


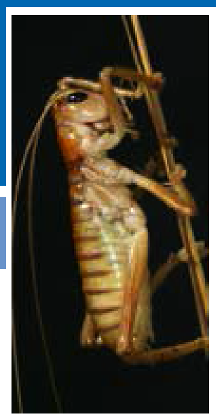

A SIMPLE BUT USEFUL MAP OF VEGETATION STRUCTURE IN AND NEAR CANBERRA

Claire Wimpenny, Brett Howland and Don Fletcher

Technical Report 33

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http://www.environment.act.gov.au
Telephone: Canberra Connect 13 22 81

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Front cover: (small pictures 1-4): Management of Eastern Grey Kangaroos *Macropus giganteus* (1) and management of bushfire hazard (2) can potentially benefit from a unified, objective and consistent map of vegetation structure (3). Among many small creatures likely to benefit from more sophisticated management of kangaroos and bushfire hazard are Canberra Raspy Crickets *Cooraboorama Canberrae* (4).

Technical Report 33

A simple but useful map of vegetation structure in and near Canberra

Claire Wimpenny, Brett Howland and Don Fletcher

Conservation Research
Environment Division
Environment and Planning Directorate
ACT Government

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Executive Summary

The structure of vegetation in and surrounding the city of Canberra was mapped for the first time using definitions compatible with the ACT *Strategies* for woodlands (ACT Government 2004) and native grasslands (ACT Government 2005), and the National Vegetation Inventory System (ESCAVI 2003). Based mainly on percentage tree canopy cover, this map is the first to identify structural formation elements in this area. In addition, some corridors and islands of urban vegetation were mapped.

The aim was to fill an information need quickly without any above-base funding in 2009.

The structure of vegetation (as grassland, open woodland, woodland, etc) is of importance for fauna abundance, wildlife movements, and bushfire behaviour, so a unified, objective and consistent map of vegetation structure around Canberra has the potential to lead to improvements in conservation, urban planning, fire planning, land management and the study of ecology.

In addition, corridors of urban vegetation were mapped, primarily because of their relevance to a planned study of kangaroo movements but the mapped corridors are transit routes for other wildlife also (e.g. honeyeaters) and fires. Thus they are relevant to the growing interest in ecological connectivity and to the management of fire fuel.

More sophisticated mapping of ACT vegetation than that in this report was commenced later by the Environment and Planning Directorate (Baines *et al* 2013). The new mapping is community based, and at first appearance may not meet the need identified in this report for an accurate map of vegetation structure but the purchase of LIDAR imagery will enable far superior mapping of vegetation structure than ours for at least those sections completed in future. The map described in this report, which is freely available as an ESRI shape file and illustrated on ACTMAPi, is providing useful information in the interim, for a wide range of potential uses.

This report explains the need for the map, describes how it was made, states its limitations and compares it to other vegetation maps.

1. Introduction

1.1 The need for a vegetation structure map

The need for this map was recognised in 2009 in order to count populations of Eastern Grey Kangaroos (*Macropus giganteus*) where kangaroo culling was being proposed in five of the 34 nature reserves comprising Canberra Nature Park. The density of Eastern Grey Kangaroos (number/ha) is strongly affected by vegetation structure e.g. there are fewer kangaroos in open forest than open woodland therefore there was an efficiency benefit for the survey to be stratified (subsampled) according to vegetation structure.

Kangaroos are not the only organisms so affected. Vegetation structure has a profound effect on biodiversity and ecosystems. Structure often determines what assemblage of animals is present (e.g. Muller *et al.* 2010, and Hewson *et al*. 2011 for birds). Vegetation structure also has a greater influence than floristic composition on bushfire behaviour, sub-aerial processes such as soil erosion, utilitarian attributes such as recreation potential, and visual amenity.

Vegetation structure is defined for the purpose of this report simply in terms of the canopy cover of the tallest woody stratum (see more detail below). We also anticipated that a map of vegetation structure would be required to enable analysis of kangaroo habitat using data from GPS collars. Other potential uses for a vegetation structure map were also apparent, including for biodiversity surveys, bushfire planning, recreation planning, and reporting of vegetation condition. Because fauna, bushfires, etc, are not limited to conservation reserves, the mapped area was expanded to include all vegetation in and near Canberra (see more detail below).

In spite of the greater functional importance of vegetation structure, much vegetation mapping emphasizes floristics at the expense of structure. For example a plant community or association may be mapped as the '*Community-name Woodland community*', because it typically occurs as a woodland, but the map includes places where the structure is actually Forest, Open forest, Open Woodland, Shrubland or Grassland. This community approach to vegetation mapping may rest on assumptions that the area in question will become woodland in the future, was woodland in the past, or both, or rest on no assumptions, simply copying a common practice. An example is given below. The effect is that the vegetation structure is not mapped accurately, despite the knowledge that structure is a more powerful influence than composition on some ecological processes and important attributes such as wildlife diversity and abundance, bushfire behavior, landscape amenity, and recreation characteristics.

Our belief is that structure and floristics of vegetation are both valuable components of the vegetation community and both need to be correctly mapped for land management and planning purposes.

1.2 Aim

The requirement was to map the existing vegetation in and near Canberra Nature Park by structural classes, i.e. grassland, open woodland, forest, etc, using a classification which was:

> *unified* (meaning that an area may be allocated to no more than one class, e.g. the same area may not be represented as both grassland and also as open woodland);
>
> *objective* (based on the rational application of defined criteria); and
>
> *consistent* (the same classification and method is applied across the entire area, so all areas with a certain canopy cover are allocated to the same structure class).

1.3 Extent of map

Much of the previously published vegetation mapping in the area of interest, e.g. Ingwersen *et al*. (1974) and importantly, the two *Strategies* (ACT Government 2004, 2005) had been confined to a limited number of vegetated sites or patches of interest (e.g. Figure 4). Animals and bushfires are not restricted by such boundaries so a landscape approach was necessary for our purposes.

To meet the requirements of the project, the areas shaded in Figure 1 were mapped. A strip of land 1 km wide outside the ACT was included because such a 'buffer' is helpful for purposes such as examining kangaroo movement data and modeling bushfire behaviour. The north western part of Googong Foreshores in New South Wales was included because it is managed by the ACT Government and is a site used in various kangaroo research projects. A 1 km buffer was also applied outside Googong Foreshores. The name 'Canberra Vegetation Structure Map' (CVSM) is used hereafter to refer to this map.

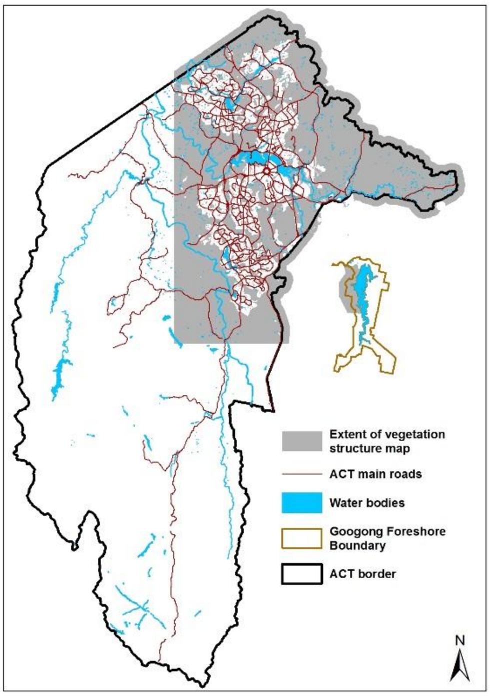

Figure 1: Extent of the Canberra Vegetation Structure Map.
Shading indicates the mapped area in relation to the ACT border, the main rivers, and the suburban extent of Canberra. The shaded area south east of the ACT is the grassy north eastern part of Googong Foreshores plus a 1 km buffer into adjoining land.

1.4 Previous definitions and mapping of vegetation structure

Vegetation structure is classified by ecologists mainly using arbitrary cutpoints, e.g. '20% canopy cover' (Table 1). Both of the endangered ecological communities within the area of interest are defined this way and we wished to base our mapping as much as possible on the definitions of these communities.

Woodland and open woodland are both defined in '*Woodlands for Wildlife: ACT Lowland Woodland Conservation Strategy*' which incorporates the *Action Plan* for the endangered Yellow Box–Red Gum Woodland community (ACT Government 2004). (*Action Plans* are statutory documents, presenting the ACT Government's response to the formal declaration of either a threatened species or an endangered ecological community.) Woodland is defined in the *Woodlands Strategy* as having projective foliage cover of 10–30%, based on Specht (1970) and AUSLIG (1990). This is equated in the *Woodlands Strategy* to canopy cover of 20–50% based on the National Vegetation Inventory System (ESCAVI 2003). Both metrics, canopy cover (also known as crown cover), and projective foliage cover, are different ways of projecting to ground level the area occupied by the tallest stratum of woody vegetation (usually trees or shrubs). In both cases, the projected area is expressed as a percentage of the area of the site. ACT Government (2004) defined 'crown cover density' as '*the percentage of the sample site within the vertical projection of the periphery of the crown i.e. the whole crown is treated as opaque*' and 'projective foliage cover' as '*the percentage of the sample site occupied by the vertical projection of foliage only i.e. gaps in the crown are excluded*'. These are similar to definitions used in the National Vegetation Inventory System (ESCAVI 2003).

The pixel size of images from satellites, or even of digital air photos as in our case (see below), is smaller than a typical tree crown but larger than the small spaces within the crown, hence we used canopy cover as our preferred metric.

Open Woodland is defined by ACT Government (2004) as having 2–20% canopy cover. However some modifications are made to the definitions of Woodland and Open Woodland on p 3 and p 21–2 of the *Woodlands Strategy,* and elsewhere (see below).

Grassland is defined in '*A Vision Splendid of the Grassy Plains Extended*: *ACT Lowland Native Grassland Conservation Strategy*' which incorporates the *Action Plan* for the endangered Lowland Natural Temperate Grassland community (ACT Government 2005, pp 3, 13). By this definition grassland has less than 10% projective foliage cover of trees, shrubs and sedges, based on Moore (1964) and Kirkpatrick (1993). This equates to less than 20% canopy cover (ESCAVI 2003).

Thus to comply with the definitions in both the *Grasslands Strategy* (ACT Government 2004) and the *Woodlands Strategy* (ACT Government 2005), areas with 2-20% canopy cover must be mapped both as 'open woodland' and as 'grassland'.

The definition of woodland described above is modified as follows '*the characteristic structure of woodland may be modified spatially and temporarily by site conditions, disturbance and regeneration at the local level, resulting in structural types ranging from forest to open woodland and grassland*. *For example dense regeneration of Yellow Box and Red Gum following fire would still be considered woodland though the structure for some time following the fire may resemble forest*' (ACT Government 2004, p3). At this point the *Strategy* is referring to all types of woodland, not just the threatened community, and allows any vegetation structure to be classed as woodland if it is thought likely to have been woodland some time in the past, or likely to become woodland at any time in the future. No time limits or other criteria are stated for such assessment.

Further definitional description is the note that in the catena of communities on a slope, grasslands naturally occur below open woodlands (i.e. at lower elevation), the boundary often being at approximately 600 m (also 625 m is stated). However the extent of Lowland Natural Temperate Grassland that was mapped above this level, and woodlands below it (ACT Government 2004, 2005), convinced us that altitude could not provide a reliable objective criterion to enable us to separate vegetation structures in the 2-20% overlap range.

Thus the prior definitions did not meet our first requirement to be unified (see 'Aim'), nor our third requirement to be consistent.

The unpublished spatial database associated with the two Strategies contains structure classifications for 69% of the area mapped. It is this more comprehensive information, rather than the printed maps in the *Strategies* (ACT Government 2004, 2005), which is referred to hereafter, wherever comparison is made in this report to the previous mapping (e.g. Figures 4–6).

It is clear that the definitions given in the two strategies were not used in compiling the database because there is no overlap between grassland and open woodland. It is clear that a community approach has been taken to the mapping associated with the two *Strategies*.

After our mapping was done, vegetation structure was mapped by others using remote sensing across all vegetation in the study area and much larger areas beyond. Mapping from airphotos and field inspections by Macguire and Mulvaney (2011) was carried out to delineate the extent of 'EPBC woodland' (defined in the report). Mapping from radar and satellite imagery by Barrett and Love (2012) was carried out to delineate wildlife corridors with woody vegetation. Neither product was available in 2009 nor did either of them meet our needs. Only two structure classes, 'woodland' and 'not woodland' were delineated in the former case (Macguire and Mulvaney 2011). Only two classes, 'woody' and 'not woody' are presented in the report by Barrett and Love (2012), but in this case we were able to access source data which has four levels of tree stand density, or Above Ground Biomass (ABG, i.e. 'woodiness'). The Discussion and Figures 4 to 6 show that even if the four ABG classes could be matched to our larger number of vegetation structures, another important difference would remain due to the manual removal of false haloes of misclassified vegetation from our data, as explained in Methods and Figure 3. The same phenomenon affected the mapping by Barrett and Love (2012) but manual correction would presumably have been prohibitively expensive over the greater extent of the area they mapped.

1.5 Vegetation structure classes defined in relation to our aims

The classification we used for natural vegetation is given in Table 1. Table 2 gives our full list of structure classes including artificial vegetation forms such as vineyard. Also given in Table 1 are the canopy cover classifications used by ACT Government (2004, 2005) and the National Vegetation Inventory System (NVIS) (ESCAVI 2003). Our classification is close to, or fully compatible with, the two earlier standards i.e. those used for NVIS (ESCAVI 2003) and the *Woodlands Strategy* (ACT Government 2004).

Table 1: Percent tree canopy cover cut points used in this report to classify structure of native vegetation, and values used in other sources mentioned in the text.

	Canberra Vegetation Structure Map	Woodlands Strategy (ACT Government 2004)	Grasslands Strategy (ACT Government 2005)	National Vegetation Inventory (ESCAVI 2003)
Grassland	0-2	0-2	0-20	-
Open Woodland	2-20	2-20	-	0.25-20
Woodland	20-50	20-50	-	20-50
Open Forest	50-80	-	-	50-80
Forest	>80	-	-	>80

2. Methods

An initial map of canopy cover was created (by BH) from a high resolution (50 cm) aerial photograph flown in 2008. First, the image was imported into the program MultiSpec (Landgrebe and Biehl 1994) and classified into 14 spectral clusters using an unsupervised Iterative Self-Organizing Data Analysis Technique (Debinski *et al*. 1999, Franklin and Wulder 2002). The resulting raster image was imported into ArcGIS 9.3 (ESRI 2009), where spectral clusters were reclassified into canopy or non-canopy, based on inspection of the original image, using the Spatial Analyst extension (Figure 2).

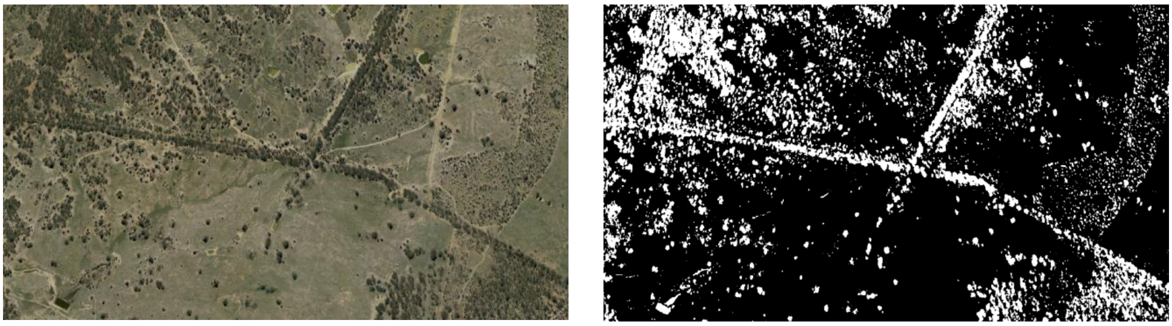

Figure 2: Canopy and non-canopy classification
Left, aerial image; Right, classification generated by program Multispec.

The accuracy of this classification was checked by ground sampling in 24 plots of area 1 hectare. At each plot digital photographs of canopy cover were taken at 12 locations systematically distributed across the plot. Canopy cover percentage was obtained by analysis of the photographs in program SamplePoint (Version 1.54, http://samplepoint.org). These canopy cover estimates from ground sampling were compared to values from our map using simple linear regression. There was strong agreement between the ground sampling and the map ($F = 147.36$; $df = 23$; $p < 0.001$; $r^2=86.4$), supporting the air-photo classification as an index of canopy cover. Finally, polygons of similar canopy cover were created using nearest neighbour and reclassification tools in Spatial Analyst.

The resulting map was then manually adjusted (by CW) as illustrated in Figure 3. First, non-vegetated land such as buildings, roads and water bodies were removed from the map. A decision had been made in advance about the scale of accuracy required in the final product. We had selected 3 ha as the minimum mapping unit for our final map, because we were confident that areas down to 3 ha could be mapped correctly. Therefore, the second step was that polygons of less than 3 ha were dissolved into the surrounding polygon. An exception was made for polygons separated from other vegetated land, in particular narrow corridors of urban vegetation were retained which are less than 3 ha.

Third, artefacts of the Multispec classification were corrected. Two types of artefacts were corrected. The first arose because the value given to each pixel by the MultiSpec algorithm is influenced by the value of adjacent pixels. This type of calculation, while appropriate for most of the map, produced a false classification at the meeting of non-consecutive classes of vegetation, e.g. where tree clearing had resulted in grassland adjoining forest. For example, in Figure 3a, the airphoto shows an area of grassland next to areas of forest as a result of clearing of trees in some areas and planting in others. The MultiSpec classification for this area, Figure 3b, shows false concentric polygons of open woodland, woodland and open forest between the grassland and forest. The false polygons were deleted manually to match the airphoto (Figure 3c).

The second type of artefact was that dark areas of the airphoto, such as those in shadow, had been classified as having a higher percentage tree canopy than in reality. These areas were checked against other airphotos taken in different seasons and times of day, and adjusted if the error was obvious, mainly overestimation of percent canopy cover on steep ground. However, some inaccuracy due to the shadow effect was accepted in the interests of maintaining a consistent and objective mapping process. However the final product appears comparable to one produced by more sophisticated and expensive methods (G. Baines pers. comm.).

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b

c

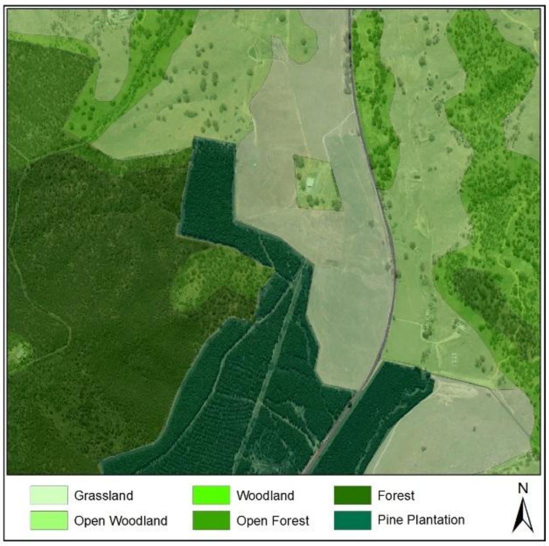

Figure 3. Removal of false polygons
(a) Aerial photo showing artificial boundaries between forest and grassland with no intermediate classes present; (b) Uncorrected classification from program MultiSpec overlaid semi-transparently on the same airphoto, showing concentric halos of false vegetation classes; (c) corrected map. The false intermediate classes have been removed by manual editing. Main roads and polygons smaller than 3 ha have also been removed and an additional classification 'Pine Plantation' has been added (see below).

2.1 Additional vegetation structure classes

In order to encompass all vegetated areas, including small patches of artificial vegetation (created by humans) and modified vegetation, five pre-defined vegetation structure classes were added, 'vineyard', 'pine plantation', 'golf course vegetation' (a mix of exotic plantings, partly-cleared native woodland and artificial grassland), 'arboretum' and 'urban vegetation', the latter being mainly corridors of vegetation extending outward from the nature reserves into the suburbs and typically modified by clearing of some trees, and planting of others. An additional natural vegetation class, 'Shrubland', was also added (Table 2). Shrubland was defined as areas with more than 20% canopy cover of shrubs, shrubs being woody plants less than 8m high and mostly multi-stemmed. Mapping of these six additional classes was done independently of the Multispec analysis, either manually or by integrating shapefiles from other sources into our map. However the final classification is based mainly on ACT Government (2004, 2005) and ESCAVI (2003).

Table 2: Complete list of vegetation structure classes used in the Canberra Vegetation Structure Map.

Name of vegetation class	Definition
Grassland	0–2% canopy cover of trees
Open Woodland	2–20% canopy cover of trees
Woodland	20–50% canopy cover of trees
Open Forest	50–80% canopy cover of trees
Forest	>80% canopy cover of trees
Shrubland	Few trees and >20% canopy cover of shrubs
Pine Plantation	Mapped as the legally defined extent of the ACT forestry estate. Canopy cover 0–100% depending on stage in management cycle.
Vineyard	Trellises planted in rows.
Golf Course Vegetation	Mix of mature trees and grassland in curving rows dotted with small areas of artificial bare sand or water
Urban vegetation	Mix of grassland, amenity tree plantations, and remaining natural trees, contained within suburban matrix
Canberra Arboretum	Many small monoculture plots of trees in straight lines, the total comprising a high diversity of tree forms.

2.2 Institutions omitted

Institutions such as defence facilities and jails may contain extensive vegetated areas which provide potential corridors for fauna and bushfires. In a few cases such as the extensive Majura Training Area and Belconnen Naval Transmission Station we have mapped the vegetation structure, but most institutions have been treated as developed land, i.e. the vegetation structure was not mapped.

3. Results

An image of the resulting map is presented in Appendix 1 at reduced scale (approximately 1:200,000). The map itself is freely available from ACT Government as an ArcGIS shapefile and will be also be available on ACTMAPi.

The area occupied by each vegetation classification and percent of total is shown in Table 3.

Table 3: Area and percentage of vegetated land occupied by each structure class.

Vegetation structure	Area (sq km)	%
Arboretum	3	0
Forest	37	5
Golf Course	7	1
Grassland	173	24
Open Forest	37	5
Open woodland	231	32
Pine Forest*	67	9
Shrubland	7	1
Urban Vegetation	40	5
Vineyard	1	0
Woodland	120	17
TOTAL	723	100

* mapped as a landuse not vegetation

4. Discussion

The CVSM was needed because no map of vegetation structure was available to meet our needs for stratification of kangaroo counting sites and vegetation sampling sites and for analysis of data from GPS tracking collars to characterise kangaroo habitat and movement patterns. We needed the map to be unified, objective and consistent so that it would do the job reliably and be defensible in contested forums such as the Administrative and Civil Appeals Tribunal. Another requirement was to have the product ready in minimal time at no cost. The resulting map (Appendix 1) met these requirements and also has a range of other potential uses. Current work in the Conservation Research unit will eventually remap ACT vegetation in fine detail but that project had not commenced when the CVSM was made.

The resulting map has classified the vegetation of Canberra into eleven vegetation structure classes, each with an explicit definition (Table 2). The resolution of the map is defined, and consistent across the study area, areas less than 3 ha being deemed below the limit of resolution of this map. In practice, the limitations of the map become more evident at any scale more detailed than approximately 1:12,000 so the recommended scale for use is between 1:10,000 and 1:50,000.

The area of mapped vegetation is 723 sq km, compared to 419 sq km mapped in association with the two *Strategies* (ACT Government 2004, 2005) of which 295 sq km had the vegetation structure specified. The 2.5 times increase is partly a result of including new types of vegetation such as ‘vineyard’ in order to provide complete coverage, however if the comparison is restricted to the native vegetation structure classes listed in Table 1, the vegetated area mapped in the CVSM is still more than twice that in the *Strategies* (Table 4).

Table 4: Vegetated area mapped in the CVSM in comparison to the area mapped for the two *Strategies* ACT Government (2004, 2005).

Structure	Strategies Area (sq km)	CVSM Area (sq km)	Increase (sq km)	Strategies %	CVSM %
Grassland	65	173	108	22	29
Open Woodland	159	231	72	54	39
Woodland	55	120	64	19	20
Open Forest	15	37	22	5	6
Forest	0	37	37	0	6
TOTAL	295	598	303	100	100

More important than the area mapped is the quality of mapping. Figure 4 shows Mulligans Flat Nature Reserve and adjoining land. Both the previous mapping (undated ACT Government records ~ 2008) (upper) and the new mapping (lower) are illustrated as semi-transparent overlays to enable them to be evaluated in relation to the vegetation visible in the underlying airphoto. The CVSM is similar to the previous map that had been prepared by manual air-photo interpretation and field inspection, except the new map is more extensive. Figure 5 enables the same comparison to be made for Mt Painter Nature Reserve and Figure 6 for Mulanggari Nature Reserve. In these two cases there are strong differences between the CVSM and the older maps, and it is clear that the new map displays more plausible boundaries between the structure categories.

Close examination of the boundaries of mapped polygons reveal the effect of the classification algorithm (Figures 4– 6). Natural vegetation boundaries are rarely discrete. They are generally a transition between one community to the next. Applying a polygon overlay requires a distinct boundary and each ecologist could draw it differently. There may be no perfect answer. However the CVSM is consistent in where the boundary is drawn. Also the CVSM includes the entire vegetated area rather than just the area reserved, and corridors of urban vegetation have also been mapped where possible.

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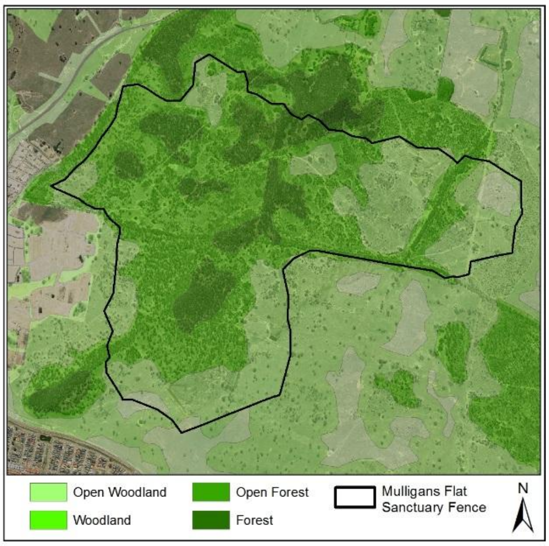

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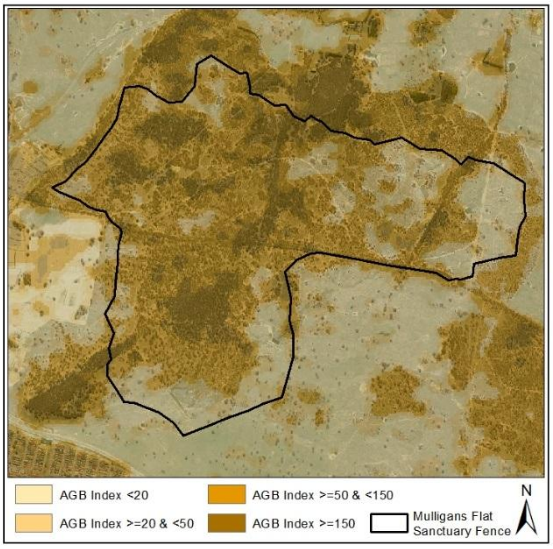

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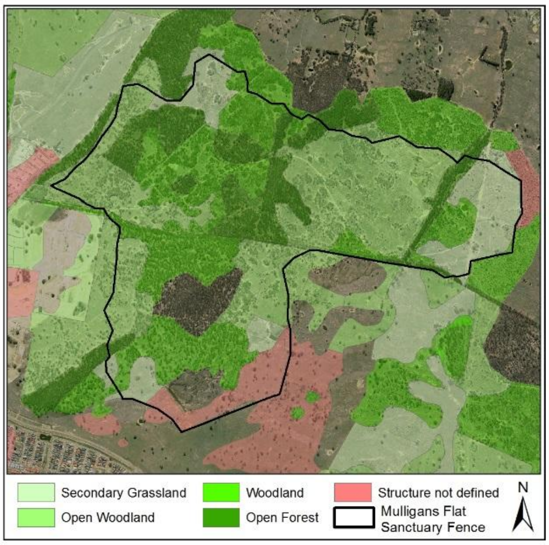

Figure 4: Vegetation Structure of Mulligans Flat Nature Reserve
(a) The CVSM is presented as a semi-transparent overlay on an air photo image to enable the actual tree and shrub cover to be seen through the map; (b) A map made from the tree stand density data underlying the report by Barrett and Love (2012). Four vegetation classes (levels of above ground biomass, or woodiness, measured by radar) are visible. Even before allowing for the differences to the CVSM, e.g. 4 structure classes compared to 5, the maps are reassuringly similar; (c) A map made from the database linked to the Woodland and Grassland Strategies. This map and the CVSM are also similar but the CVSM is complete.

a

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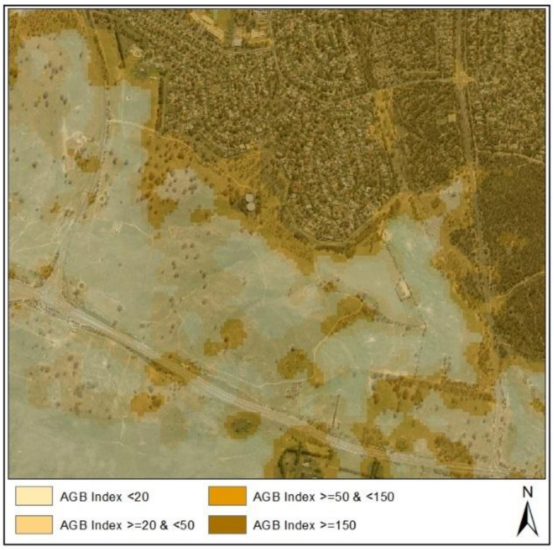
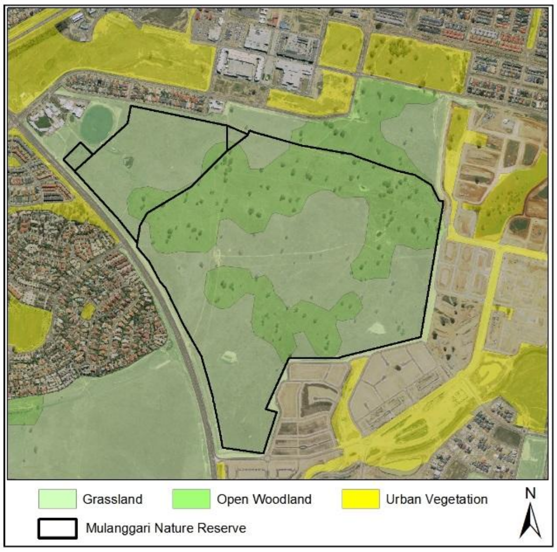


c

Figure 5: Vegetation Structure of Mt Painter Nature Reserve and environs

(a) The CVSM presented as a semi-transparent overlay on an air photo image to enable the actual tree and shrub cover to be seen through the map; (b) A map made from the tree stand density data underlying the report by Barrett and Love (2012). Four vegetation classes (levels of above ground biomass, or woodiness, measured by radar) are visible. The classifications are plausible and similar to those in the CVSM but the benefit of manually editing the CVSM are also apparent; (c) A map made from the database linked to the Woodland and Grassland Strategies. Unlike the comparison in Figure 4, this map and the CVSM are distinctly different. The CVSM is more complete but also provides a noticeably more plausible representation of the vegetation structure.

a



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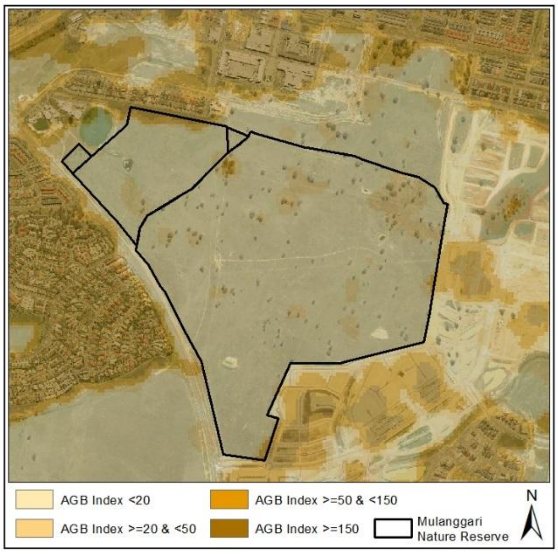

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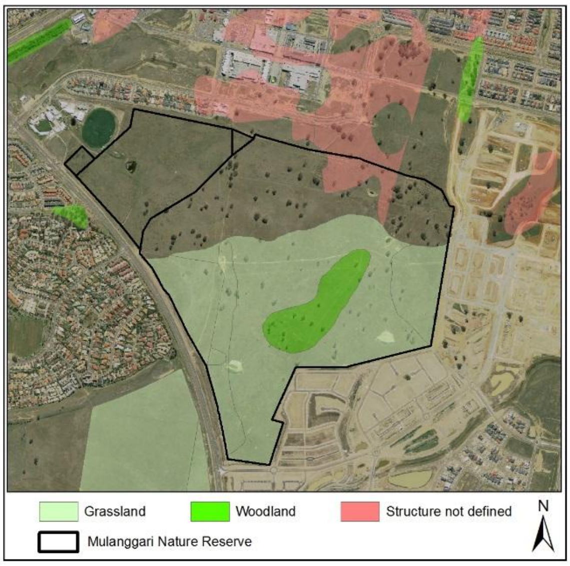

Figure 6: Vegetation Structure of Mulanggari Nature Reserve
(a) The CVSM presented as a semi-transparent overlay on an air photo image to enable the actual tree and shrub cover to be seen through the map. Corridors of 'urban vegetation' have also been mapped.; (b) A map made from the data underlying the report by Barrat and Love (2012). Four vegetation classes are visible (levels of above ground biomass or 'woodiness' measured by radar). However the concentric haloes of false intermediate classes of vegetation that were removed manually from the CVSM are still present in this map; (c) A map made from the database linked to the Woodland and Grassland Strategies. Unlike the comparison in Figure 4, this map and the CVSM are distinctly different. The CVSM is more complete but also provides a noticeably more plausible representation of the vegetation structure.

The overlap between the definition of grassland in ACT Government (2004) and that of open woodland in ACT Government (2005) (Table 1), corresponds exactly to our definition of open woodland (2–20% canopy cover). Our mapping shows that areas with 2-20% canopy cover (Open Woodland) are the most extensive of all the structure classes, occupying 39% of the land area. Thus there is more land in the overlap between these defined structures than is not overlapping. In future editions of the *Strategies*, the grassy woodland ecological community regarded as endangered (YBRG) should not be defined as YBRG 'woodland' when it is clear that this distinctive community occurs in all structural forms (ACT Government 2004, p3, 13, 21). It may be worth considering in future revisions exactly what the target community comprises – perhaps simply 'Yellow box – Red gum'. Alternatively if it is 'woodland' that is of interest, its definition and mapping should not include grassland, forest and other structural forms as in ACT Government (2004, p 3).

We suggest that future vegetation mapping should define floristic associations and structure independently. For example an *Allocasuarina verticillata* community is distinctive. It's name is not improved by the addition of the word 'woodland', especially not when this community is often found in the form of forest, open forest, or open woodland. We envisage vegetation maps that distinguish both structure and floristic attributes accurately.

4.1 Wildlife corridors and bushfire tracks

Much of the urban vegetation comprises movement corridors for animals including kangaroos and migratory honeyeaters, and potential bushfire corridors. Corridors were not our main priority, and we left many smaller examples unmapped. What has been mapped provides a finer scale and more accurate corridor map for Canberra.

Despite its limitations, the urban vegetation that has been mapped clearly illustrates the fine scale connectivity between nature reserves and large areas of undeveloped land. This could be a useful baseline map for studies of connectivity, habitat corridors, dispersal of plant and animal species in Canberra, and potential bushfire behaviour. It has been retained in the shapefile because of that potential, but we do not regard it as having the same quality as the other classifications.

5 Conclusions

A vegetation structure map has been prepared based mainly on tree canopy cover which could be useful for a wide range of purposes, including ecological research (including vegetation and kangaroo studies), connectivity planning and bushfire management in and near Canberra.

We suggest that structure and floristics of vegetation are both too valuable to compromise by mapping as one entity and recommend accurate mapping of both, according to stated definitions, which are unified, objective and consistent.

6 Acknowledgments

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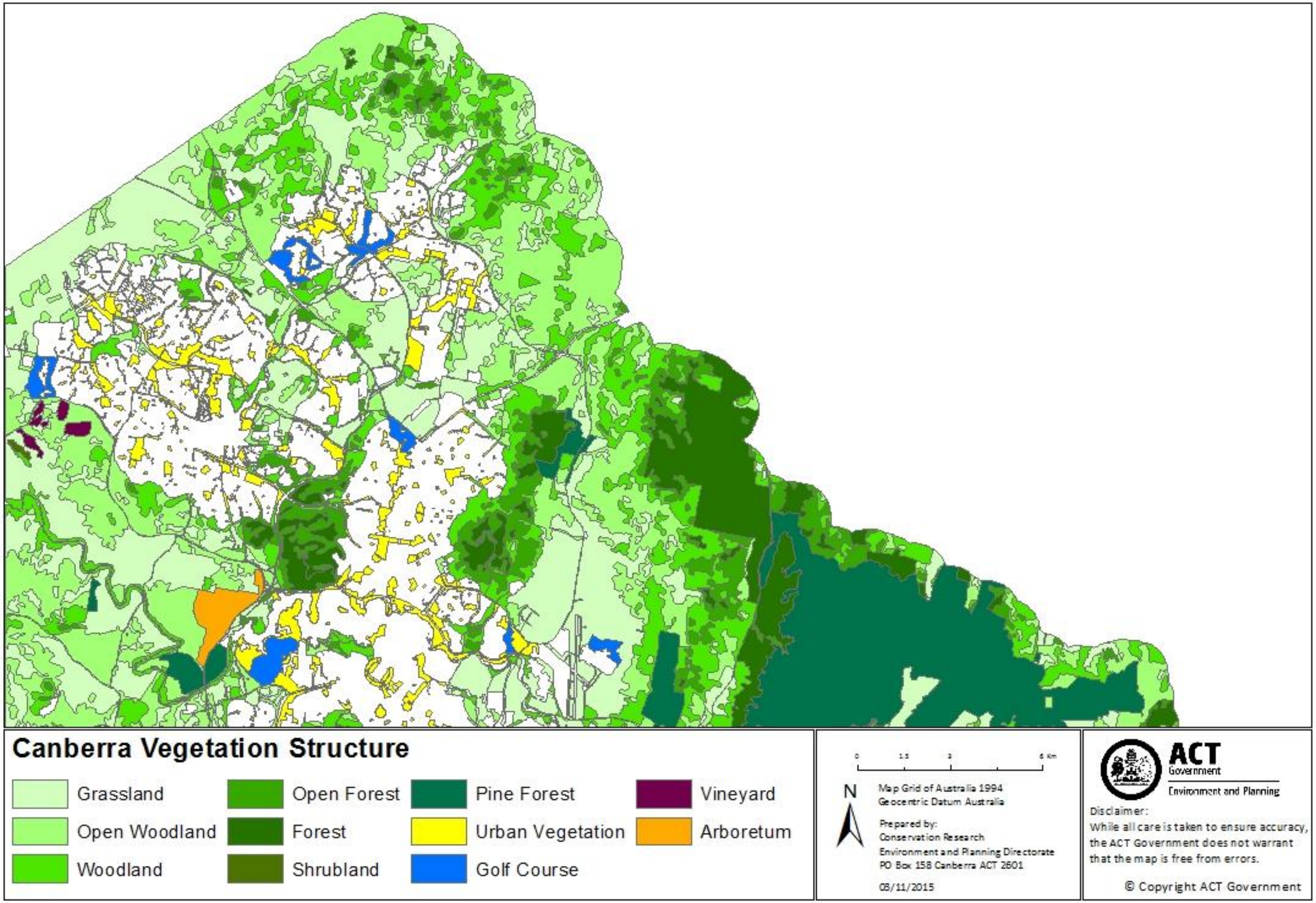
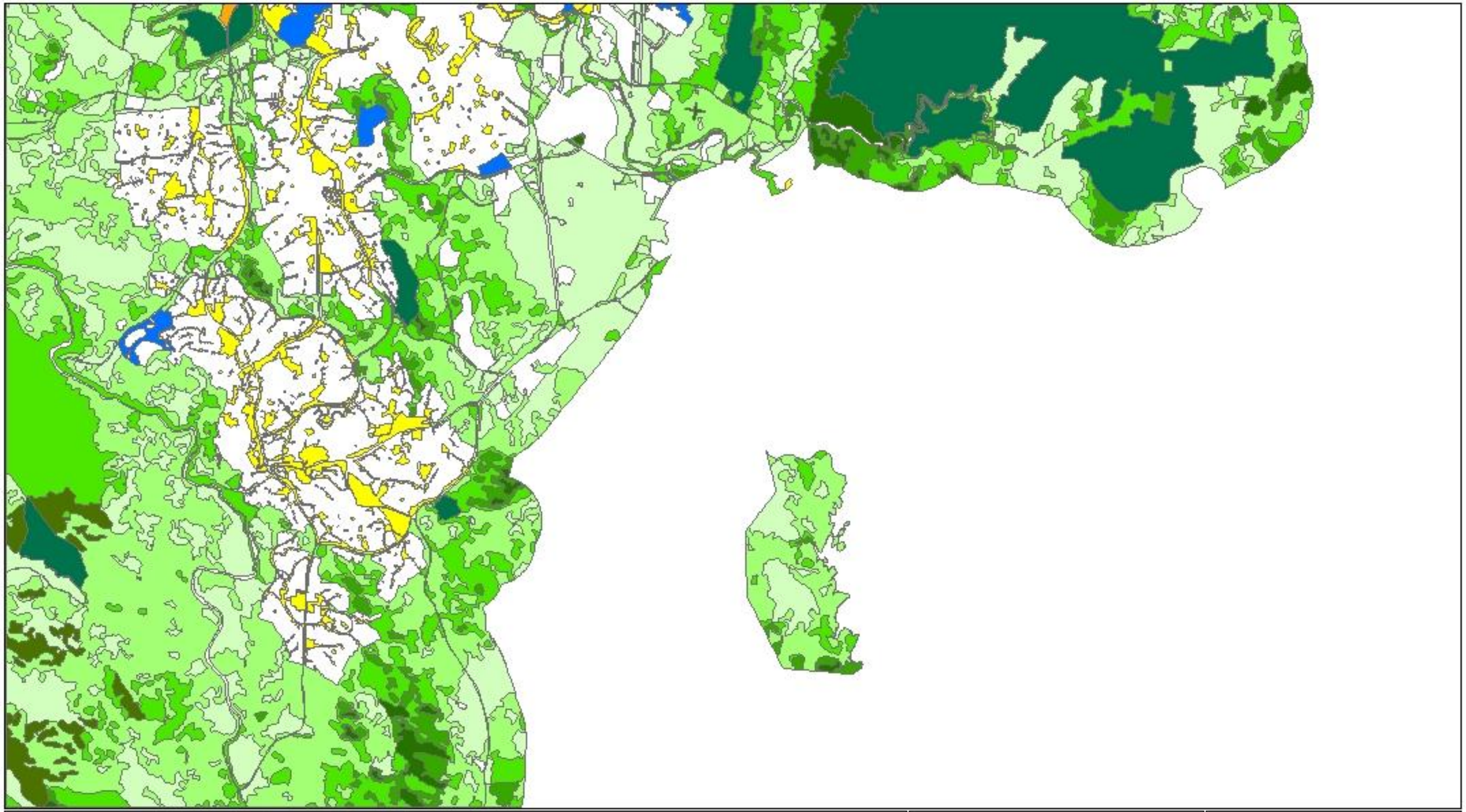
Appendix 1: Canberra Vegetation Structure Map – scale reduced to ~ 1:200,000





Canberra Vegetation Structure

Grassland	Open Forest	Pine Forest	Vineyard
Open Woodland	Forest	Urban Vegetation	Arboretum
Woodland	Shrubland	Golf Course	

0 1.5 3 6 Km

N

Map Grid of Australia 1994
Geocentric Datum Australia

Prepared by:
Conservation Research
Environment and Planning Directorate
PO Box 158 Canberra ACT 2601

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ACT Government
Environment and Planning

Disclaimer:
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