNRE, 1999).

Where pest species (such as starlings, mynas, sparrows, honey bees, black rats or feral cats) are present, the following measures may be applied where relevant:

- close the nest box off for a period, and remove nesting material and/or eggs (DNRE, 1999);
- control access by modifying the entrance-hole size (DNRE, 1999);
- completely remove the box and relocate it into an alternative location (DNRE, 1999);
- where bees are occupying a nest box, an apiarist could be contacted to remove the bees. Alternatively, insect repelling strips may be suspended on a wire from the ceiling of the box (DNRE, 1999). These should be removed as soon as bees are killed or evicted.

4. Monitoring and Maintenance

It is important to monitor nest box use to determine whether target species are using the nest boxes. Monitoring will also inform maintenance requirements, and may establish the suitability of nest box design, size, number and location. Maintenance is likely to be site specific, comprising the following actions where necessary:

- The removal of feral animal pests (such as mynas, starlings, bees), including eggs, nestlings and/or nesting material (Birds Australia, 1999);
- Repositioning, re-erection or relocation of dysfunctional nest boxes;
- Replacement of fallen, damaged or degraded nest boxes;
- Checking each box is not holding water or leaking;

Once native species are observed using a nest box, manual inspections should cease: regular nest box inspection is very likely to lead to desertion of the nest box (DNRE, 1999). Further monitoring of nest boxes should be carried out in the least intrusive manner possible.

Where nest boxes are empty and no evidence of fauna occupation (such as nesting material, feathers, fur, or eggs) present, an assessment of the possible reasons why could be made. Nest box design, aspect, attachment/connection to the tree, tree selection, height and spatial proximity to other nest boxes should be considered in determining the cause.

Monitoring options

It is likely that nest boxes will deteriorate after 5-10 years (Lindenmayer *et. al* 2003) and provisions should be made to ensure that nest boxes are checked until they are replaced with suitable hollows in the surrounding vegetation. Most woodland tree species need to be between 50 and 100 years old (Lindenmayer *et. al* 2003), and possibly up to 120 years old (http://www.latrobe.edu.au/wildlife/nboxes.html) before significant nest hollows develop. Placing nest-boxes in trees that are unlikely to develop hollows for several decades represents a substantial monitoring commitment. This cost will be compounded where non-durable materials are used to construct nest boxes, and regular repair and/or replacement is required.

If funding is limited, four approaches could be considered:

1. Place nest-boxes in trees approaching the age at which hollows develop. This will reduce the time over which monitoring, and potentially maintenance of nest boxes is required. Tree age can be inferred by analysing old aerial photographs. Alternatively, more exact methods are available, including dendrochronology (http://en.wikipedia.org/wiki/Dendrochronology; http://www.ensisjv.com/ResearchCapabilitiesAchievements/WoodQualityResourceAssessment/WoodPropertyAssessment/Trecor/tabid/368/Default.aspx?PageContentMode=1);
2. Erect fewer nest-boxes, but monitor and replace as often as is necessary;
3. Construct nest boxes from highly durable material, such as ceramic pipes (Birds Australia, 1997);
4. Stimulating trees to form natural hollows (Gibbons and Lindenmayer, 2002). Such an approach requires approval from the relevant land owner/manager. It should include an assessment of existing tree habitat value and fauna occupation, including the presence of nesting animals. Care should be taken to ensure techniques used do not accelerate tree mortality.

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http://www.csiro.au/communication/mediarel/mr1997/mr97034.htm

http://www.ensisjv.com/ResearchCapabilitiesAchievements/WoodQualityResourceAssessment/WoodPropertyAssessment/Trecor/tabid/368/Default.aspx?PageContentMode=1

http://www.latrobe.edu.au/wildlife/nboxes.html

http://www.longgrasssystems.com.au/Documents/Factsheet%20Building%20a%20nestbox%20for%20Brushtail%20Possums.pdf

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Appendix 9 – Field data sheets

This Appendix contains the following field data sheets which can be printed and copied as required. Each relevant data sheet should be kept on the hard-copy file for future reference:

- Clearing assessment – use to record vegetation information, Regional Value, Landscape Value attributes and Site Values.
- Offset assessment – use to record vegetation information, Regional Value, Landscape Value attributes, Site Values and management action details.
- Site Value plot data sheet – use to record locations of plots within zones, measurements of the ten condition variables with options for alternative measurement methods.
- Step point transect data sheet – use to record site condition variables that are being measured using transects rather than plots. Includes ability to record additional attributes not used in the calculation of Site Value.
- Crown Separation Ratio data sheet – use to record and calculate Percent Foliage Cover using the Crown Separation Ration technique as alternative to plots or transects.
- Species plot data sheet – use to record individual species found within plots, optional.
- Reference Sites data sheet – use to record vegetation information, locations of plots within zones, disturbance attributes and history and measurements of the ten condition variables with options for alternative measurement methods.
- Scattered Tree plot data sheet – use to record details of individual trees that are to be removed and have been assessed as low condition using the Scattered Paddock Tree tool.
- Thinning (stem density) data sheet – use to record stem densities within zones to be thinned to benchmark. Also to be used to record stem densities on reference sites to obtain benchmarks.

Clearing assessment

BioMetric

PVP Request No. (from *PADACS*)_____ **Date**_____

CMA _____ **Recorder/s**_____

VEGETATION TYPES (Refer to sections of Operational Manual noted in brackets. Use *NVAT Mapper* to determine Zone numbers and Mitchell Landscapes. Enter data into *BioMetric* Vegetation tab.)

Zone no.	Low condition? (3.2.2)	Mitchell Landscape (3.2.4)	Vegetation Formation (3.2.5)	Vegetation Type (3.2.6)	Listed Ecological Community? (3.2.7)	Can PVP assessment proceed for zone?

REGIONAL VALUE (Refer to section 3.2.7 of Operational Manual. Use *NVAT Mapper* to determine Areas. Data auto-populates into *BioMetric* Vegetation Tab from *NVAT Mapper*.)

Zone no.	Area (ha)

Zone no.	Area (ha)

Zone no.	Area (ha)

Zone no.	Area (ha)

Zone no.	Area (ha)

Zone no.	Area (ha)

Zone no.	Area (ha)

Zone no.	Area (ha)

Zone no.	Area (ha)

Zone no.	Area (ha)

LANDSCAPE VALUE (Refer to sections of Operational Manual noted in brackets. To be assessed once per clearing proposal, using imagery in *NVAT Mapper*, or on the hard copy printouts. Enter data into *BioMetric* Clearing Landscape tab.)

Attribute	Current (circle one level per attribute)	With clearing (circle one level per attribute)
% cover within 1.79km radius (1000ha) **(3.3.1.1)**	0 / >0-10 / >10-20 / >20-30 / >30-40 / >40-50 / >50-60 / >60-70 / >70-80 / >80-90 / >90-100%	0 / >0-10 / >10-20 / >20-30 / >30-40 / >40-50 / >50-60 / >60-70 / >70-80 / >80-90 / >90-100%
% cover within 0.55km radius (100ha) **(3.3.1.1)**	0 / >0-10 / >10-20 / >20-30 / >30-40 / >40-50 / >50-60 / >60-70 / >70-80 / >80-90 / >90-100%	0 / >0-10 / >10-20 / >20-30 / >30-40 / >40-50 / >50-60 / >60-70 / >70-80 / >80-90 / >90-100%
Connectivity Value: Linkage Width Class **(3.3.1.3)**	V. Narrow / Narrow / Moderate / Wide / V. Wide	V. Narrow / Narrow / Moderate / Wide / V. Wide
Connectivity Value : Linkage Condition Class **(3.3.1.3)**	Nil / Nil-Low / Low / Low-Mod / Mod / Mod-High / High	Nil / Nil-Low / Low / Low-Mod / Mod / Mod-High / High
Total adjacent remnant area **(3.3.1.2)**	Small / Medium / Large / Very Large / Extra Large	

SITE VALUE (Record values for each zone using the Site Value - plot data sheet. Enter data into *BioMetric* Clearing Site tab.)

Offset assessment

BioMetric

PVP Request No.
(from *PADACS*)_____ **Date**_____

CMA _____ **Recorder/s**_____

REGIONAL VALUE (Refer to section 3.5 of the Operational Manual. Use *NVAT Mapper* to determine Zone numbers and Areas. Enter data into *BioMetric* Offset tab.)

Zone no.	Area (ha)	Vegetation Formation	Vegetation Type

LANDSCAPE VALUE (Refer to sections of Operational Manual noted in brackets. To be assessed once per offset proposal, using imagery in *NVAT Mapper*, or on the hard copy printouts. Enter data into *BioMetric* Offset Landscape tab.)

Attribute	**Current** (circle one level per attribute)	**With offsets** (circle one level per attribute)
% cover within 1.79km radius (1000ha) **(3.3.1.1)**	0 / >0-10 / >10-20 / >20-30 / >30-40 / >40-50 / >50-60 / >60-70 / >70-80 / >80-90 / >90-100%	0 / >0-10 / >10-20 / >20-30 / >30-40 / >40-50 / >50-60 / >60-70 / >70-80 / >80-90 / >90-100%
% cover within 0.55km radius (100ha) **(3.3.1.1)**	0 / >0-10 / >10-20 / >20-30 / >30-40 / >40-50 / >50-60 / >60-70 / >70-80 / >80-90 / >90-100%	0 / >0-10 / >10-20 / >20-30 / >30-40 / >40-50 / >50-60 / >60-70 / >70-80 / >80-90 / >90-100%
Connectivity Value: Linkage Width Class **(3.3.1.3)**	V. Narrow / Narrow / Moderate / Wide / V. Wide	V. Narrow / Narrow / Moderate / Wide / V. Wide
Connectivity Value: Linkage Condition Class **(3.3.1.3)**	Nil / Nil-Low / Low / Low-Mod / Mod / Mod-High / High	Nil / Nil-Low / Low / Low-Mod / Mod / Mod-High / High
Total adjacent remnant area **(3.3.1.2)**		Small / Medium / Large / Very Large / Extra Large
% within riparian area **(3.6.1.1)**		<1% / 1-10% / >10-25% / >25%
Additional Site Value score **(3.6.1.2)**		Calculated automatically

SITE VALUE (Record "Current score" values for each zone using the Site Value - plot data sheet. "Score with offset" values can only be completed following assessment of the current condition of each zone. Enter data in *BioMetric* Offset Site tab.)

MANAGEMENT ACTIONS (Refer to Appendix 7 of Operational Manual. Tick relevant management actions for each zone, and record details. Predicted future condition of each condition variable must be scored by the assessor in *BioMetric* Offset Site tab, and management action details recorded in *BioMetric* Management Actions tab.)

Zone No.	Grazing exclusion	Strategic grazing	Planting/ direct seeding	Weed control	Erosion control	Feral &/or over-abundant native herbivore control	Retain dead timber	Retain regrowth	Provide artificial hollows	Exclude fertilisers	Management action specifications (brief)

Site Value (zones) - plot data sheet

Start a new sheet for each zone (Clearing or Offset proposals)

BioMetric

PLOT TYPE: **Clearing zone / Offset zone** (circle one)

Linked zones (list type/s & nos.)

CMA

Recorder/s

Date

Site location & description:

PVP Request No. (from *PADACS*)

Veg Zone No. (from *NVAT Mapper*)

Vegetation Formation (as per Keith 2004)

Vegetation Class (as per Keith 2004)

Vegetation Type (*BioMetric)*

PLOT 1 Lat.	Long.
Orientation	Photos

PLOT 2 Lat.	Long.
Orientation	Photos

PLOT 3 Lat.	Long.
Orientation	Photos

PLOT 4 Lat.	Long.
Orientation	Photos

PLOT 5 Lat.	Long.
Orientation	Photos

PLOT 6 Lat.	Long.
Orientation	Photos

PLOT 7 Lat.	Long.
Orientation	Photos

PLOT 8 Lat.	Long.
Orientation	Photos

PLOT 9 Lat.	Long.
Orientation	Photos

Plot 10 Lat.	Long.
Orientation	Photos

20m x 20m plot (Refer to Appendix 4 of Operational Manual for methods. see also Step Point Transect or Crown Separation Ratio data sheets for assessing foliage cover (%). 20x20m plot method is not considered reliable for the over-storey stratum.)

Plot No.:	1	2	3	4	5	6	7	8	9	10
Number of native plant species										
Native mid-storey cover (%)										
Native ground stratum cover (%) - grasses										
Native ground stratum cover (%) - shrubs										
Native ground stratum cover (%) - other										
Exotic plant cover (%)										

Larger sampling area ([1]20m x 50m plot, or [2]whole of zone) (Refer to methods in Appendix 4 of Operational Manual.)

[1]Number of trees with hollows – use Alternative method below if appropriate										
[2]Over-storey regeneration (proportion of over-storey spp)										
[1]Total length of fallen logs (m)										

Alternative methods for zones containing scattered trees (whole-of-zone methods) (Refer to methods in Appendix 4 of *BioMetric* Operational Manual. Use Paddock Tree Calculator, accessible via the *NVAT Mapper* for calculations.)

Native over-storey cover (%)	av. crown diameter (m)= av. foliage cover (%) = # trees= sample area (ha)=									
No. trees with hollows	sample area (ha)= no. trees with hollows =									

Notes – additional conservation values: e.g. riparian areas, special features, geology etc.

Step point transect data sheet

Start a new sheet for each zone (Clearing or Offset) or Reference Site

BioMetric

PLOT TYPE: (circle one) **Clearing / Offset / Reference**

Linked zones (list type/s & nos.)

CMA | **Recorder/s** | **Date**

Site location & description:

PVP Request No. (from *PADACS*)

Veg Zone No. (from *NVAT Mapper*)

Vegetation Type (*BioMetric)*

Step point transect tally tables (Refer to Appendix 4 of *BioMetric* Operational Manual for methods. Only needs to be completed for the variables that have not been measured using an alternate method e.g. plots or whole of zone.)

PLOT No. _____ TRANSECT No/s. _____	No. hits (tally)	%
Native over-storey cover (%)		
Native mid-storey cover (%)		
Native ground stratum cover (%) - grasses		
Native ground stratum cover (%) - shrubs		
Native ground stratum cover (%) - other		
Exotic plant cover (%)		
Litter cover (%) - optional		
Rock cover (%) - optional		
Bare ground cover (%) - optional		
Cryptogam cover (%) - optional		

PLOT No. _____ TRANSECT No/s. _____	No. hits (tally)	%
Native over-storey cover (%)		
Native mid-storey cover (%)		
Native ground stratum cover (%) - grasses		
Native ground stratum cover (%) - shrubs		
Native ground stratum cover (%) - other		
Exotic plant cover (%)		
Litter cover (%) - optional		
Rock cover (%) - optional		
Bare ground cover (%) - optional		
Cryptogam cover (%) - optional		

PLOT No. _____ TRANSECT No/s. _____	No. hits (tally)	%
Native over-storey cover (%)		
Native mid-storey cover (%)		
Native ground stratum cover (%) - grasses		
Native ground stratum cover (%) - shrubs		
Native ground stratum cover (%) - other		
Exotic plant cover (%)		
Litter cover (%) - optional		
Rock cover (%) - optional		
Bare ground cover (%) - optional		
Cryptogam cover (%) - optional		

PLOT No. _____ TRANSECT No/s. _____	No. hits (tally)	%
Native over-storey cover (%)		
Native mid-storey cover (%)		
Native ground stratum cover (%) - grasses		
Native ground stratum cover (%) - shrubs		
Native ground stratum cover (%) - other		
Exotic plant cover (%)		
Litter cover (%) - optional		
Rock cover (%) - optional		
Bare ground cover (%) - optional		
Cryptogam cover (%) - optional		

PLOT No. _____ TRANSECT No/s. _____	No. hits (tally)	%
Native over-storey cover (%)		
Native mid-storey cover (%)		
Native ground stratum cover (%) - grasses		
Native ground stratum cover (%) - shrubs		
Native ground stratum cover (%) - other		
Exotic plant cover (%)		
Litter cover (%) - optional		
Rock cover (%) - optional		
Bare ground cover (%) - optional		
Cryptogam cover (%) - optional		

PLOT No. _____ TRANSECT No/s. _____	No. hits (tally)	%
Native over-storey cover (%)		
Native mid-storey cover (%)		
Native ground stratum cover (%) - grasses		
Native ground stratum cover (%) - shrubs		
Native ground stratum cover (%) - other		
Exotic plant cover (%)		
Litter cover (%) - optional		
Rock cover (%) - optional		
Bare ground cover (%) - optional		
Cryptogam cover (%) - optional		

PLOT No. _____ TRANSECT No/s. _____	No. hits (tally)	%
Native over-storey cover (%)		
Native mid-storey cover (%)		
Native ground stratum cover (%) - grasses		
Native ground stratum cover (%) - shrubs		
Native ground stratum cover (%) - other		
Exotic plant cover (%)		
Litter cover (%) - optional		
Rock cover (%) - optional		
Bare ground cover (%) - optional		
Cryptogam cover (%) - optional		

PLOT No. _____ TRANSECT No/s. _____	No. hits (tally)	%
Native over-storey cover (%)		
Native mid-storey cover (%)		
Native ground stratum cover (%) - grasses		
Native ground stratum cover (%) - shrubs		
Native ground stratum cover (%) - other		
Exotic plant cover (%)		
Litter cover (%) - optional		
Rock cover (%) - optional		
Bare ground cover (%) - optional		
Cryptogam cover (%) - optional		

PLOT No. _____ TRANSECT No/s. _____	No. hits (tally)	%
Native over-storey cover (%)		
Native mid-storey cover (%)		
Native ground stratum cover (%) - grasses		
Native ground stratum cover (%) - shrubs		
Native ground stratum cover (%) - other		
Exotic plant cover (%)		
Litter cover (%) - optional		
Rock cover (%) - optional		
Bare ground cover (%) - optional		
Cryptogam cover (%) - optional		

Crown Separation Ratio transect tables - plot data sheet

BioMetric

Start a new sheet for each zone (Clearing or Offset) or Reference Site

PLOT TYPE: (circle one) **Clearing / Offset / Reference**

Linked zones (list type/s & nos.)

CMA | **Recorder/s** | **Date**

Site location & description:

PVP Request No. (from *PADACS*)

Veg Zone No. (from *NVAT Mapper*)

Vegetation type (*BioMetric)*

Crown Separation Ratio transect tables (Refer to Appendix 4 of *BioMetric* Operational Manual for methods. Record stratum (o/s, m/s, g/s(g), g/s(s) or g/s(o). Use consistent units within each plot, i.e. m OR cm. Use cm for ground stratum. Circle units used.)

PLOT No. ______ STRATUM ________	1	2	3	4	5	6	7	8	9	10	11	12	Mean
Crown width (m? OR cm?)													
Crown Separation/Gap (m? OR cm?)													
Crown type/ Degree of openness (%)													

Calculations:
CSR = mean Gap/mean Crown width = _________ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _______ %
Foliage Cover = CC (%) x mean Crown type (%)/100= ________ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

PLOT No. ______ STRATUM ________	1	2	3	4	5	6	7	8	9	10	11	12
Crown width (m? OR cm?)												
Crown Separation/Gap (m? OR cm?)												
Crown type/ Degree of openness (%)												

Calculations:
CSR = mean Gap/mean Crown width = _________ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _______ %
Foliage Cover = CC (%) x mean Crown type (%)/100= ________ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

PLOT No. ______ STRATUM ________	1	2	3	4	5	6	7	8	9	10	11	12
Crown width (m? OR cm?)												
Crown Separation/Gap (m? OR cm?)												
Crown type/ Degree of openness (%)												

Calculations:
CSR = mean Gap/mean Crown width = _________ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _______ %
Foliage Cover = CC (%) x mean Crown type (%)/100= ________ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

PLOT No. ______ STRATUM ________	1	2	3	4	5	6	7	8	9	10	11	12
Crown width (m? OR cm?)												
Crown Separation/Gap (m? OR cm?)												
Crown type/ Degree of openness (%)												

Calculations:
CSR = mean Gap/mean Crown width = _________ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _______ %
Foliage Cover = CC (%) x mean Crown type (%)/100= ________ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

PLOT No. ______ STRATUM ________	1	2	3	4	5	6	7	8	9	10	11	12
Crown width (m? OR cm?)												
Crown Separation/Gap (m? OR cm?)												
Crown type/ Degree of openness (%)												

Calculations:

CSR = mean Gap/mean Crown width = _________ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _______ %
Foliage Cover = CC (%) x mean Crown type (%)/100= ________ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

PLOT No. ______ STRATUM ________	1	2	3	4	5	6	7	8	9	10	11	12
Crown width (m? OR cm?)												
Crown Separation/Gap (m? OR cm?)												
Crown type/ Degree of openness (%)												

Calculations:

CSR = mean Gap/mean Crown width = _________ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _______ %
Foliage Cover = CC (%) x mean Crown type (%)/100= ________ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

PLOT No. ______ STRATUM ________	1	2	3	4	5	6	7	8	9	10	11	12
Crown width (m? OR cm?)												
Crown Separation/Gap (m? OR cm?)												
Crown type/ Degree of openness (%)												

Calculations:

CSR = mean Gap/mean Crown width = _________ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _______ %
Foliage Cover = CC (%) x mean Crown type (%)/100= ________ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

PLOT No. ______ STRATUM ________	1	2	3	4	5	6	7	8	9	10	11	12
Crown width (m? OR cm?)												
Crown Separation/Gap (m? OR cm?)												
Crown type/ Degree of openness (%)												

Calculations:

CSR = mean Gap/mean Crown width = _________ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _______ %
Foliage Cover = CC (%) x mean Crown type (%)/100= ________ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

PLOT No. ______ STRATUM ________	1	2	3	4	5	6	7	8	9	10	11	12
Crown width (m? OR cm?)												
Crown Separation/Gap (m? OR cm?)												
Crown type/ Degree of openness (%)												

Calculations:

CSR = mean Gap/mean Crown width = _________ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _______ %
Foliage Cover = CC (%) x mean Crown type (%)/100= ________ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

PLOT No. ______ STRATUM ________	1	2	3	4	5	6	7	8	9	10	11	12
Crown width (m? OR cm?)												
Crown Separation/Gap (m? OR cm?)												
Crown type/ Degree of openness (%)												

Calculations:

CSR = mean Gap/mean Crown width = _________ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _______ %
Foliage Cover = CC (%) x mean Crown type (%)/100= ________ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

PLOT No. ______ STRATUM ________	1	2	3	4	5	6	7	8	9	10	11	12
Crown width (m? OR cm?)												
Crown Separation/Gap (m? OR cm?)												
Crown type/ Degree of openness (%)												

Calculations:

CSR = mean Gap/mean Crown width = _________ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _______ %
Foliage Cover = CC (%) x mean Crown type (%)/100= ________ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

PLOT No. ______ STRATUM ________	1	2	3	4	5	6	7	8	9	10	11	12
Crown width (m? OR cm?)												
Crown Separation/Gap (m? OR cm?)												
Crown type/ Degree of openness (%)												

Calculations:

CSR = mean Gap/mean Crown width = _________ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _______ %
Foliage Cover = CC (%) x mean Crown type (%)/100= ________ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

***BioMetric* plot work sheets: Full species IDs are not required for *BioMetric*, but may be useful for identification of correct vegetation type & for monitoring purposes.**

Site type: Clearing zone / Offset zone / Reference site **PVP Request No. & Zone No. OR Ref. site ID:**_____ **Date** _____ **Recorder/s** _____

Veg type: _____ **AMG (Zone/Easting Northing) OR Lat/Long (dec. degrees):** _____ **Photos:** _____

Native OVER_STOREY species list [20x20m plot]	Regen (√) [zone]	Native MID-STOREY species list (>1m to <over-storey) [20x20m plot]	Native GROUND STRATUM COVER (GRASSES) species list (ground stratum <~1m) [20x20m plot]	Native GROUND STRATUM COVER (SHRUBS) species list (ground stratum <~1m) [20x20m plot]	Native GROUND STRATUM COVER (OTHER) species list* (ground stratum <~1m) [20x20m plot]	EXOTIC plants species list [20x20m plot]	FALLEN LOGS (min. 10cm diam x 50cm long [20x50m plot]
Total no. species =							
Foliage Cover (FC, %) =							
Benchmark FC value (%) =							
av. crown diam. = **av. Foliage Cover (%) =** **# trees =** **sample area =** **[whole of zone]**							
# trees with HOLLOWS = **Sample area =** **Benchmark value =** **[20x50m plot or whole zone]**		Total no. species = Foliage Cover (%) = Benchmark FC value (%) =	Total no. species = Foliage Cover (%) = Benchmark FC value (%) =	Total no. species = Foliage Cover (%) = Benchmark FC value (%) =	Total no. species = Foliage Cover (%) = Benchmark FC value (%) =	Total no. species = Foliage Cover (%) = Benchmark FC value (%) =	Total (m) = Benchmark (m) =

*** = forbs, herbs, ferns, lilies, rushes, sedges etc. N.B.** Plots/transects should be placed randomly with a min of one plot and a max of ten plots within a zone (more may be required in zones that have high internal variability).

Site & Other Notes:

Reference sites - plot data sheet

Start a new sheet for each Reference site (Refer to Appendix 5 for Reference Site methods & tips)

BioMetric

Ref site ID (assigned by assessor)		**CMA**		**Recorder/s**		**Date**	

Vegetation Formation (*sensu* Keith 2004)

Vegetation Class (*sensu* Keith 2004)

Vegetation Type (*BioMetric)*

Dominant species per stratum

Over-storey	Mid-storey	Ground stratum

PLOT 1 Lat.	Long.
Orientation	**Photos**

PLOT 2 Lat.	Long.
Orientation	**Photos**

PLOT 3 Lat.	Long.
Orientation	**Photos**

PLOT 4 Lat.	Long.
Orientation	**Photos**

PLOT 5 Lat.	Long.
Orientation	**Photos**

PLOT 6 Lat.	Long.
Orientation	**Photos**

PLOT 7 Lat.	Long.
Orientation	**Photos**

PLOT 8 Lat.	Long.
Orientation	**Photos**

PLOT 9 Lat.	Long.
Orientation	**Photos**

Plot 10 Lat.	Long.
Orientation	**Photos**

Disturbance attributes & history (Record Severity, Frequency, Evidence and Age codes for each plot, e.g. **L| Occ | Ob | R** . See over for details).

Plot No.	1	2	3	4	5	6	7	8	9	10
Canopy dieback	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |
Grazing and trampling	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |
Soil disturbance	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |
Timber harvesting	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |
Flood damage	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |
Storm damage	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |
Firewood collection & tidying up	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |
Dense regrowth post-disturbance	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |
Fertiliser addition	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |
Fire damage	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |
Feral herbivores										
Weeds	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |
Other - indicate type: _____	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |

20m x 20m plot (Refer to methods in Appendix 4 of *BioMetric* Operational Manual. Step Point Transect or Crown Separation Ratio methods can also be used to assess % Foliage Cover.)

Number of native plant species										
Native mid-storey cover (%)										
Native ground stratum cover (%)- grasses										
Native ground stratum cover (%) - shrubs										
Native ground stratum cover (%) - other										

Larger sampling area (20m x 50m plot) (Refer to methods in Appendix 4 of *BioMetric* Operational Manual.)

Number of trees with hollows – use Alternative method below if appropriate										
Total length of fallen logs (m)										

Alternative (whole-of-zone) methods for zones containing scattered trees, such as sparsely wooded reference sites.
(Scattered Tree Calculator in *BioMetric* can be used for calculations.)

Native over-storey cover (%)	av. crown diameter (m)= av. foliage cover (%) = # trees= sample area (ha)=									
No. trees with hollows	sample area (ha)= no. trees with hollows =									

Step point transect tally tables (for methodology refer to Appendix 4 of *BioMetric* Operational Manual.)

PLOT No. _____ TRANSECT No/s. _____	No. hits (tally)	%
Native over-storey cover (%)		
Native mid-storey cover (%)		
Native ground stratum cover (%) - grasses		
Native ground stratum cover (%) - shrubs		
Native ground stratum cover (%) - other		
Exotic plant cover (%)		
Litter cover (%) - optional		
Rock cover (%) - optional		
Bare ground cover (%) - optional		
Cryptogam cover (%) - optional		

PLOT No. _____ TRANSECT No/s. _____	No. hits (tally)	%
Native over-storey cover (%)		
Native mid-storey cover (%)		
Native ground stratum cover (%) - grasses		
Native ground stratum cover (%) - shrubs		
Native ground stratum cover (%) - other		
Exotic plant cover (%)		
Litter cover (%) - optional		
Rock cover (%) - optional		
Bare ground cover (%) - optional		
Cryptogam cover (%) - optional		

Crown Separation Ratio transect tables (for methodology refer to Appendix 4 of *BioMetric* Operational Manual. Record stratum (o/s, m/s, g/s(g), g/s(s) or g/s(o). Use consistent units within each plot, i.e. m OR cm. Use cm for ground stratum. Circle units used.)

PLOT No. _____ STRATUM _____	1	2	3	4	5	6	7	8	9	10	11	12	Mean
Crown width (m? OR cm?)													
Crown Separation/Gap (m? OR cm?)													
Crown type/ Degree of openness (%)													

Calculations:

CSR = mean Gap/mean Crown width = _____ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _____ %
Foliage Cover = CC (%) x mean Crown type (%)/100= _____ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

PLOT No. _____ STRATUM _____	1	2	3	4	5	6	7	8	9	10	11	12
Crown width (m? OR cm?)												
Crown Separation/Gap (m? OR cm?)												
Crown type/ Degree of openness (%)												

Calculations:

CSR = mean Gap/mean Crown width = _____ m? or cm?
Crown Cover (CC) = 80.6/(1+CSR) = _____ %
Foliage Cover = CC (%) x mean Crown type (%)/100= _____ %. Enter this value into *BioMetric* for correct stratum within appropriate plot.

Disturbance attributes & history record - Scoring codes and Notes table

- Timber harvesting = stumps, coppicing, cut logs, ringbarking etc. (use Notes table below to record details)
- Grazing & trampling = grazing and trampling by introduced herbivores or over-abundant native herbivores (use Notes table below)
- Soil disturbance = ripping, cultivation, compaction, erosion (use Notes table below)
- Fire damage – indicate if high frequency, or if certain strata particularly affected (use Notes table below)
- Feral animals – indicate species (if known) and observed impacts (use Notes table below)

Severity codes	Frequency codes	Evidence codes	Age codes
N = Nil (no evidence)	A = Absent (i.e. n/a)	O = Observation	On = Ongoing
L = Light	Ra = Rare	W = Word of mouth (e.g. landholder)	R = Recent (<3 years)
M = Moderate	Occ = Occasional		NR = Not recent
S = Severe	F = Frequent		O = Old

Notes

Modification type	Plot #	Details

Please fax or email completed sheets to: Native Vegetation Science Unit, NSW DECCW.
Fax (02) 6229 7001. Email: biometric.tool@environment.nsw.gov.au. Thank you.

***BioMetric* & Threatened Species Tool SCATTERED TREE plot work sheets:** **Full species IDs are not required for *BioMetric*, but may be useful for identification of correct vegetation type & for monitoring purposes.**

Site type: Clearing zone / Offset zone / Reference site **PVP Request No. & Zone No. OR Ref. site ID:**_____

AMG (Zone/Easting Northing) OR Lat/Long (dec. degrees): _____ **Date** _____

Recorder/s _____ **Veg Type:** _____**Photos:** _____

Tree No.	Species	DBHOB (cm)	Crown Diameter (m)	Foliage Cover (%)	Hollows (cm) size in 5cm increments	Mistletoe
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
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41						
42						
43						
44						
45						
46						
47						
48						
49						
50						

No. trees: _____ **Av. Foliage Cover (%):** _____

No. trees with hollows: _____ **Av. no. hollow-bearing trees (per 50x20m plot):** _____

Sample area ID: _____ **Sample area (ha):** _____

Notes

Thinning (stem density) – plot data sheet

BioMetric

Start a new page for each zone (Thinning proposals) or Stem density Reference site

PLOT TYPE: (circle one) **Thinning zone / Stem density reference site**

CMA | **Recorder/s** | **Date**

	PVP Request No.	Veg. Zone No.	Area (ha)
PVP Request No. (from *PADACS*), **Zone No.** (from *NVAT Mapper*) **& Zone Area**			

OR

Ref site ID (assigned by assessor)

Vegetation Formation (*sensu* Keith 2004)

Vegetation Class (*sensu* Keith 2004)

Vegetation Type (*BioMetric*)

Species present in stem classes	>0 to 10 cm DBHOB	>10 to 20 cm DBHOB	>20 to 30 cm DBHOB

PLOT 1 Lat.	Long.	PLOT 2 Lat.	Long.	PLOT 3 Lat.	Long.	PLOT 4 Lat.	Long.	PLOT 5 Lat.	Long.
Orientation	**Photos**	**Orientation**	**Photos**	**Orientation**	**Photos**	**Orientation**	**Photos**	**Orientation**	**Photos**

PLOT 6 Lat.	Long.	PLOT 7 Lat.	Long.	PLOT 8 Lat.	Long.	PLOT 9 Lat.	Long.	Plot 10 Lat.	Long.
Orientation	**Photos**	**Orientation**	**Photos**	**Orientation**	**Photos**	**Orientation**	**Photos**	**Orientation**	**Photos**

Plot No.	1	2	3	4	5	6	7	8	9	10
>0 to 10 (cm) DBHOB class:										
>10 to 20 (cm) DBHOB class:										
>20 to 30 (cm) DBHOB class:										
>30 (cm) DBHOB class – optional:										

20m x 50m plot (Refer to Appendix 4 of Operational Manual for methods. Thinning assessments for PVPs do not have to be plot-based, but plots must be used on Reference Sites. DBHOB = diameter at breast height (1.3m above ground level), measured over bark.)

Please fax or email completed Reference Site sheets to: Native Vegetation Science Unit, NSW DECCW. Fax (02) 6229 7001
Email: biometric.tool@environment.nsw.gov.au . Thank you.

NOTES: