Vegetation condition benchmarks
Short-term review

Dani Ayers, Woodland Ecology Unit
July 2006

Brief description and aim of the review

This was a review of the vegetation condition benchmarks required to correct errors and anomalies. It was not a full revision, as time and resources did not allow for this. Nor was it sensible to undertake a full revision at this time, given that a full revision would be necessitated by the veg type reviews.

Detail of review process

This minor review was aimed specifically at addressing a suite of generic issues that required checking, correcting or reviewing on the basis of definitional amendments, across all CMA. The list of generic review tasks included:

- review all pre-existing benchmarks for each vegetation class within each CMA, in light of the definitions and information contained in the Benchmark Review document;
- check for errors in the benchmarks and suggest improved benchmarks, where necessary, drawing on expert judgement and/or plot data (including from reference sites);
- review of all per cent foliage cover benchmarks against new vegetation strata definitions (especially for over-storey and mid-storey benchmarks, and most notably those highlighted on the *BioMetric* website) because some existing cover benchmarks were provided according to previous definitions;
- review of per cent foliage cover benchmarks for specified strata in particular CMAs that had been converted from crown cover (%) to an approximate per cent foliage cover during the 2005 preparation of benchmarks;
- review of mid-storey per cent foliage cover benchmarks for woodland, forest and rainforest vegetation classes where the recommended 2005 benchmark range was 0-0% and had been changed to 0-10% to include regeneration of over-storey species;
- review all per cent foliage cover benchmarks of 0% to x% to overcome the problem of degraded sites with 0% cover being assessed as within benchmark;
- incorporate any data or expert information obtained from reference plot data in relevant vegetation classes into corresponding benchmarks, where such data exist.

A small number of additional review tasks were undertaken in specific CMAs as necessary.

Attachment 1 summarises the following information used by reviewers in undertaking the vegetation condition benchmark review process:

- definition of 'vegetation condition benchmarks'
- summary of the uses for which vegetation condition benchmarks are required, and

- relevant definitions needed for correct interpretation and review of the benchmarks (vegetation conditions, vegetation strata, per cent cover, minimum width of fallen logs and plot-sizes for area-dependent variables).

Final list of reviewers

The following is the final list of reviewers who actively participated in the veg condition benchmark review process:

- **DEC:** Rainer Rehwinkel, Tim Hager, Daniel Connolly, Keith McDougall;
- **SFNSW:** Doug Binns;
- **DNR:** Alan Ede, Chris Nadolny, Steve Lewer, Wendy Hawes, Megan McNellie, James Val, Phil Redpath, Ken Turner, Russell Grant;
- **CMAs:** Greg Steenbeeke, Michael Dunn, Ray Willis, Dennis Boschma, Laura Babian, Noel Hayward, Claire Wilkinson, Else Foster, Silvana Keating, Sarah Munro, Rob Armstrong, Liz Clark;
- **Consultants:** Rick Webster, Travis Peake, Stephen Bell.

Attachment 1: Benchmark Review February/March 2006

Danielle Ayers[1], Sue Briggs, Phil Gibbons, Julian Seddon and Stuart Doyle

[1]NSW Department of Environment and Conservation, ph. 02 6242 1549, danielle.ayers@csiro.au

A. Introduction

Benchmarks are measures of the range of variability in condition in vegetation with relatively little evidence of alteration, disturbance or modification by humans since European settlement. Benchmarks are described for a suite of condition variables by vegetation community at the scale of the stand or patch.

Benchmarks are used in *BioMetric* (the PVP assessment tool for biodiversity) as yardsticks against which to assess vegetation condition at the scale of the stand or patch. The Operational Manual for *BioMetric* is at the web site **http://www.nationalparks.nsw.gov.au/npws.nsf/Content/BioMetric_tool.**

Benchmarks are used for vegetation condition assessment because: (1) Benchmarks allow the condition of vegetation at the stand scale to be objectively and transparently assessed in a repeatable way. Vegetation condition at the scale of the stand is an important determinant of biodiversity (reviewed by McElhinney 2002, McElhinney *et al.* 2005). (2) Benchmarks of vegetation condition from sites that are relatively unmodified by European land use and management practices best reflect the habitat conditions to which native biota are adapted. (3) Benchmarks provide measures of vegetation condition for individual vegetation communities. They assess like against like and avoid the problem of grasslands being scored lower than woodlands because woodlands have higher structural complexity. (4) Vegetation is more resilient when managed within its range of variation (Holling and Meffe 1996). (5) Historical conditions provide one of the best means for predicting impacts to ecological systems today (Landres *et al.* 1999).

We are reviewing benchmarks for Keith (2004) vegetation classes, and for vegetation types where these have already been provided, by CMA. The review is a review of benchmarks, not a revision of benchmarks. Neither time nor resources are available to revise the vegetation condition benchmarks at present. The goals of the benchmark review in February and March 2006 are to fix errors and anomalies in the benchmark database and to provide better benchmark information where this can be provided readily by experts. Better benchmark information can include benchmarks for vegetation types instead of vegetation class, where such data are available. Vegetation types can be found at http://www.nationalparks.nsw.gov.au/images/BioMetric_Vegetation_Type_CMA.xls

B. Vegetation condition benchmark variables

Benchmarks are quantitative measures that describe the range of variability in condition in vegetation with relatively little evidence of alteration, disturbance or modification by humans since European settlement. Vegetation condition benchmarks are used in *BioMetric* to assess changes in vegetation condition with management. Unmodified vegetation encompasses a range of disturbance states, hence the vegetation condition benchmarks derived for *BioMetric* are not restricted to the 'climax state' of each vegetation class. Instead they are intentionally broad and encompass a range of natural disturbance states of unmodified forms of vegetation types in each vegetation class of each CMA area.

Interim vegetation condition benchmarks are currently available in each CMA area for broad vegetation classes (*sensu* Keith 2004), except for the Hawkesbury-Nepean CMA area, for which benchmarks have been compiled for individual vegetation types. Benchmarks are the typical range of values (nominally between 10th and 90th percentiles) for a suite of vegetation condition variables (Table 1) that would be observed on sites of a vegetation class that are relatively unmodified by Europeans. Benchmarks describe values for condition variables across a number of sites in good condition, not values from one site. Hence they do not include extreme values that would occur on only a small proportion of plots (e.g. per cent foliage cover measured in woodland plots might range between extremes of 0-40%, but the woodland

typically has cover values between 15% and 25%. The benchmark range would be 15%-25% in this situation).

Five of the vegetation condition variables relate to vegetation strata. These strata are defined in Table 1, and illustrated in Figure 1. Not all possible vegetation community structural types are included in Figure 1. The following two important principles are highlighted by these illustrations: (1) the tallest structural layer above 1m in height is always termed the over-storey; and (2) all other structural layers below the over-storey and above 1m in height are collectively referred to as the mid-storey, regardless of how many layers there are. Thus, an identical layer of vegetation (height and species composition) can be defined as the over-storey in one vegetation type and the mid-storey in an adjacent vegetation type. This point is critical for reviewers. This approach to defining the over-storey and mid-storey strata was adopted in preference to the use of specific height thresholds because of the huge variation in structural layer heights across the vegetation types in NSW.

Table 1: Definitions and field methodologies for measuring the vegetation condition variables used in *BioMetric*. Per cent foliage cover is the amount of shadow that would be cast on the ground if there were a light source directly overhead (see Appendix 1). Per cent foliage cover benchmark estimates are not dependent on the plot size/transect length used to estimate them. In contrast, plant species richness, trees with hollows and fallen logs length must be reported for the plot areas used in *BioMetric*. Variables for which benchmarks are not required (exotic plant cover and over-storey regeneration) are defined only.

Vegetation condition variable (and plot/transect type)	Definition and benchmark description
Indigenous plant species richness **20m x 20m plot (0.04 ha)**	**Definition – indigenous plant species:** Indigenous plant species refers to vascular species local to the area and, if planted, come from a local seed source. **Benchmark description:** Only the lower benchmark value is required for native plant species richness as vegetation with the lower benchmark or a greater number of native species is within the benchmark and therefore scores the maximum points for this condition variable (i.e. there is no reason to penalise vegetation that has very high richness). For simplicity, we suggest that the benchmark value for number of native species be the number of species likely to be visible in an average poor season.
Native over-storey cover (%)	**Definition - native over-storey:** Native over-storey refers to all native life-forms in the tallest dominant stratum (including emergents) present above 1m and includes all species native to Australia (i.e. native species not local to the area can contribute to over-storey structure). For example, in a woodland community the over-storey stratum is the tree layer (see Figure 1A); in a shrubland community the over-storey stratum is the tallest shrub layer above 1m (see Figure 1C); in a wetland or swamp the over-storey stratum may comprise sedges, rushes or bulrushes; and in a tall grassland there may be an over-storey stratum of grasses >1m high. Some vegetation types (e.g. low grasslands) may not have an over-storey stratum. **Benchmark description:** Upper and lower benchmark values describe the range of per cent foliage cover for the over-storey. Record all cover cast by life-forms that make up this stratum (i.e., include all foliage and branches attached to plants in this stratum even if they hang below the canopy). Some vegetation classes such as grasslands have a benchmark of zero for native over-storey cover. Cover estimates should be provided to the nearest % point where possible.

Vegetation condition variable (and plot size)	Definition and benchmark description
Native mid-storey cover (%)	**Definition - native mid-storey:** The mid-storey contains all native life-forms between the over-storey stratum and 1m in height (typically tall shrubs, under-storey trees and regeneration of over-storey species, see Figures 1A-1C) and includes all species native to Australia (i.e. native species not local to the area can contribute to mid-storey structure). Some vegetation types (e.g. grasslands) may not have a mid-storey stratum. **Benchmark description:** Upper and lower benchmark values for native mid-storey cover describe the range of per cent foliage cover for the mid-storey. Record all cover cast by life-forms that make up this stratum (i.e., include all foliage and branches attached to plants in this stratum, even if they hang below 1m). Cover estimates should be provided to the nearest % point where possible.
Native ground cover (%) *** grasses** *** shrubs** *** other**	**Definition - native ground stratum:** The ground stratum contains all native life-forms below 1m in height (see Figures 1A-C) and includes all species native to Australia (i.e. is not confined to species indigenous to the area). Ground stratum (grasses) refers to native grasses (i.e. plants belonging to the family Poaceae). Ground stratum (shrubs) refers to native woody vegetation <1m. Ground stratum (other) refers to non-woody native vegetation (vascular plants only) <1m that is not grass (e.g. forbs, herbs, ferns, lilies, rushes and sedges). **Benchmark description:** Upper and lower benchmark values for native ground cover describe the range of per cent foliage cover values separately for three life form classes: grasses, shrubs, other (e.g. forbs). Cover estimates should be provided to the nearest % point where possible. For simplicity, we suggest that the lower benchmark values for native ground be cover for an average poor season, and the upper benchmark values for be those for an average good season.
Exotic plant cover (%)	**Definition – exotic plants:** Exotic plants are vascular plants not native to Australia. **Benchmark description:** Benchmarks are not used for exotic plant cover.

Vegetation condition variable (and plot size)	Definition and benchmark description
Number of trees with hollows 20m x 50m (0.1 ha) plot*	**Definition - trees with hollows:** A tree with hollows is a living or dead tree with one or more hollows in the stem or branches of the crown of the tree (ie, at least 1 m above the ground), with a minimum entrance width approximately ≥5 cm and with apparent depth. Trees with hollows at the base of the tree such as fire scars and hollows in stumps are not included. **Benchmark description:** Upper and lower benchmarks are required for tree hollows.
Over-storey regeneration	**Definition – over-storey regeneration:** The proportion of over-storey species at the site that are regenerating (i.e. with dbh ≤ 5cm). Dbh = diameter at breast height, i.e. at 1.3 metres above the ground. The maximum value for this measure is 1. **Benchmark description:** Benchmarks are not used for over-storey regeneration.
Total length of fallen logs (m) 20m x 50m (0.1 ha) plot	**Definition – total length of fallen logs:** This is total length of fallen wood in the plot that is ≥10cm diameter and ≥0.5m long. Only those parts of logs lying within the plot are measured. **Benchmark description:** Upper and lower benchmarks are required for fallen logs.
Number of stems in specified diameter classes 20m x 50m (0.1 ha) plot	**Definition – number of stems in specified diameter classes:** This is a count of the number of stems of over-storey tree species in dbh classes relevant for the vegetation type. **Benchmark description:** This variable is used only in the assessment of vegetation thinning proposals. Upper and lower benchmarks are required for each dbh class. Record only those trees in which the centre of the stem is within the plot. Individual trees of multi-stemmed and coppiced species count as one stem, in which case dbh is the measure of the largest stem for that individual. Dbh is stem diameter at breast height, i.e., at 1.3 metres above the ground. Ten over-storey stems per 0.1 ha plot is equivalent to trees being spaced approximately 10 m apart.

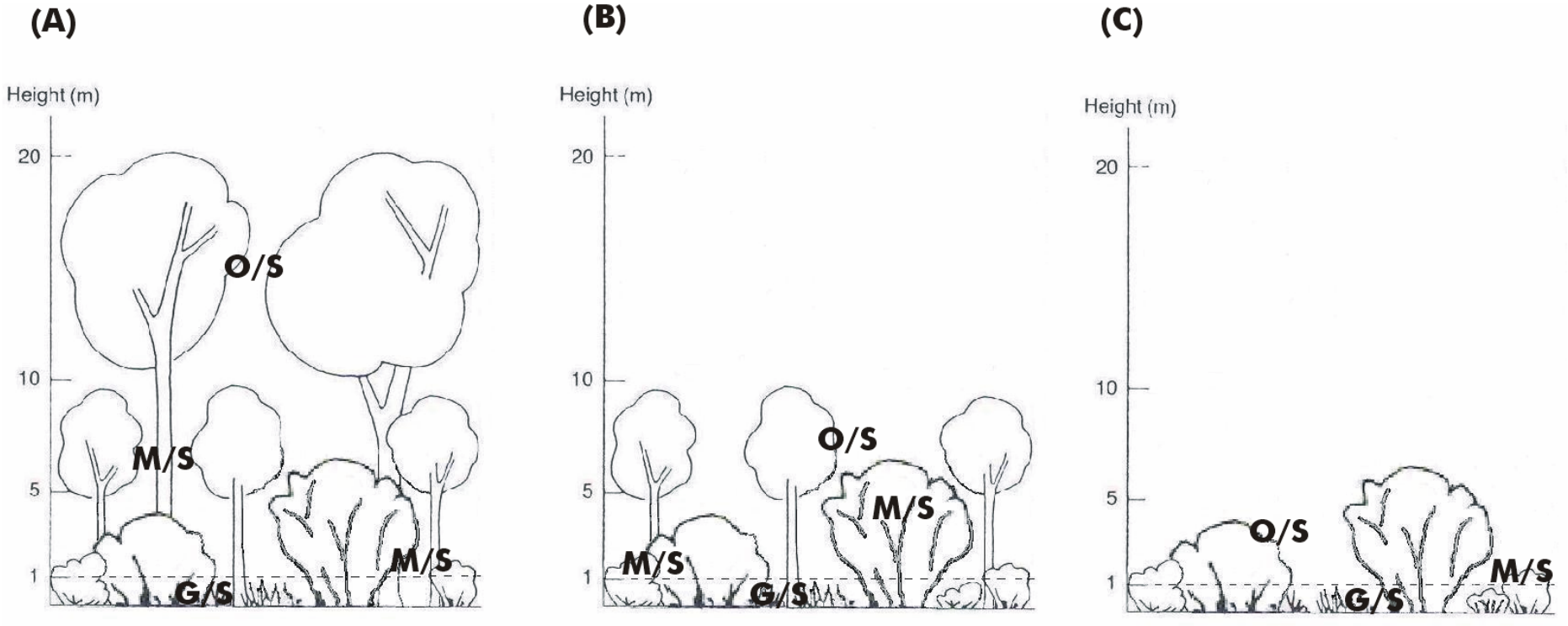

Figure 1: Vegetation strata, as defined in Table 1. (A) woodland with a multi-layered mid-storey of regenerating trees and shrubs. (B) low arid woodland with shrubby mid-storey. (C) shrubland with mid-storey of young shrubs. In each case the tallest stratum is termed the over-storey, even though a layer of identical composition may form the mid-storey in a more structurally diverse vegetation type such as (A). Measurement of per cent foliage cover for a stratum is based on the complete cover cast by life-forms comprising that stratum and not just the amount of foliage within any specified vertical height limitations. For example, the mid-storey cover in (A) comprises the cover cast by whole shrubs and low trees below the over-storey (including all foliage and branches attached to plants in this stratum, even if they hang below 1m) and not simply the cover cast by the foliage present >1m and <10m. Base diagram from Walker and Hopkins (1990).

C. Development of vegetation condition benchmarks

The upper and lower cut-offs of benchmarks should be chosen to represent the range of variation in relatively unmodified vegetation of the relevant Keith (2004) class or vegetation type. Experts have to judge what constitutes relatively unmodified in the context of the vegetation classes (or types) in the CMAs they are reviewing. Unmodified vegetation 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.

If calculating benchmarks from pre-existing plot data then the range of sites from which the plot data was collected needs to be considered. For example, the range of values from the 10th to the 90th decile would generally provide benchmarks from plot data collected from high condition sites, whereas the range of values from the 50th to 90th decile would generally provide benchmarks where plot data was collected from across all condition states.

Some benchmarks need to be derived for specific plot sizes, as indicated in Table 1.

D. Derived vegetation communities

In *BioMetric*, derived or secondary vegetation communities are assessed against the original vegetation community determined from the best information available. This means that condition of derived vegetation communities is assessed against benchmarks for the notional original community.

Appendix 1. Figure 5 from Walker and Hopkins (1998). The percentages are per cent foliage cover.

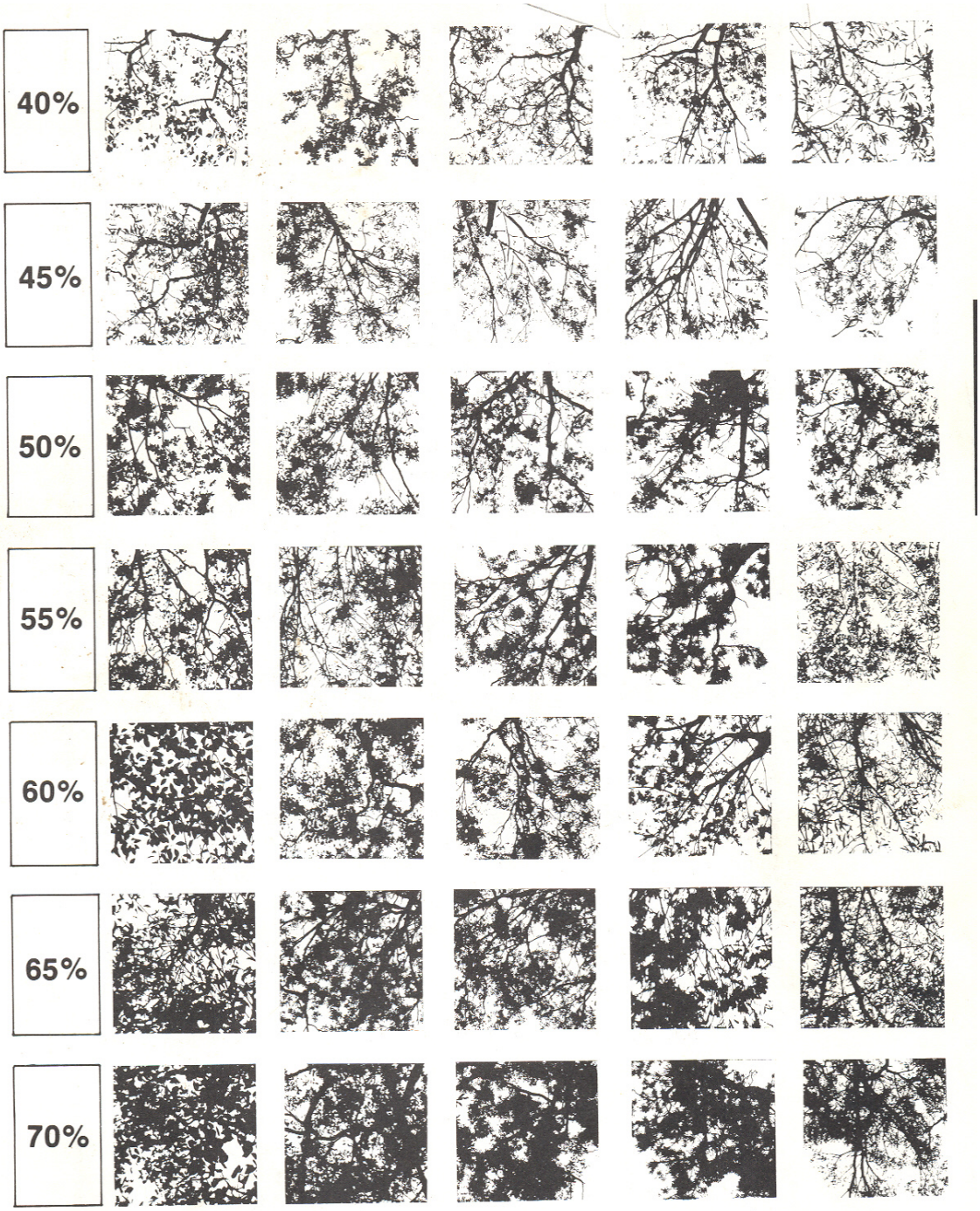

Figure 5 Crown types. Estimate the openness of individual tree or shrub crowns by matching the crown with a photograph. The rows show similar crown types for different leaf sizes (large to small, left to right); *Acacia* phyllodes are in the right hand row. Most Australian woody plants are in the range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

Appendix 2. Statewide Vegetation Classes as defined by Keith (2004). Descriptions are provided in Keith (2004).

Vegetation Formation	Vegetation Class
Rainforests	Subtropical Rainforests
Rainforests	Northern Warm Temperate Rainforests
Rainforests	Southern Warm Temperate Rainforests
Rainforests	Cool Temperate Rainforests
Rainforests	Dry Rainforests
Rainforests	Western Vine Thickets
Rainforests	Littoral Rainforests
Rainforests	Oceanic Rainforests
Rainforests	Oceanic Cloud Forests
Wet sclerophyll forests (Shrubby subformation)	North Coast Wet Sclerophyll Forests
Wet sclerophyll forests (Shrubby subformation)	South Coast Wet Sclerophyll Forests
Wet sclerophyll forests (Shrubby subformation)	Northern Escarpment Wet Sclerophyll Forests
Wet sclerophyll forests (Shrubby subformation)	Southern Escarpment Wet Sclerophyll Forests
Wet sclerophyll forests (Grassy subformation)	Northern Hinterland Wet Sclerophyll Forests
Wet sclerophyll forests (Grassy subformation)	Southern Lowland Wet Sclerophyll Forests
Wet sclerophyll forests (Grassy subformation)	Northern Tableland Wet Sclerophyll Forests
Wet sclerophyll forests (Grassy subformation)	Southern Tableland Wet Sclerophyll Forests
Wet sclerophyll forests (Grassy subformation)	Montane Wet Sclerophyll Forests
Grassy woodlands	Coastal Valley Grassy Woodlands
Grassy woodlands	Tableland Clay Grassy Woodlands
Grassy woodlands	New England Grassy Woodlands
Grassy woodlands	Southern Tableland Grassy Woodlands
Grassy woodlands	Subalpine Woodlands
Grassy woodlands	Western Slopes Grassy Woodlands
Grassy woodlands	Floodplain Transition Woodlands
Grasslands	Maritime Grasslands
Grasslands	Temperate Montane Grasslands
Grasslands	Western Slopes Grasslands
Grasslands	Riverine Plain Grasslands
Grasslands	Semi-arid Floodplain Grasslands
Dry sclerophyll forests (Shrub/grass subformation)	Clarence Dry Sclerophyll Forests
Dry sclerophyll forests (Shrub/grass subformation)	Hunter-Macleay Dry Sclerophyll Forests
Dry sclerophyll forests (Shrub/grass subformation)	Cumberland Dry Sclerophyll Forests
Dry sclerophyll forests (Shrub/grass subformation)	Southern Hinterland Dry Sclerophyll Forests
Dry sclerophyll forests (Shrub/grass subformation)	Northern Gorge Dry Sclerophyll Forests
Dry sclerophyll forests (Shrub/grass subformation)	Central Gorge Dry Sclerophyll Forests
Dry sclerophyll forests (Shrub/grass subformation)	New England Dry Sclerophyll Forests
Dry sclerophyll forests (Shrub/grass subformation)	Upper Riverina Dry Sclerophyll Forests
Dry sclerophyll forests (Shrub/grass subformation)	North-west Slopes Dry Sclerophyll Woodlands
Dry sclerophyll forests (Shrub/grass subformation)	Pilliga Outwash Dry Sclerophyll Forests
Dry sclerophyll forests (Shrubby subformation)	Coastal Dune Dry Sclerophyll Forests
Dry sclerophyll forests (Shrubby subformation)	North Coast Dry Sclerophyll Forests
Dry sclerophyll forests (Shrubby subformation)	Sydney Coastal Dry Sclerophyll Forests
Dry sclerophyll forests (Shrubby subformation)	Sydney Hinterland Dry Sclerophyll Forests

Vegetation Formation	Vegetation Class
Dry sclerophyll forests (Shrubby subformation)	Sydney Sand Flats Dry Sclerophyll Forests
Dry sclerophyll forests (Shrubby subformation)	South Coast Sands Dry Sclerophyll Forests
Dry sclerophyll forests (Shrubby subformation)	South East Dry Sclerophyll Forests
Dry sclerophyll forests (Shrubby subformation)	Southern Wattle Dry Sclerophyll Forests
Dry sclerophyll forests (Shrubby subformation)	Northern Escarpment Dry Sclerophyll Forests
Dry sclerophyll forests (Shrubby subformation)	Sydney Montane Dry Sclerophyll Forests
Dry sclerophyll forests (Shrubby subformation)	Northern Tableland Dry Sclerophyll Forests
Dry sclerophyll forests (Shrubby subformation)	Southern Tableland Dry Sclerophyll Forests
Dry sclerophyll forests (Shrubby subformation)	Western Slopes Dry Sclerophyll Forests
Dry sclerophyll forests (Shrubby subformation)	Yetman Dry Sclerophyll Forests
Heathlands	Wallum Sand Heaths
Heathlands	Sydney Coastal Heaths
Heathlands	Coastal Headland Heaths
Heathlands	South Coast Heaths
Heathlands	Northern Montane Heaths
Heathlands	Sydney Montane Heaths
Heathlands	Southern Montane Heaths
Alpine complex	Alpine Heaths
Alpine complex	Alpine Fjaeldmarks
Alpine complex	Alpine Herbfields
Alpine complex	Alpine Bogs and Fens
Freshwater wetlands	Coastal Heath Swamps
Freshwater wetlands	Montane Bogs and Fens
Freshwater wetlands	Coastal Freshwater Lagoons
Freshwater wetlands	Montane Lakes
Freshwater wetlands	Inland Floodplain Swamps
Freshwater wetlands	Inland Floodplain Shrublands
Forested wetlands	Coastal Swamp Forests
Forested wetlands	Coastal Floodplain Wetlands
Forested wetlands	Eastern Riverine Forests
Forested wetlands	Inland Riverine Forests
Saline wetlands	Mangrove Swamps
Saline wetlands	Saltmarshes
Saline wetlands	Seagrass Meadows
Saline wetlands	Inland Saline Lakes
Semi-arid woodlands (Grassy subformation)	Inland Floodplain Woodlands
Semi-arid woodlands (Grassy subformation)	North-west Floodplain Woodlands
Semi-arid woodlands (Grassy subformation)	Riverine Plain Woodlands
Semi-arid woodlands (Grassy subformation)	Brigalow Clay Plain Woodlands
Semi-arid woodlands (Shrubby subformation)	North-west Alluvial Sand Woodlands
Semi-arid woodlands (Shrubby subformation)	Riverine Sandhill Woodlands
Semi-arid woodlands (Shrubby subformation)	Inland Rocky Hill Woodlands
Semi-arid woodlands (Shrubby subformation)	Subtropical Semi-arid Woodlands
Semi-arid woodlands (Shrubby subformation)	Western Peneplain Woodlands
Semi-arid woodlands (Shrubby subformation)	Dune Mallee Woodlands
Semi-arid woodlands (Shrubby subformation)	Sand Plain Mallee Woodlands
Semi-arid woodlands (Shrubby subformation)	Semi-arid Sand Plain Woodlands
Semi-arid woodlands (Shrubby subformation)	Desert Woodlands
Arid shrublands (Chenopod subformation)	Riverine Chenopod Shrublands
Arid shrublands (Chenopod subformation)	Aeolian Chenopod Shrublands
Arid shrublands (Chenopod subformation)	Gibber Chenopod Shrublands
Arid shrublands (Acacia subformation)	North-west Plain Shrublands
Arid shrublands (Acacia subformation)	Gibber Transition Shrublands
Arid shrublands (Acacia subformation)	Stony Desert Mulga Shrublands
Arid shrublands (Acacia subformation)	Sand Plain Mulga Shrublands

References

McElhinny (2002), McElhinny *et al.* (2005), Holling and Meffe (1996), and Landres *et al.* (1999) are available from Sue Briggs.

Keith D. (2004). Ocean Shores To Desert Dunes. The Native Vegetation of New South Wales and the ACT. NSW Department of Environment and Conservation, Sydney.

Walker, J. and Hopkins, M.S. (1990). Vegetation. *In* Australian Soil and Land Survey. Ed by McDonald, R.C., R.F. Isbell, J.G. Speight, J. Walker, and M.S. Hopkins. Inkata Press, Melbourne.