State of the catchments 2010

Native vegetation

Technical report series

Monitoring, evaluation and reporting program

Assessing the extent and condition of native vegetation in NSW

Martin Dillon
Megan McNellie
Ian Oliver

Office of Environment and Heritage

Monitoring, evaluation and reporting program
Technical report series

Native vegetation
Native fauna
Threatened species
Invasive species
Riverine ecosystems
Groundwater
Marine waters
Wetlands
Estuaries and coastal lakes
Soil condition
Land management within capability
Economic sustainability and social well-being
Capacity to manage natural resources

Published by:

Office of Environment and Heritage
59 Goulburn Street, Sydney NSW 2000
PO Box A290, Sydney South NSW 1232
Phone: (02) 9995 5000 (switchboard)
Phone: 131 555 (environment information and publications requests)
Phone: 1300 361 967 (national parks, climate change and energy efficiency information, and publications requests)
Fax: (02) 9995 5999
TTY: (02) 9211 4723
Email: info@environment.nsw.gov.au
Website: www.environment.nsw.gov.au

Report pollution and environmental incidents
Environment Line: 131 555 (NSW only) or info@environment.nsw.gov.au
See also www.environment.nsw.gov.au

This publication may be cited as:

Dillon M, McNellie M & Oliver I 2011, *Assessing the extent and condition of native vegetation in NSW,* Monitoring, evaluation and reporting program, Technical report series, Office of Environment and Heritage, Sydney.

ISBN 978 1 74293 334 4
OEH 2011/0713
September 2011

Acknowledgments

The authors thank the Office of Environment and Heritage, Department of Premier and Cabinet (OEH) staff involved in the development of the NSW Interim Native Vegetation Extent (2008 – Version 1) (DECC 2008), the Keith and Simpson (2006) Intact Vegetation version002 dataset, and the NSW Land Use Mapping Program.

We are grateful for the support and constructive feedback on the development of the Native Vegetation technical reports provided by Ron Avery, Len Banks, Keith Emery, Geoff Horn, David Keith, Klaus Koop, Tony Roper, Rod Ruffio, Graham Turner, Richard Thackway and numerous staff members from the catchment management authorities (CMAs).

Contents

Figures

Tables

1. Introduction

This document provides technical background information describing the state-wide spatial data layers developed for the New South Wales State of the catchments (SOC) 2010 reports: Native vegetation. Three primary data layers were developed:

- Vegetation extent
- Vegetation condition
- Pressures affecting native vegetation.

All three data layers were derived by integrating spatial data from other existing state-wide datasets and applying a series of transparent decision rules. The integration of existing state-wide datasets compiled from several programs delivers decision-makers within NSW a powerful and comprehensive snapshot of the state's native vegetation resource condition. A description of the three primary data layers, the component datasets used to derive them, and the methods used to integrate these component datasets are outlined in this report.

1.1 Terminology

Terminology used throughout the SOC and technical reports is drawn from that used within existing state-wide datasets, or from the NSW Standard 'Definition of Native Vegetation (combined definition) and Operational Terms for Reporting its Extent' (OEH 2011a), or from national classification systems.

1.2 Out of scope

Vegetation type, although integral to a complete understanding of the extent and condition of native vegetation within NSW, was outside of the initial scope of the SOC reports and the Natural Resources Commission's (NRC's) target for native vegetation due to incomplete data coverage.

1.3 NRC target for native vegetation

By 2015, there is an increase in native vegetation extent and an improvement in native vegetation condition.

2. Vegetation extent

2.1 Description of the state-wide vegetation extent data layer

The status of vegetation extent within NSW was mapped as a state-wide raster grid with a cell resolution of 25 m. Each cell represented one of four different vegetation extent categories:

- Native – intact
- Native – derived
- Native/non-native mosaic
- Non-native or other.

These categories conformed to the NSW Definitions of Native Vegetation Extent (OEH 2011a). A fifth category – 'no data' – denoted cells that did not have data values in one or more of the component datasets used to compile the state-wide extent layer. The state-wide vegetation extent layer was used as the basis for maps of vegetation extent for each CMA region. The state-wide vegetation extent layer and the CMA boundaries are shown below. The map legend provides the percentage of NSW represented by each category (rounded to the nearest per cent).

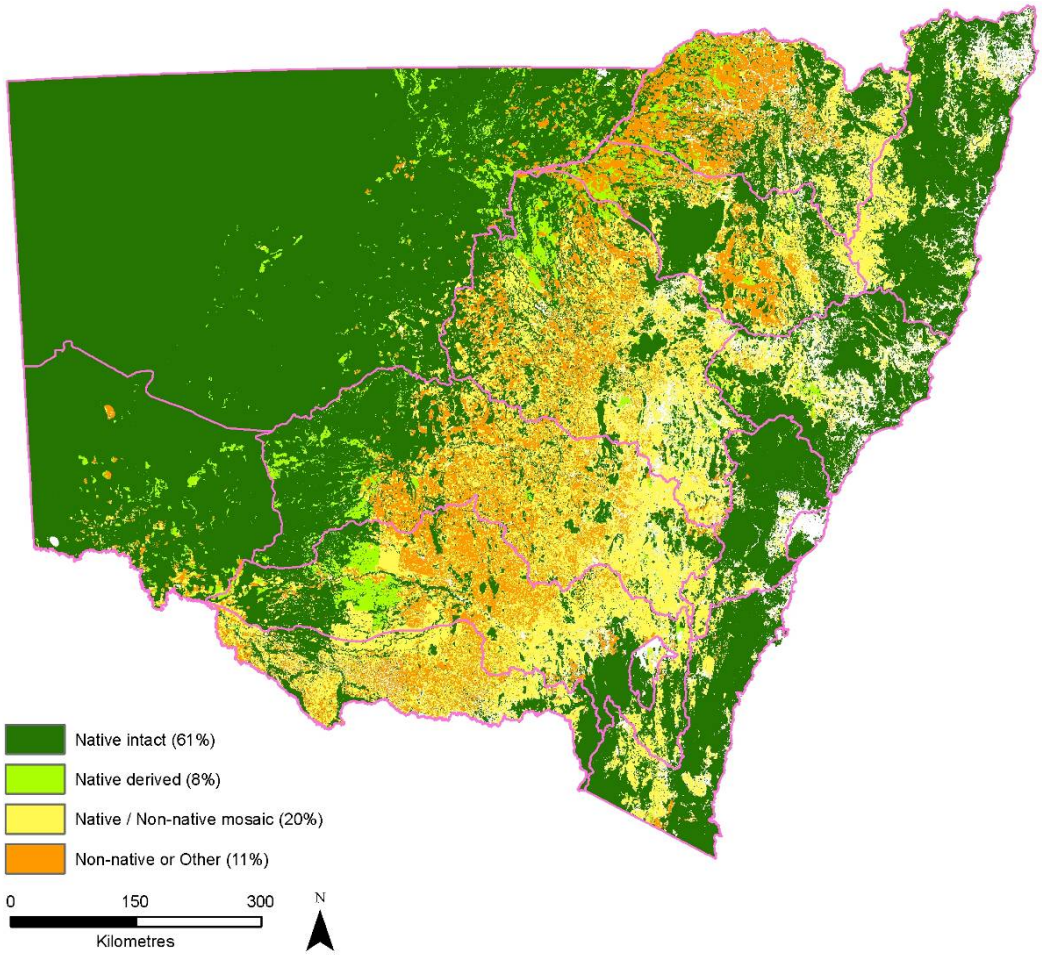

Figure 1: Vegetation extent within NSW and the 13 CMA regions

Each vegetation extent category was defined according to the definitions contained within the NSW Definitions of Native Vegetation Extent (OEH 2011a), as follows:

- Native – intact: native vegetation in which the structure has not been substantially altered by human activities, or has been altered and has since recovered
- Native – derived: vegetation that is predominantly native but has been substantially altered by human activities and is no longer structurally intact
- Native/non-native mosaic: vegetation that cannot readily be classified as either native or non-native using current remote sensing methods
- Non-native or other: non-native vegetation including crops, non-native plantations and non-native pastures, or other non-vegetation land cover types including urban, industrial and infrastructure.

The percentage of the total area of each mapped region represented by each of the four vegetation extent categories was also presented in each SOC report as a bar chart. The vegetation extent bar chart for all of NSW is presented in Figure 2.

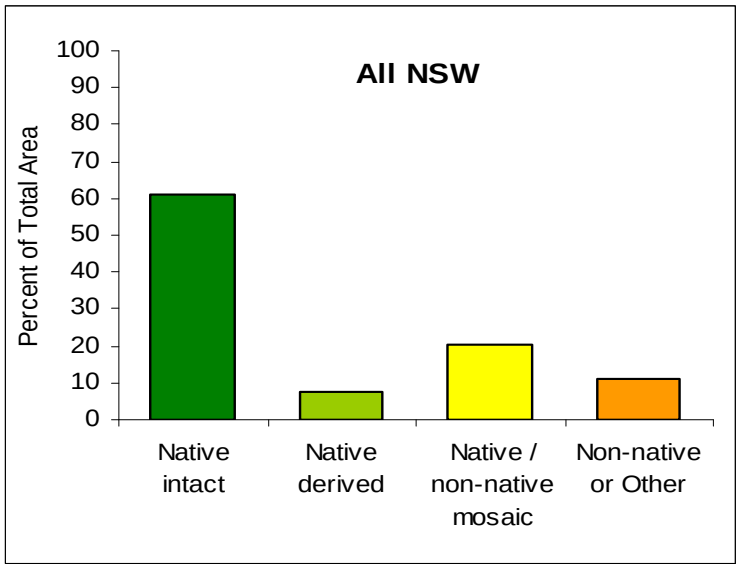

Figure 2: Percentage of total NSW land area represented by each of the four vegetation extent states

Two other vegetation categories were assessed for each SOC report:

- Native woody: native vegetation that is dominated by an overstorey of native trees (forests, woodlands) or tall woody shrubs (shrublands) with an overall foliage projective cover (FPC) greater than or equal to 25 per cent.
- Native non-woody: native vegetation characterised by native grass and/or herbaceous and/or non-woody shrubby vegetation (grasslands, sedgelands, herbfields and low chenopod shrublands) with little or no woody overstorey and an overall FPC less than 25 per cent.

These categories were assessed for each SOC report to establish trend information, and the associated bar charts were included in each SOC report to provide for the allocation of trend

information as soon as possible. Two programs are currently underway within OEH to monitor vegetation extent change; the first concentrates on woody vegetation and the second on non-woody vegetation. The two programs use different approaches, which presents challenges for integration of the data into the four categories shown in Figure 1. Importantly, these programs and the data derived do not in themselves make assessments of whether the woody or non-woody vegetation is 'structurally intact' or 'derived'.

The two vegetation extent monitoring programs also have different levels of confidence in their assessments. This was indicated in each bar-chart as hatched bars for the upper estimate and solid bars for the lower estimate. The percentage of native woody and native non-woody vegetation for all of NSW is presented in Figure 3.

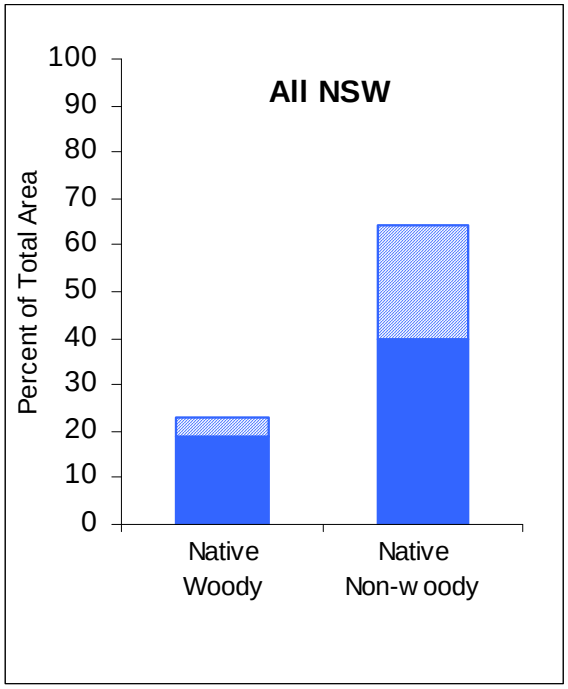

Figure 3: Upper and lower estimates of the per cent of native woody and native non-woody vegetation in NSW

2.2 Primary datasets used to derive the vegetation extent data layer

The state-wide vegetation extent layer was compiled from two primary data sources:

i) Keith and Simpson (2006) Intact Vegetation version002 dataset (ANZLIC Metadata No. ANZNS0208000230)

Keith and Simpson (2006, 2008) compiled state-wide maps of extant native woody vegetation, and extant areas of remnant native grassland. Each map is a raster grid with a cell size of 250 m (6.25 ha) with complete coverage of NSW and the Australian Capital Territory. The maps were compiled from a set of 42 vegetation survey datasets spanning the period 1970 to 2005. The candidate datasets were merged into a composite layer representing the highest level of currency and reliability available. Land-use maps of western NSW were used to exclude any areas recorded as cleared or cropped between 1985-2005 (Keith and Simpson 2006, 2008). Keith and Simpson (2006, 2008) acknowledge that significant mapping gaps exist in the coverage of native grasslands, particularly over large parts of the north coast, northern and central tablelands and parts of the western slopes and plains. The native vegetation mapped by this program is considered the best available estimate of the extent of structurally intact native vegetation in NSW.

ii) NSW Interim Native Vegetation Extent (2008 – Version 1) (DECC 2008) (ANZLIC Metadata No. ANZNS 0208000244)

A detailed description of the NSW Interim Native Vegetation Extent (2008 – Version 1) dataset is provided in NSW Interim Native Vegetation Extent (2008 – Version 1) (DECC 2008). This program used the State-wide Landcover and Trees Study (SLATS – see Department of Natural Resources and Water 2007) methodology applied to Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM) satellite imagery to quantify average foliage projected cover (FPC) values at a 25 m cell resolution. A conservative threshold of 25 per cent FPC was applied to differentiate between the likely occurrence of woody (≥ 25 per cent FPC) or non-woody (< 25 per cent FPC) vegetation within each 25 m cell. Data from the DECC Land Use Mapping Program (OEH 2011b) was used to determine whether the woody and non-woody vegetation within each 25 m cell was likely to be *native*, *non-native* or *indeterminate* (shown as hatched bars in Figure 3) based on mapped land-use (DECC 2008). Examples of areas with indeterminate vegetation include areas of some state forests in which it was not known whether trees were native or introduced plantation species, or areas of pasture in which the proportion of native to exotic grass species was unknown. The definition of native vegetation used in the NSW Interim Native Vegetation Extent (2008 – Version 1) dataset did not imply the vegetation was structurally intact.

DECC (2008) lists a number of caveats and limitations present in the NSW Interim Native Vegetation Extent (2008 – Version 1) dataset that will be addressed in future versions. In particular, the interim FPC was derived from four Landsat epochs (2000, 2002, 2004 and 2006) while the SLATS methodology recommends a minimum of eight epochs for reliable interpretation. The 2000–2006 period was drier than average, and it is likely that FPC signatures during this period underestimated woody vegetation in dry areas. Furthermore, the FPC values were calibrated based on information from the Queensland SLATS program and have not yet been calibrated for NSW conditions. Lastly, the assignment of nativeness of vegetation was sometimes constrained by incomplete land-use data (OEH 2011b). These limitations are also relevant to the derived state-wide vegetation extent layer.

2.3 GIS operations used to derive the state-wide vegetation extent layer

A list of the GIS data layers used to create the NSW vegetation extent layer and associated data is presented in Table 1. The analysis was performed using raster data grids in ESRI ArcGIS 9.2 with the Spatial Analyst extension. All layers were projected using Lamberts Conformal Conical Projection based on the GDA94 data (Department of Lands *no date*). Two main data products were produced:

i) Extent of native woody and native non-woody vegetation ('wd_nonwd_ext')

The extent of native woody and native non-woody vegetation was derived by combining and intersecting the three layers produced by the NSW Interim Native Vegetation Extent (2008 – Version 1) project listed in Table 1. A woody/non-woody mask layer was created by reclassifying the 14 different classes in layer 'vegtype_08v1' into three general classes: 'woody', 'non-woody' and 'other'. The woody/non-woody mask was separately PLUSed with the indicative nativeness layers 'wdy_nat_08v1' and 'nwdy_nat_ind' and the results combined to produce the final grid 'wd_nonwd_ext'. Each cell in the final grid 'wd_nonwd_ext' was assigned to one of seven classes: 'native woody', 'native non-woody', 'indeterminate woody', 'indeterminate non-woody', 'exotic woody', 'exotic non-woody' and 'other'.

The percentage of cells within each class in layer 'wd_nonwd_ext' were used to populate the bar chart presented in Figure 3. The lower estimate of the percentage area of native woody vegetation was calculated by dividing the total number of cells classed as 'native woody' by the overall total number of cells. The upper estimate of the percentage area of native woody vegetation was calculated using the total number of cells classed as either 'native woody' or 'indeterminate woody'. The lower estimate of the percentage area of native non-woody vegetation was calculated using only the total number of cells classed as 'native non-woody'. The upper estimate of the percentage area of native non-woody vegetation was calculated using the total number of cells classed as either 'native non-woody' or 'indeterminate non-woody'.

ii) Native vegetation extent layer ('veg_ext_nsw_1')

The native vegetation extent layer was derived by intersecting the Keith and Simpson (2006) map of remnant structurally intact native vegetation ('extveg_002') with a four class nativeness mask ('vegnativeness'). The nativeness mask was created by reclassifying the seven classes in layer 'wd_nonwd_ext' down to four general classes: 'native vegetation', 'non-native (exotic) vegetation', 'vegetation with indeterminate nativeness', and 'non-vegetation'. By intersecting these two layers, each cell in the final grid 'veg_ext_nsw_1' was assigned to one of five vegetation states: 'structurally intact native vegetation', 'derived native vegetation', 'vegetation with indeterminate nativeness', 'non-native (exotic) vegetation' or 'non-vegetation'. The percent of total NSW land area represented by each of the vegetation extent states is presented in Figure 2 (rounded to the nearest percent). Note that in this map the 'non-native (exotic) vegetation' (10.8 per cent) and 'non-vegetation' (0.4 per cent) categories have been tallied together and presented as a single category called 'non-native or other' (11.2 per cent).

Table 1: GIS datasets used to derive NSW vegetation extent layers

ESRI grid filename (cell size)	Description	Source
extveg_002 (250 m)	Mask of extant remnant structurally intact native vegetation used to assign intactness to cells in other layers. Includes two classes: 'structurally intact native vegetation' and 'other'.	Keith & Simpson (2006)
vegtype_08v1 (25 m)	Native vegetation extent grid (25 m). Extent derived from interim FPC and nativeness (or uncertainty) informed by land-use. Includes five classes: 'native non-woody', 'native woody', 'exotic non woody', 'exotic woody' and 'other'.	DECC (2008)
wdy_nat_08v1 (25 m)	Mask of nativeness for woody vegetation derived from land-use and used to assign nativeness to woody cells in other layers. Includes three classes: 'native', 'non-native', and 'indeterminate nativeness'.	DECC (2008)
nwdy_nat_ind (25 m)	Mask of nativeness for non-woody vegetation derived from land-use and used to assign nativeness to non-woody cells in other layers. Includes three classes: 'native', 'non-native' and 'indeterminate nativeness'.	DECC (2008)
wd_nonwd_ext	Native, exotic and indeterminate vegetation layer derived from the above layers. Includes seven classes: 'native woody', 'native non-woody', 'indeterminate woody', 'indeterminate non-woody', 'exotic woody', 'exotic non-woody' and 'other'. This layer was created by reclassifying 'vegtype_08v1' into 2 classes ('woody' and 'non-woody') and applying the Spatial Analyst 'plus' operation to 'wdy_nat_08v1' and 'nwdy_nat_ind'.	This SOC report
vegnativeness	Vegetation extent layer derived by reclassifying 'wd_nonwd_ext' into four classes: 'native vegetation', 'non-native (exotic) vegetation', 'vegetation with indeterminate nativeness' and 'non-vegetation'.	This SOC report
Veg_ext_nsw_1	Vegetation extent layer derived by combining 'vegnativeness' and 'extveg_002'. Includes five classes: 'structurally intact native vegetation', 'derived native vegetation', 'vegetation with indeterminate nativeness', 'non-native (exotic) vegetation' and 'non-vegetation'. For mapping purposes the 'non-native (exotic) vegetation', and 'non-vegetation' classes were combined into a category called 'non-native or other' (Figure 1).	This SOC report

2.4 Vegetation extent index generation

To generate an overall vegetation extent index for each CMA region each vegetation extent category was assigned an index reflecting the authors' opinions on the average relative difference

in vegetation integrity between the four categories (Table 2). Different index values may be justified and can be explored if required in the future.

Table 2: Vegetation extent category index weighting

Vegetation extent category	Index
Native – intact vegetation	1.00
Native – derived vegetation	0.50
Native/non-native mosaic vegetation	0.25
Non-native or other	0.00

The overall vegetation extent index for each CMA region was calculated by multiplying the percentage of each extent category (within each CMA region) by its associated index value and then summing for all categories.

The calculation of the vegetation extent index for the state of NSW is shown below:

Table 3: NSW vegetation extent index calculation

Vegetation extent category	Index	Percentage of NSW	Component score
Native – intact vegetation	1.00	61.1	61.10
Native – derived vegetation	0.50	7.5	3.75
Native/non-native mosaic vegetation	0.25	20.2	5.05
Non-native or other	0.00	11.2	0.00
Overall vegetation extent index for NSW			69.9

Indices were mapped to vegetation extent classes according to the following index ranges:

Extent index	Extent class
> 80–100	Very good
> 60–80	Good
> 40–60	Fair
> 20–40	Poor
0–20	Very poor

2.5 Limitations

The extent of vegetation in NSW has been mapped by integrating a number of gridded datasets considered to be the best available state-wide data. The component datasets have been compiled using a range of data, and they carry a number of caveats and limitations (DECC 2008; Keith &

Simpson 2006, 2008). These limitations are also relevant to the derived state-wide vegetation extent layer.

The satellite imagery and processing used by DECC (2008) to produce the Interim Native Vegetation Extent dataset are still under active development. In particular, the interim FPC was derived from four Landsat epochs (2000, 2002, 2004 and 2006) while the SLATS methodology recommends a minimum of eight epochs for reliable interpretation. The 2000–2006 period was drier than average, and it is likely that FPC signatures during this period underestimated woody vegetation in dry areas. Furthermore, the FPC values were calibrated based on information from the Queensland SLATS program and have not yet been calibrated for NSW conditions. To address the uncertainties surrounding the limited number of Landsat epochs and the lack of specific calibration for NSW, DECC (2008) used a conservative threshold of 25 per cent FPC above which vegetation was deemed to be woody vegetation. This figure is slightly higher than the 20 per cent canopy cover threshold used to define woody vegetation during ground based surveys (OEH 2011a). The limitations present in the Interim Native Vegetation Extent dataset preclude their use as a basis for quantifying trends in changes to the extent of woody vegetation at this time.

Similarly it is not yet possible to quantify trends in changes in the extent of native non-woody vegetation on a state-wide scale. A high proportion of non-woody vegetation falls within the native/non-native mosaic vegetation extent category. This is particularly the case for grazing pastures that may contain a mix of native and non-native grasses, herbs and forbs. Currently, remote sensing data cannot accurately identify the 'nativeness' of such non-woody vegetation. Methodologies for using Landsat and Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data to identify cropped and recently cropped areas and pasture improved areas that contain non-native non-woody vegetation are currently being evaluated by OEH.

2.6 Potential for improvement

OEH's annualised Native Vegetation Report Card (DECC 2007) identifies changes in the structure of woody vegetation and describes losses in extent due to agriculture, forestry and infrastructure activities. It also reports on canopy changes due to the effects of bushfires. For these reports woody vegetation is defined as >2 m tall with > 20 per cent canopy cover, which effectively applies to open and closed forests, and woodlands.

The woody change record is produced by analysing Landsat remote sensing data with satellite imagery techniques based on the State-wide Land and Tree Survey (SLATS) methodology, developed in Queensland. A record of change over the last 20 years, from 1998–2008, has been developed using the same methodology and is nearing publication, but the present vegetation extent layer is based on the available 2000–2006 datasets. As soon as the more complete information becomes available it may be possible to add trend information to Figure 3 above as well as to the corresponding graphics in each SOC report. Relating this new information to the Figure 1 extent categories is more challenging.

OEH is similarly making significant advances in the mapping and monitoring of native grasslands through a variety of remote sensing programs and projects. For some CMA regions a first iteration 'candidate native non-woody' data layer could be used in the near future to provide trend information to the non-woody bar in Figure 3 above and to the corresponding image in some CMA region SOC reports.

With continued investment in these programs, OEH's level of knowledge of the extent of, and trend in, native woody and native non-woody vegetation will be markedly improved for the 2013 SOC reports. Over this period, the ability to integrate the information from these two extent monitoring programs into the four extent categories shown in Figure 1 will likewise improve.

Assessment of vegetation extent based on the above programs will also be complemented by future interrogations of the Land Management Database, into which CMAs are currently entering spatial information concerning land cover and land-use changes, supported by their own incentive programs.

3. Vegetation condition

3.1 Description of the state-wide vegetation condition data layer

Vegetation condition represents a measure of the 'naturalness' of vegetation. Areas that retain a high measure of naturalness (ie proportion of their original structure and diversity) have a high condition rating; areas with a low naturalness measure (ie have been disturbed or degraded and therefore have reduced structural integrity and/or reduced diversity) have a lower condition rating. The potential status of vegetation condition within NSW was mapped as a raster grid with a cell resolution of 25 m. Each cell represents one of six different vegetation condition categories (from highest to lowest):

- Residual
- Modified
- Transformed
- Transformed/replaced-adventive mosaic
- Replaced-managed
- Removed.

These categories conform to the modification states of the draft National Vegetation Condition Classification (VAST – see Table 4) (Thackway & Lesslie 2005, 2006 and 2008). A seventh category – 'no data' – denotes cells that did not have data values in one or more of the component base datasets used to compile the vegetation condition layer. The state-wide vegetation condition layer was used as the basis of maps of vegetation condition for each CMA region. This layer and the CMA boundaries are shown below. The map legend provides the percentage of NSW represented by each category (rounded to the nearest percent).

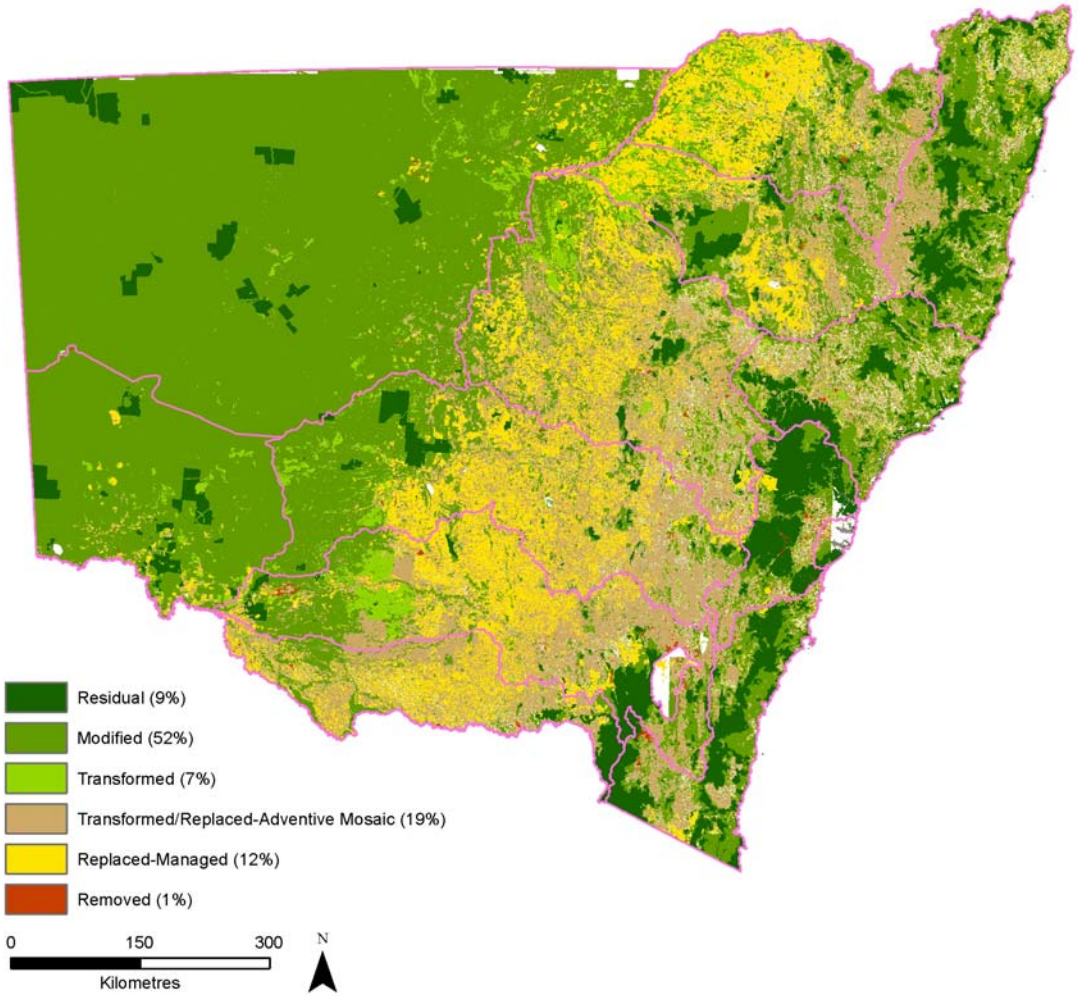

Figure 4: Vegetation condition within NSW and the 13 CMA regions

For the purposes of the SOC reports, each vegetation condition category was defined according to the VAST modification states (see Table 4), as follows:

- Residual: native vegetation community structure, composition and regenerative capacity intact – no significant perturbation from land-use or land management practices
- Modified: native vegetation community structure, composition and regenerative capacity intact – perturbed by land-use or land management practices
- Transformed: native vegetation community structure, composition and regenerative capacity significantly altered by land-use or land management practices
- Transformed/replaced-adventive mosaic: vegetation that cannot readily be classified as either transformed (native) or replaced-adventive (non-native) on the basis of available state-wide datasets
- Replaced-managed: native vegetation replaced with cultivated vegetation
- Removed: vegetation removed to leave non-vegetated land cover.

VAST modification states (SOC vegetation condition categories) are based on the impacts of human land-use and land management practices on vegetation, relative to a vegetation condition

benchmark. Terminology used in classifying vegetation condition is consistent with that used by other states, territories and the Australian Government; the exception is the combined 'transformed/replaced-adventive mosaic', which represents a native/non-native mosaic that results from the incomplete state of knowledge surrounding vegetation extent. Table 3 provides further detail on the VAST modification states.

The percentage of the total area of each mapped region represented by each of the six potential vegetation condition categories was presented in each SOC report as a bar chart. The potential vegetation condition bar chart for all of NSW is presented in Figure 5.

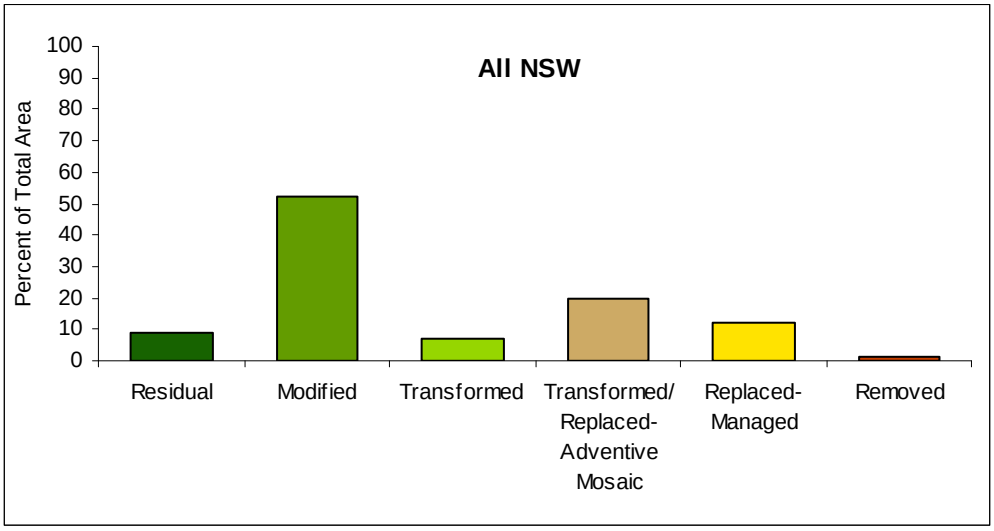

Figure 5: Percentage of total NSW land area represented by each of the six vegetation condition states

Table 4: Vegetation Assets, States and Transitions (VAST) classification framework with columns representing states and shifts between them defined as transitions

Increasing vegetation modification from left to right

			Native Vegetation Cover Dominant structuring plant species indigenous to the locality and spontaneous in occurrence – i.e. a vegetation community described using definitive vegetation types relative to estimated pre1750 states			Non-native Vegetation Cover Dominant structuring plant species indigenous to the locality but cultivated; alien to the locality and cultivated; or alien to the locality and spontaneous		
Vegetation Cover Classes		State 0: NATURALLY BARE areas where native vegetation does not naturally persist and recently naturally disturbed areas where native vegetation has been entirely removed. (i.e. open to primary succession)	State I: RESIDUAL native vegetation community structure, composition, and regenerative capacity intact – no significant perturbation from land use/land management practice	State II: MODIFIED native vegetation community structure, composition and regenerative capacity intact – perturbed by land use/land management practice	State III: TRANSFORMED native vegetation community structure, composition and regenerative capacity significantly altered by land use/land management practice	State IV: REPLACED – *ADVENTIVE* native vegetation replacement – species alien to the locality and spontaneous in occurrence	State V: REPLACED – *MANAGED* native vegetation replacement with cultivated vegetation	State VI: REMOVED vegetation removed – alienation to non-vegetated land cover
Diagnostic criteria	Current regenerative capacity	Complete absence of in-situ regeneration capacity except for ephemerals and lower plants	Natural regenerative capacity unmodified	Natural regeneration capacity persists under past and /or current land management practices	Natural regenerative capacity limited / at risk under past and/or current land use or land management practices. Rehabilitation and restoration possible through modified land management practice	Regeneration potential of native vegetation community has been suppressed and in-situ resilience at least significantly depleted. May still be considerable potential for restoration using assisted natural regeneration approaches	Regeneration potential of native vegetation community likely to be highly depleted by intensive land management. Very limited potential for restoration using assisted natural regeneration approaches	Nil or minimal regeneration potential. Restoration potential dependent on reconstruction approaches
	Vegetation structure	Nil or minimal	Structural integrity of native vegetation community is very high	Structure is predominantly altered but intact e.g. a layer / strata and/or growth forms and/or age classes removed	Dominant structuring species of native vegetation community significantly altered e.g. a layer / strata frequently and repeatedly removed	Dominant structuring species of native vegetation community removed or predominantly cleared or extremely degraded	Dominant structuring species of native vegetation community removed	Vegetation absent or ornamental
	Vegetation composition	Nil or minimal	Compositional integrity of native vegetation community is very high	Composition of native vegetation community is altered but intact	Dominant structuring species present – species dominance significantly altered	Dominant structuring species of native vegetation community removed	Dominant structuring species of native vegetation community removed	Vegetation absent or ornamental
Examples		Bare mud; rock; river and beach sand, salt freshwater lakes, rock slides and lava flows	Old growth forests; Native grasslands that have not been grazed; Wildfire in native forests and woodlands of a natural frequency and/or intensity	Native vegetation types managed using sustainable grazing systems; Selective timber harvesting practices; Severely burnt (wildfire) native forests and woodlands not of a natural frequency and/or intensity	Intensive native forestry practices; Heavily grazed native grasslands and grassy woodlands; Obvious thinning of trees for pasture production; Weedy native remnant patches; Degraded roadside reserves; Degraded coastal dune systems; Heavily grazed riparian vegetation	Severe invasions of introduced weeds; Invasive native woody species found outside their normal range; Isolated native trees/shrubs/grass species in the above examples	Forest plantations; Horticulture; Tree cropping; Orchards; Reclaimed mine sites; Environmental and amenity plantings; Improved pastures. (includes heavy thinning of trees for pasture); Cropping; Isolated native trees/ shrubs/ grass species in the above examples	Water impoundments; Urban and industrial landscapes; quarries and mines; Transport infrastructure; salt scalded areas

Source: Thackway & Lesslie (2006)

3.2 Primary datasets used to derive the vegetation condition layer

The state-wide vegetation condition layer was compiled from five primary datasets:

i) The vegetation extent layer produced as part of this program ('veg_ext_nsw_1')

The integrity of vegetation represented as the five vegetation extent categories – 'structurally intact', 'derived', 'native/non-native mosaic', 'exotic' and 'non-vegetation' – was used as the primary surrogate for vegetation condition. In addition, the following land-use and tenure based datasets were used to further guide the assessment of potential vegetation condition.

ii) NSW Merged Land-Use Layer

Filename 'nsw_lu_merge.shp'. This polygon layer was the base dataset used for mapping potential vegetation condition according to land-use. It is a state-wide land-use dataset compiled as part of the 'interim native vegetation extent layer' project (DECC 2008). It is a draft product that continues to be developed by the OEH NSW Land Use Mapping Program. Inherent in the NSW land-use mapping layer, each land-use '*TAG*' has been assigned to the National Australian Land Use and Management (ALUM) classification (Australian Government 2006), both at the Primary Class and Major Category levels (look-up table Land Use version 42.dbf OEH 2011b). The Major Category level was used as the link between land-use and potential vegetation condition (see Table 4 and Appendix 1 Table A1).

The land-use layer was supplied in draft format and contained some unmapped areas around the NSW-QLD border, around the ACT and the urban area of Sydney east of Parramatta (42 per cent of the Sydney Metropolitan CMA region). Unmapped areas or polygons lacking ALUM codes were tagged as 'unknown' in the look-up table. To more clearly link land-use to potential vegetation condition, some minor changes were made to the ALUM classification (such as changing defence facilities from intensive land-use to dryland agriculture and plantations), and areas coded as mining in the Hunter–Central Rivers CMA were classified as no data. The latter was due to there being insufficient information to determine the link between land-use and potential vegetation condition (ie whether land under mining lease had been mined and restored – variable condition status – or had not been mined – potentially good condition). In addition, some land-use polygons were re-coded after it was determined that they were incorrectly mapped.

Amendments to the land-use layer were submitted to the GIS Manager of the then Department of Environment, Climate Change and Water (DECCW) to be validated and included in the OEH corporate spatial dataset. In addition to the above base land-use dataset, the following three datasets were used to ensure the most up-to-date land-use and thus potential vegetation condition layer was produced.

iii) NSW National Parks and Wildlife Service (NPWS) Estate 2008 v1

Filename 'Estate_2008_v1'. This is a polygon layer defining the boundaries of areas in NSW that have been gazetted as being under the management of the NSW NPWS as of March 2008. Areas included national parks, nature reserves, regional parks, state conservation areas, Aboriginal areas and historic sites.

iv) Forests NSW Estate (SF) 2008

Filename 'SF_Plantations_Layer.gdb'. This is an ESRI file geodatabase supplied by Forests NSW showing polygons that define the operational boundaries of areas in NSW under the management of Forests NSW as of November 2008.

v) NSW Travelling Stock Reserves (TSR) 2008

Filename 'TSR.shp'. The TSRs data were extracted in October 2008 from the Crown Lands Estate held within the OEH corporate database.

Table 5: Australian Land Use and Management Classification with columns headed by ALUM Primary Classes with Major Categories listed beneath

Source: http://adl.brs.gov.au/mapserv/landuse/docs/ALUMv6.pdf (April 2009)

AUSTRALIAN LAND USE AND MANAGEMENT CLASSIFICATION version 6

1 Conservation and Natural Environments

1.1.0 Nature conservation
- 1.1.1 Strict nature reserves
- 1.1.2 Wilderness area
- 1.1.3 National park
- 1.1.4 Natural feature protection
- 1.1.5 Habitat/species management area
- 1.1.6 Protected landscape
- 1.1.7 Other conserved area

1.2.0 Managed resource protection
- 1.2.1 Biodiversity
- 1.2.2 Surface water supply
- 1.2.3 Groundwater
- 1.2.4 Landscape
- 1.2.5 Traditional indigenous uses

1.3.0 Other minimal use
- 1.3.1 Defence
- 1.3.2 Stock route
- 1.3.3 Residual native cover
- 1.3.4 Rehabilitation

2 Production from Relatively Natural Environments

2.1.0 Grazing natural vegetation

2.2.0 Production forestry
- 2.2.1 Wood production
- 2.2.2 Other forest production

3 Production from Dryland Agriculture and Plantations

3.1.0 Plantation forestry
- 3.1.1 Hardwood production
- 3.1.2 Softwood production
- 3.1.3 Other forest production
- 3.1.4 Environmental

3.2.0 Grazing modified pastures
- 3.2.1 Native/exotic pasture mosaic
- 3.2.2 Woody fodder plants
- 3.2.3 Pasture legumes
- 3.2.4 Pasture legume/grass mixtures
- 3.2.5 Sown grasses

3.3.0 Cropping
- 3.3.1 Cereals
- 3.3.2 Beverage & spice crops
- 3.3.3 Hay & silage
- 3.3.4 Oil seeds
- 3.3.5 Sugar
- 3.3.6 Cotton
- 3.3.7 Tobacco
- 3.3.8 Legumes

3.4.0 Perennial horticulture
- 3.4.1 Tree fruits
- 3.4.2 Oleaginous fruits
- 3.4.3 Tree nuts
- 3.4.4 Vine fruits
- 3.4.5 Shrub nuts fruits & berries
- 3.4.6 Flowers & bulbs
- 3.4.7 Vegetables & herbs

3.5.0 Seasonal horticulture
- 3.5.1 Fruits
- 3.5.2 Nuts
- 3.5.3 Flowers & bulbs
- 3.5.4 Vegetables & herbs

3.6.0 Land in transition
- 3.6.1 Degraded land
- 3.6.2 Abandoned land
- 3.6.3 Land under rehabilitation
- 3.6.4 No defined use

4 Production from Irrigated Agriculture and Plantations

4.1.0 Irrigated plantation forestry
- 4.1.1 Irrigated hardwood production
- 4.1.2 Irrigated softwood production
- 4.1.3 Irrigated other forest production
- 4.1.4 Irrigated environmental

4.2.0 Irrigated modified pastures
- 4.2.1 Irrigated woody fodder plants
- 4.2.2 Irrigated pasture legumes
- 4.2.3 Irrigated legume/grass mixtures
- 4.2.4 Irrigated sown grasses

4.3.0 Irrigated cropping
- 4.3.1 Irrigated cereals
- 4.3.2 Irrigated beverage & spice crops
- 4.3.3 Irrigated hay & silage
- 4.3.4 Irrigated oil seeds
- 4.3.5 Irrigated sugar
- 4.3.6 Irrigated cotton
- 4.3.7 Irrigated tobacco
- 4.3.8 Irrigated legumes

4.4.0 Irrigated perennial horticulture
- 4.4.1 Irrigated tree fruits
- 4.4.2 Irrigated oleaginous fruits
- 4.4.3 Irrigated tree nuts
- 4.4.4 Irrigated vine fruits
- 4.4.5 Irrigated shrub nuts fruits & berries
- 4.4.6 Irrigated flowers & bulbs
- 4.4.7 Irrigated vegetables & herbs

4.5.0 Irrigated seasonal horticulture
- 4.5.1 Irrigated fruits
- 4.5.2 Irrigated nuts
- 4.5.3 Irrigated flowers & bulbs
- 4.5.4 Irrigated vegetables & herbs

4.6.0 Irrigated land in transition
- 4.6.1 Degraded irrigated land
- 4.6.2 Abandoned irrigated land
- 4.6.3 Irrigated land under rehabilitation
- 4.6.4 No defined use (irrigation)

5 Intensive Uses

5.1.0 Intensive horticulture
- 5.1.1 Shadehouses
- 5.1.2 Glasshouses
- 5.1.3 Glasshouses (hydroponic)

5.2.0 Intensive animal production
- 5.2.1 Dairy
- 5.2.2 Cattle
- 5.2.3 Sheep
- 5.2.4 Poultry
- 5.2.5 Pigs
- 5.2.6 Aquaculture

5.3.0 Manufacturing and industrial

5.4.0 Residential
- 5.4.1 Urban residential
- 5.4.2 Rural residential
- 5.4.3 Rural living

5.5.0 Services
- 5.5.1 Commercial services
- 5.5.2 Public services
- 5.5.3 Recreation and culture
- 5.5.4 Defence facilities
- 5.5.5 Research facilities

5.6.0 Utilities
- 5.6.1 Electricity generation/transmission
- 5.6.2 Gas treatment, storage and transmission

5.7.0 Transport and communication
- 5.7.1 Airports/aerodromes
- 5.7.2 Roads
- 5.7.3 Railways
- 5.7.4 Ports and water transport
- 5.7.5 Navigation and communication

5.8.0 Mining
- 5.8.1 Mines
- 5.8.2 Quarries
- 5.8.3 Tailings

5.9.0 Waste treatment and disposal
- 5.9.1 Stormwater
- 5.9.2 Landfill
- 5.9.3 Solid garbage
- 5.9.4 Incinerators
- 5.9.5 Sewage

6 Water

6.1.0 Lake
- 6.1.1 Lake - conservation
- 6.1.2 Lake - production
- 6.1.3 Lake - intensive use

6.2.0 Reservoir/dam
- 6.2.1 Reservoir
- 6.2.2 Water storage - intensive use/farm dams
- 6.2.3 Evaporation basin
- 6.2.4 Effluent pond

6.3.0 River
- 6.3.1 River - conservation
- 6.3.2 River - production
- 6.3.3 River - intensive use

6.4.0 Channel/aqueduct
- 6.4.1 Supply channel/aqueduct
- 6.4.2 Drainage channel/aqueduct

6.5.0 Marsh/wetland
- 6.5.1 Marsh/wetland - conservation
- 6.5.2 Marsh/wetland - production
- 6.5.3 Marsh/wetland - intensive use

6.6.0 Estuary/coastal waters
- 6.6.1 Estuary/coastal waters - conservation
- 6.6.2 Estuary/coastal waters - production
- 6.6.3 Estuary/coastal waters - intensive use

Primary ALUM class

Major ALUM category

The ALUM Classification is based on a scheme developed by Baxter and Russell (1994). It has been refined collaboratively by partners in the Western Australia Department of Agriculture; New South Wales Department of Natural Resources; Northern Territory Department of Lands, Planning and Environment; South Australia Department of Water, Land and Biodiversity Conservation; Queensland Department of Natural Resources and Mines; Tasmanian Department of Primary Industries, Water and Environment; the Victorian Department of Primary Industries; the National Land and Water Resources Audit; the Murray-Darling Basin Commission; the Australian Government Bureau of Rural Sciences and Department of Agriculture, Fisheries and Forestry.

3.3 GIS operations used to derive the state-wide vegetation condition layer

Analysis was performed using raster data grids in ESRI ArcGIS 9.2 with the Spatial Analyst extension. All layers were projected using Lamberts Conformal Conical Projection based on the GDA94 datum (Department of Lands *no date*).

The land-use shapefile 'nsw_lu_merge' was converted to raster with 25 m cell resolution using the ArcGIS 9.2 'Polygon to Raster Tool' (not the 'Feature to Raster Tool'). Cell values were assigned using the 'Maximum Combined Area' option. The overall extent and the exact boundaries of each 25 m raster pixel were kept identical across all layers and snapped to align with the 'veg_ext_nsw_1' grid by specifying this grid in the Spatial Analyst Environment settings. The output grid was named 'nsw_lu_25' and land-use *TAGs* were retained to ensure that subsequent join operations could be processed.

To ensure the most up-to-date vegetation condition layer was produced, a new composite land-use layer was created by replacing areas in the 'nsw_lu_25' grid assigned to National Park estate, State Forest estate and Travelling Stock Reserves with the 2008 datasets for these land-use categories. The NPWS, SF and TSR shapefiles were converted to binary raster layers with 25 m cell size aligned to the 'veg_ext_nsw_1' grid. The value of each raster pixel was determined using the maximum combined area of each land-use class. Each binary layer was PLUSed in Spatial Analyst to replace areas within the 'nsw_lu_25' grid. Replaced pixels were uniquely coded so that changes to the original land-use layer could be identified. Non-replaced pixels that were previously mapped as National Park Estate, State Forest or Travelling Stock Reserves were assigned 'no data' value.

The composite land-use layer and the vegetation extent layer were joined on '*TAG*' field ('nsw_LU_Veg_25') and potential condition states were assigned to each cell by attributing ALUM codes to VAST categories constrained by vegetation extent attributes (see Appendix 1 Table A1).

The lookup table (Appendix 1 Table A1) shows that final VAST allocation was based first on which vegetation extent category an area of land fell within (its integrity) and subsequently, which ALUM land-use Major Category applied to this area of land.

For example, for an area to be mapped as *residual,* it first needed to be mapped as *structurally intact* and show a Major Category allocation of either Nature Conservation or Managed Resource Protection. In comparison, if the area was mapped as *structurally intact* but was under a productive land-use it was mapped as one of the other VAST categories based on the authors' opinions of the intensity of that land-use and the likely impacts on vegetation condition.

3.4 Vegetation condition index generation

To generate an overall vegetation condition index for each CMA region, each vegetation condition category was assigned an index reflecting the authors' opinions on the average relative difference in vegetation condition between the six categories (Table 6). These values were based on work undertaken for earlier versions of the SOC reports, where vegetation field experts (n=13) were canvassed for their opinions on the likely average vegetation condition score (out of 100) for a range of land-use/land cover combinations (Table 7). Different final index values may be justified and can be explored if required in the future.

Table 6: Vegetation condition category index weighting

Vegetation condition category (from VAST)	Index
Residual	80
Modified	60
Transformed	50
Transformed/replaced-adventive mosaic	40
Replaced-managed	20
Removed	5

Table 7: Land-use/land cover classes and the expert-derived condition scores

Land-use/land cover class	Expert condition score
Nature conservation	80
Forestry – native hardwood	65
Travelling Stock Reserve	60
Grazing – natural vegetation	50
Environmental planting	45
Grazing – native/exotic mosaic	30
Forestry – native plantation	30
Forestry – exotic plantation	20
Grazing – exotic pasture	10
Urban and infrastructure	10
Cropping and horticulture	5

The overall vegetation condition index for each CMA region was calculated by multiplying the percentage of each condition category (within each CMA region) by its associated index value and then summing for all categories.

The calculation of the vegetation condition index for the state of NSW is shown below.

Table 8: NSW vegetation condition index calculation

Vegetation condition category (from VAST)	Index	Percentage of NSW	Component score
Residual	0.8	8.6	6.9
Modified	0.6	51.6	31.0
Transformed	0.5	6.6	3.3
Transformed/replaced-adventive mosaic	0.4	19.7	7.9
Replaced-managed	0.2	12.0	2.4
Removed	0.05	0.8	0.0
Overall vegetation condition index for NSW			51.5

Indices were mapped to vegetation condition classes according to the following index ranges:

Condition index	Condition class
> 80–100	Very good
> 60–80	Good
> 40–60	Fair
> 20–40	Poor
0–20	Very poor

3.5 Limitations

It is acknowledged that the draft land-use layer was not developed for the purpose of assessing vegetation condition; however together with the vegetation extent layer it was the best available state-wide dataset to inform inferences about vegetation condition at a coarse scale. SOC reports were required to report on the state-wide resource, and therefore consistent state-wide datasets were required. Detailed information or data specific to CMA regions has not been included, and no accuracy assessments have been undertaken.

If vegetation fell within a reserve and if it was mapped as structurally intact it was considered on average to be in the top condition class: *residual*. OEH acknowledges the shortcomings of this approach (particularly in the Western region) and, as discussed below, are working towards an improved bottom-up methodology for incorporation in the 2013 SOC reports.

3.6 Potential for improvement

OEH's knowledge of vegetation condition modelling and mapping is in its infancy. A top-down approach for mapping vegetation condition for the SOC 2010 reports; that is, a decision hierarchy linking potential site condition to mapped extent of intact and derived native vegetation, land tenure and land-use has been implemented. It has been agreed that this is a very coarse approach to mapping potential vegetation condition.

However, OEH has initiated a state-wide Vegetation Condition Monitoring, Evaluating and Reporting (MER) Program that is collecting site-based data in collaboration with CMAs (currently six) across a range of land cover, land-use and land management conditions. Assuming this program continues, OEH will use these data in a bottom-up approach to modelling and mapping vegetation condition for use in the SOC 2013 reports. Such an approach will be better able to accurately predict the likely status of vegetation condition across regions based on a range of input layers including land cover and land-use.

4. Vegetation pressures

4.1 Description of the state-wide vegetation pressures data layer

Different types of land-use typically exert a range of pressures on native vegetation extent and condition. Land-use data was aggregated into one of the five primary classes (Table 9), according to the Australian Land Use and Management (ALUM) Classification (Australian Government 2006). These were mapped as a raster grid of NSW with a cell resolution of 25 m. Each cell represents one of five different pressure classes:

- Conservation and natural environments
- Production from relatively natural environments
- Production from dryland agriculture and plantations
- Production from irrigated agriculture and plantations
- Intensive uses.

A sixth category – 'no data' – denotes cells that did not have data values in one or more of the component base layers used to compile the pressure layer.

ALUM is the nationally agreed classification for land-use. It is a three-tiered hierarchical classification that can be used to relate land-uses to increasing levels of intervention or potential impact on the natural landscape. The state-wide vegetation pressures layer was used as the basis of maps of vegetation pressures for each CMA region. This layer and the CMA boundaries are shown below. The map legend provides the percentage of NSW represented by each category (rounded to the nearest per cent).

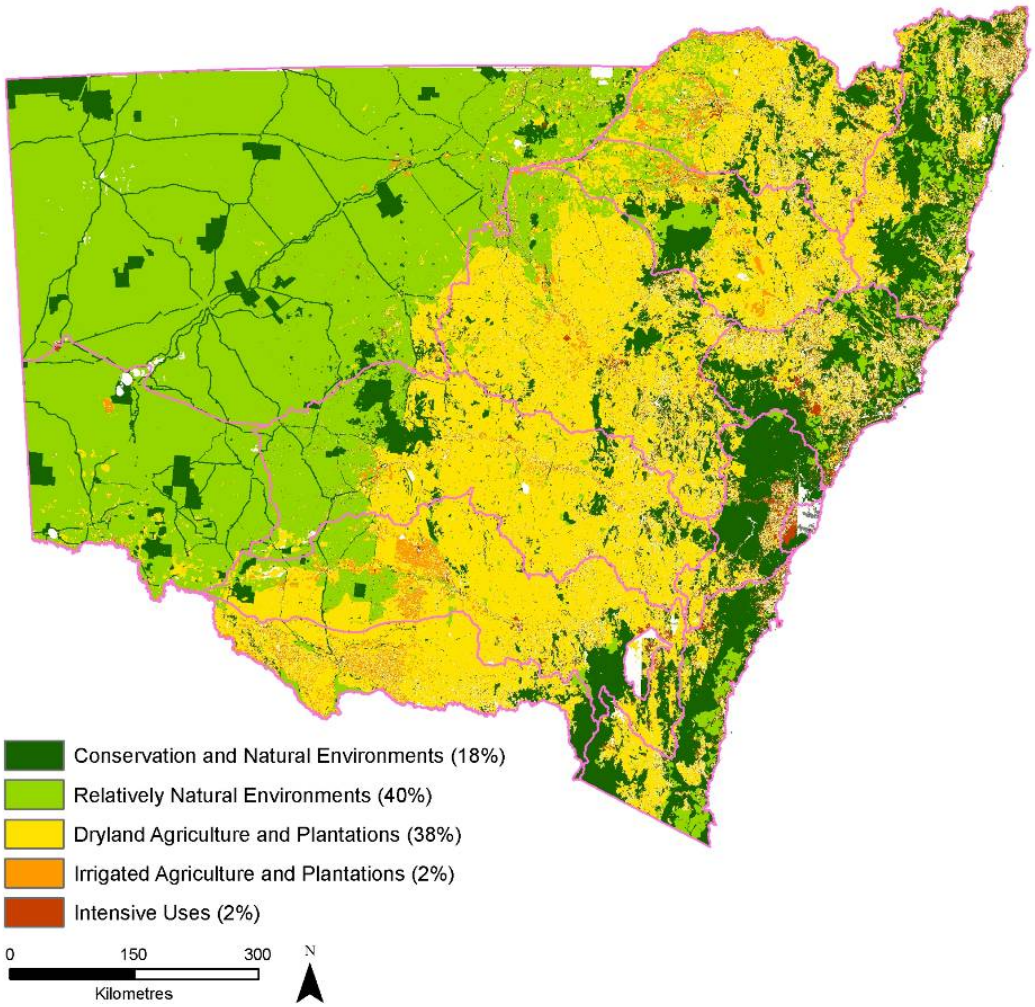

Figure 6: Pressures on native vegetation within NSW and the 13 CMA regions

For the purposes of the SOC reports, each vegetation pressure category was defined according to the ALUM primary classes as follows (see Table 4):

- Conservation and natural environments: land used primarily for conservation purposes, based on the maintenance of the essentially natural ecosystems present
- Relatively natural environments: land used primarily for primary production, with limited change to the native vegetation
- Dryland agriculture and plantations: land used mainly for primary production, based on dryland farming systems
- Irrigated agriculture and plantations: land used mostly for primary production based on irrigated farming
- Intensive uses: land subject to extensive modification, generally in association with closer residential settlement, commercial or industrial uses.

Water is also included in the ALUM classification as a primary class, but water bodies were masked out for the purposes of reporting on vegetation pressure for SOC.

The percentage of the total area of each CMA region represented by each of the five pressure classes was also presented in each SOC report as a bar chart. The pressure bar chart for all of NSW is presented in Figure 7.

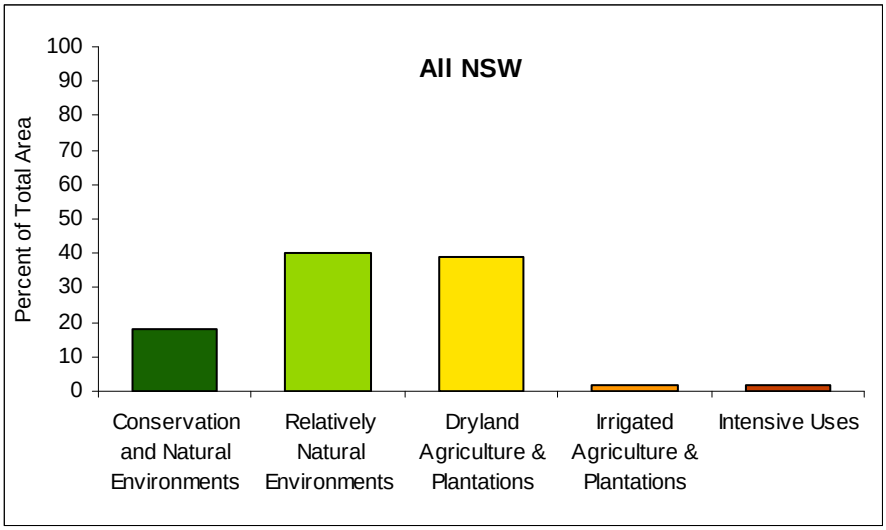

Figure 7: Percentage of total NSW land area represented by each of the five vegetation pressure states

4.2 Primary datasets used to derive the vegetation pressures data layer

The state-wide vegetation pressures layer was compiled from four primary datasets:

i) NSW Merged Land-use Layer

Filename 'nsw_lu_merge.shp'. This polygon layer was the base dataset used for mapping pressures on vegetation. It is a state-wide land-use dataset compiled as part of the 'interim native vegetation extent layer' project (DECC 2008). It is a draft product, continuing to be developed by the OEH NSW Land Use Mapping Program. The land-use layer was supplied in draft format and contained some unmapped areas around the NSW-QLD border, around the ACT and the urban area of Sydney east of Parramatta (42 per cent of the Sydney Metropolitan CMA region). Unmapped areas or polygons lacking ALUM codes were tagged as 'unknown' in the look-up table.

Inherent in the NSW Land Use Mapping layer, each land-use '*TAG*' has been assigned to the ALUM classification (look-up table Land Use version 42.dbf OEH 2011b). For the purpose of more clearly relating the likely pressures on vegetation, some minor changes were made to the ALUM classifications (such as changing defence facilities from 'intensive land-use' to 'dryland agriculture and plantations'), and areas coded as mining in the Hunter–Central Rivers CMA were classified as 'no data' because there was insufficient information to determine the current land-use pressure. Pressures were mapped according to the Primary ALUM class assigned to each polygon (see Table 9).

Some land-use polygons were re-coded after it was determined that they were incorrectly mapped. Amendments to the land-use layer were submitted to the GIS Manager of the former DECCW to be validated and included in the OEH corporate spatial dataset.

In addition to the base land-use dataset, the following three datasets were used to ensure the most up-to-date pressures data layer was produced.

ii) NSW National Parks and Wildlife Service (NPWS) Estate 2008 v1

Filename 'Estate_2008_v1'. This is a polygon layer defining the boundaries of areas in NSW that have been gazetted as being under the management of the NSW NPWS as of March 2008. Areas included national parks, nature reserves, regional parks, state conservation areas, Aboriginal areas and historic sites.

iii) Forests NSW Estate (SF) 2008

Filename 'SF_Plantations_Layer.gdb'. This is an ESRI file geodatabase supplied by Forests NSW, showing polygons that define the operational boundaries of areas in NSW under the management of Forests NSW as of November 2008.

iv) NSW Travelling Stock Reserves 2008

Filename 'TSR.shp'. The Travelling Stock Reserves (TSR) data were extracted in October 2008 from the Crown Lands Estate held within the OEH corporate database.

4.3 GIS operations used to derive the vegetation pressures data layer

Analysis was performed using raster data grids in ESRI ArcGIS 9.2 with the Spatial Analyst extension. All layers were projected using Lamberts Conformal Conical Projection based on the GDA94 data (Department of Lands *no date*).

The land-use shapefile 'nsw_lu_merge' was converted to raster with 25 m cell resolution using the ArcGIS 9.2 'Polygon to Raster Tool' (not the 'Feature to Raster Tool'). Cell values were assigned using the 'Maximum Combined Area' option. The overall extent and the exact boundaries of each 25 m raster pixel were kept identical across all layers and snapped to align with the 'veg_ext_nsw_1' grid by specifying this grid in the Spatial Analyst Environment settings. The output grid was named 'nsw_lu_25' and land-use *TAGs* were retained to ensure that subsequent join operations could be processed.

To ensure the most up-to-date pressures layer was produced, a new composite land-use layer was created by replacing areas in the 'nsw_lu_25' grid assigned to National Park estate, State Forest estate and Travelling Stock Reserves with the 2008 datasets for these land-use categories. The NPWS, SF and TSR shapefiles were converted to binary raster layers with 25 m cell size aligned to the 'veg_ext_nsw_1' grid. The value of each raster pixel was determined using the maximum combined area of each land-use class. Each binary layer was PLUSed in Spatial Analyst to replace areas within the 'nsw_lu_25' grid. Replaced pixels were uniquely coded so that changes to the original land-use layer could be identified. Non-replaced pixels that were previously mapped as National Park Estate, State Forest or Travelling Stock Reserves were assigned 'no data' value.

The composite land-use layer and the vegetation extent layer were joined on '*TAG*' field (nsw_LU_Veg_25) and pressure states were assigned to each cell based ALUM Primary Class. The decision rules used to make these allocations are contained in the look-up table in Appendix 1 Table A1. The look-up table was re-joined to 'nsw_LU_Veg_25' and pressure ratings were displayed.

Table 9: Australian Land Use and Management Classification with columns headed by ALUM Primary Classes and Major Categories listed beneath

Source: http://adl.brs.gov.au/mapserv/landuse/docs/ALUMv6.pdf (April 2009)

AUSTRALIAN LAND USE AND MANAGEMENT CLASSIFICATION version 6

1 Conservation and Natural Environments

1.1.0 Nature conservation
- 1.1.1 Strict nature reserves
- 1.1.2 Wilderness area
- 1.1.3 National park
- 1.1.4 Natural feature protection
- 1.1.5 Habitat/species management area
- 1.1.6 Protected landscape
- 1.1.7 Other conserved area

1.2.0 Managed resource protection
- 1.2.1 Biodiversity
- 1.2.2 Surface water supply
- 1.2.3 Groundwater
- 1.2.4 Landscape
- 1.2.5 Traditional indigenous uses

1.3.0 Other minimal use
- 1.3.1 Defence
- 1.3.2 Stock route
- 1.3.3 Residual native cover
- 1.3.4 Rehabilitation

2 Production from Relatively Natural Environments

2.1.0 Grazing natural vegetation

2.2.0 Production forestry
- 2.2.1 Wood production
- 2.2.2 Other forest production

3 Production from Dryland Agriculture and Plantations

3.1.0 Plantation forestry
- 3.1.1 Hardwood production
- 3.1.2 Softwood production
- 3.1.3 Other forest production
- 3.1.4 Environmental

3.2.0 Grazing modified pastures
- 3.2.1 Native/exotic pasture mosaic
- 3.2.2 Woody fodder plants
- 3.2.3 Pasture legumes
- 3.2.4 Pasture legume/grass mixtures
- 3.2.5 Sown grasses

3.3.0 Cropping
- 3.3.1 Cereals
- 3.3.2 Beverage & spice crops
- 3.3.3 Hay & silage
- 3.3.4 Oil seeds
- 3.3.5 Sugar
- 3.3.6 Cotton
- 3.3.7 Tobacco
- 3.3.8 Legumes

3.4.0 Perennial horticulture
- 3.4.1 Tree fruits
- 3.4.2 Oleaginous fruits
- 3.4.3 Tree nuts
- 3.4.4 Vine fruits
- 3.4.5 Shrub nuts fruits & berries
- 3.4.6 Flowers & bulbs
- 3.4.7 Vegetables & herbs

3.5.0 Seasonal horticulture
- 3.5.1 Fruits
- 3.5.2 Nuts
- 3.5.3 Flowers & bulbs
- 3.5.4 Vegetables & herbs

3.6.0 Land in transition
- 3.6.1 Degraded land
- 3.6.2 Abandoned land
- 3.6.3 Land under rehabilitation
- 3.6.4 No defined use

4 Production from Irrigated Agriculture and Plantations

4.1.0 Irrigated plantation forestry
- 4.1.1 Irrigated hardwood production
- 4.1.2 Irrigated softwood production
- 4.1.3 Irrigated other forest production
- 4.1.4 Irrigated environmental

4.2.0 Irrigated modified pastures
- 4.2.1 Irrigated woody fodder plants
- 4.2.2 Irrigated pasture legumes
- 4.2.3 Irrigated legume/grass mixtures
- 4.2.4 Irrigated sown grasses

4.3.0 Irrigated cropping
- 4.3.1 Irrigated cereals
- 4.3.2 Irrigated beverage & spice crops
- 4.3.3 Irrigated hay & silage
- 4.3.4 Irrigated oil seeds
- 4.3.5 Irrigated sugar
- 4.3.6 Irrigated cotton
- 4.3.7 Irrigated tobacco
- 4.3.8 Irrigated legumes

4.4.0 Irrigated perennial horticulture
- 4.4.1 Irrigated tree fruits
- 4.4.2 Irrigated oleaginous fruits
- 4.4.3 Irrigated tree nuts
- 4.4.4 Irrigated vine fruits
- 4.4.5 Irrigated shrub nuts fruits & berries
- 4.4.6 Irrigated flowers & bulbs
- 4.4.7 Irrigated vegetables & herbs

4.5.0 Irrigated seasonal horticulture
- 4.5.1 Irrigated fruits
- 4.5.2 Irrigated nuts
- 4.5.3 Irrigated flowers & bulbs
- 4.5.4 Irrigated vegetables & herbs

4.6.0 Irrigated land in transition
- 4.6.1 Degraded irrigated land
- 4.6.2 Abandoned irrigated land
- 4.6.3 Irrigated land under rehabilitation
- 4.6.4 No defined use (irrigation)

5 Intensive Uses

5.1.0 Intensive horticulture
- 5.1.1 Shadehouses
- 5.1.2 Glasshouses
- 5.1.3 Glasshouses (hydroponic)

5.2.0 Intensive animal production
- 5.2.1 Dairy
- 5.2.2 Cattle
- 5.2.3 Sheep
- 5.2.4 Poultry
- 5.2.5 Pigs
- 5.2.6 Aquaculture

5.3.0 Manufacturing and industrial

5.4.0 Residential
- 5.4.1 Urban residential
- 5.4.2 Rural residential
- 5.4.3 Rural living

5.5.0 Services
- 5.5.1 Commercial services
- 5.5.2 Public services
- 5.5.3 Recreation and culture
- 5.5.4 Defence facilities
- 5.5.5 Research facilities

5.6.0 Utilities
- 5.6.1 Electricity generation/transmission
- 5.6.2 Gas treatment, storage and transmission

5.7.0 Transport and communication
- 5.7.1 Airports/aerodromes
- 5.7.2 Roads
- 5.7.3 Railways
- 5.7.4 Ports and water transport
- 5.7.5 Navigation and communication

5.8.0 Mining
- 5.8.1 Mines
- 5.8.2 Quarries
- 5.8.3 Tailings

5.9.0 Waste treatment and disposal
- 5.9.1 Stormwater
- 5.9.2 Landfill
- 5.9.3 Solid garbage
- 5.9.4 Incinerators
- 5.9.5 Sewage

6 Water

6.1.0 Lake
- 6.1.1 Lake - conservation
- 6.1.2 Lake - production
- 6.1.3 Lake - intensive use

6.2.0 Reservoir/dam
- 6.2.1 Reservoir
- 6.2.2 Water storage - intensive use/farm dams
- 6.2.3 Evaporation basin
- 6.2.4 Effluent pond

6.3.0 River
- 6.3.1 River - conservation
- 6.3.2 River - production
- 6.3.3 River - intensive use

6.4.0 Channel/aqueduct
- 6.4.1 Supply channel/aqueduct
- 6.4.2 Drainage channel/aqueduct

6.5.0 Marsh/wetland
- 6.5.1 Marsh/wetland - conservation
- 6.5.2 Marsh/wetland - production
- 6.5.3 Marsh/wetland - intensive use

6.6.0 Estuary/coastal waters
- 6.6.1 Estuary/coastal waters - conservation
- 6.6.2 Estuary/coastal waters - production
- 6.6.3 Estuary/coastal waters - intensive use

Primary ALUM Class

The ALUM Classification is based on a scheme developed by Baxter and Russell (1994). It has been refined collaboratively by partners in the Western Australia Department of Agriculture; New South Wales Department of Natural Resources; Northern Territory Department of Lands, Planning and Environment; South Australia Department of Water, Land and Biodiversity Conservation; Queensland Department of Natural Resources and Mines; Tasmanian Department of Primary Industries, Water and Environment; the Victorian Department of Primary Industries; the National Land and Water Resources Audit; the Murray-Darling Basin Commission; the Australian Government Bureau of Rural Sciences and Department of Agriculture, Fisheries and Forestry.

4.4 Vegetation pressures index generation

To generate an overall pressure index for each CMA region, each ALUM Primary Class was assigned a pressure index (Table 10). Land-uses that exhibit a greater pressure on native vegetation received a higher pressure index. The index values were chosen by the authors to show relative pressure indices state-wide. Different index weightings may be justified and can be explored if required in the future.

Table 10: ALUM land-use classes and their assigned pressure index weighting

ALUM Primary Class	Index
Conservation and natural environments	0.0
Production from relatively natural environments	0.3
Production from dryland agriculture and plantations	0.6
Production from irrigated agriculture and plantations	0.9
Intensive uses	1.5

The overall pressure index for each CMA region was calculated by multiplying the percentage of each pressure class (within each CMA region) by its associated index value and then summing for all classes.

The calculation of the vegetation pressure index for the state of NSW is shown below (the conservation and natural environments class is included as future indices for this category may be non-zero).

Table 11: NSW vegetation pressure index calculation

ALUM Primary Class	Index	Percentage of NSW	Component score
Conservation and natural environments	0.0	17.7	0.0
Production from relatively natural environments	0.3	40.0	12.0
Production from dryland agriculture and plantations	0.6	38.8	23.3
Production from irrigated agriculture and plantations	0.9	1.8	1.6
Intensive uses	1.5	1.6	2.4
Overall vegetation pressure index for NSW			39.3

Indices were mapped to pressure classes according to the following index ranges:

Pressure index	Pressure class
0–20	Very low
> 20–40	Low
> 40–60	Moderate
> 60–80	High
> 80–100	Very high

4.5 Limitations

The conceptual framework is based on current pressures not future pressures (risks). Consequently, land under mining lease (but unmined) or land contained within urban development plans (but as yet undeveloped) are considered risks and therefore are not considered current pressures in the SOC reports.

Different types of land-use typically exert a range of pressures on native vegetation extent and condition that are commonly associated with that land-use. Existing land-use mapping was used to map pressures on native vegetation for the SOC 2010 reports. The authors accept the limitations (for example, data currency) with the land-use mapping information but stress its significant value towards a state-wide assessment of coarse pressures on native vegetation extent and condition.

For the SOC 2010 reports, land-use has been used as a surrogate (ultimate pressure) for a range of actual (proximate) pressures on native vegetation extent and condition, including clearing, thinning, die-back, burning, fire-wood collection, fertiliser application, domestic stock grazing, and invasion by exotic species.

Monitoring each of this proximate pressure separately would result in a more accurate assessment of real and current (proximate) pressures. OEH's ability to monitor clearing and thinning are improving. This provides some potential to monitor this proximate pressure directly, hence the

inclusion of the native woody and native non-woody graph, to which OEH aims to add trend information as soon as possible.

However, at this point there is limited ability to monitor in any spatially explicit sense the other proximate pressures. OEH aims to monitor land-use and land management change as the ultimate pressure surrogate.

4.6 Potential for improvement

OEH's involvement in the National Dynamic Land Cover Mapping project holds much promise in monitoring some of the above proximate pressures on native vegetation, particularly in the non-woody landscape. The next three years should see significant improvements in OEH's capability to directly monitor some of these proximate pressures.

The capturing of spatially explicit information about land cover, land-use and land management change by the CMAs in the Land Management Database will similarly improve OEH's ability to monitor changes in pressures on the extent and condition of native vegetation in the future.

5. References

Australian Government 2006, *Guidelines for Land-use Mapping in Australia: principles, procedures and definitions – a technical handbook supporting the Australian Collaborative Land-use Mapping Program*, Edition 3, Bureau of Rural Sciences, Canberra [http://adl.brs.gov.au/mapserv/landuse/pdf_files/Web_Guidelines_for_LUMapping.pdf].

DECC 2007, *Native Vegetation Report Card – Woody Vegetation Change* [www.environment.nsw.gov.au/resources/vegetation/Woodyvegchange2006-07.pdf].

DECC 2008, *NSW Interim Native Vegetation Extent (2008-Version 1),* Report and data prepared by NSW Department of Environment and Climate Change for the National Land and Water Resources Audit, Project No. DONR 000397, ANZLIC Metadata No. ANZNS0208000244 [www.canri.nsw.gov.au/download/INVE_08V1-2.pdf].

Department of Lands (no date), *NSW GDA94 Lambert Conformal Conic Projection Policy,* Department of Lands, Sydney [www.lpma.nsw.gov.au/data/assets/pdf_file/0006/25728/GDA_Lambert.pdf].

Department of Natural Resources and Water 2007, *Land cover change in Queensland 2004–2005: a State-wide Landcover and Trees Study (SLATS) Report,* Department of Natural Resources and Water, Brisbane.

Keith DA & Simpson CC 2006, *Spatial data layers for extant native vegetation in New South Wales*, Internal Report Biodiversity Conservation Science, Department of Environment & Conservation [www.mapdata.environment.nsw.gov.au].

Keith DA & Simpson CC 2008, 'A protocol for assessment and integration of vegetation maps, with an application to spatial datasets from south-eastern Australia', *Austral Ecology,* vol. 33, pp. 761–774.

OEH 2011a, *Definition of native vegetation (combined definition) and operational terms for reporting its extent Version 4.3*, Internal report, Native Vegetation Technical Working Group, Office of Environment and Heritage, Department of Premier and Cabinet, Sydney.

OEH 2011b, *Land use Mapping – New South Wales,* Office of Environment and Heritage, Department of Premier and Cabinet, Sydney [www.mapdata.environment.nsw.gov.au/].

Thackway R & Lesslie R 2005, *Vegetation assets, states and transitions: accounting for vegetation condition in the Australian landscape*, BRS Technical Report, Bureau of Rural Sciences, Canberra.

Thackway R & Lesslie R 2006, 'Reporting vegetation condition using the Vegetation Assets, States and Transitions (VAST) framework', *Ecological Management & Restoration,* vol. 7, (S1)S53–S62.

Thackway R & Lesslie R 2008, 'Describing and mapping human-induced vegetation change in the Australian Landscape', *Environmental Management*, vol. 42, pp. 572–590 [www.springerlink.com/content/w318w7221202v2v8/].

Appendix 1: Summary of Join tables used to translate vegetation extent and land-use TAGs to vegetation condition (VAST) categories

Table A1: Summary of Join tables used to translate vegetation extent and land-use TAGs to vegetation condition categories

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
Native Intact	Conservation and Natural Environments	Nature conservation	1.1.3	1	Residual
			1.1.7	1	Residual
		Managed resource protection	1.2.0	1	Residual
			1.2.2	1	Residual
			1.2.4	1	Residual
		Other minimal use	1.3.0	2	Modified
			1.3.2	2	Modified
			1.3.3	2	Modified
			1.3.4	2	Modified
	Production from Relatively Natural Environments	Grazing natural vegetation	2.1.0	2	Modified
		Production forestry	2.2.0	2	Modified
			2.2.1	2	Modified
	Production from Dryland Agriculture and Plantations	Dryland Agriculture and Plantations	3.0.0	2	Modified
		Plantation forestry	3.1.0	5	Replaced – Managed
			3.1.1	5	Replaced – Managed
			3.1.2	5	Replaced – Managed
			3.1.4	2	Modified
		Grazing modified pastures	3.2.0	2	Modified
			3.2.1	2	Modified
			3.2.2	5	Replaced – Managed
		Cropping	3.3.0	5	Replaced – Managed
			3.3.2	5	Replaced – Managed

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
			3.3.3	5	Replaced – Managed
			3.3.5	5	Replaced – Managed
			3.3.6	5	Replaced – Managed
			3.3.8	5	Replaced – Managed
		Perennial horticulture	3.4.0	5	Replaced – Managed
			3.4.1	5	Replaced – Managed
			3.4.2	5	Replaced – Managed
			3.4.3	5	Replaced – Managed
			3.4.4	5	Replaced – Managed
		Seasonal horticulture	3.5.0	5	Replaced – Managed
			3.5.3	5	Replaced – Managed
			3.5.4	5	Replaced – Managed
		Land in Transition	3.6.1	4	Replaced – Adventive
			3.6.2	4	Replaced – Adventive
			3.6.3	4	Replaced – Adventive
			3.6.4	4	Replaced – Adventive
	Production from Irrigated Agriculture and Plantations	Irrigated plantation forestry	4.1.1	5	Replaced – Managed
			4.1.2	5	Replaced – Managed
			4.1.4	5	Replaced – Managed
		Grazing modified pastures	4.2.1	5	Replaced – Managed
		Irrigated modified pastures	4.2.0	5	Replaced – Managed
		Irrigated cropping	4.3.0	5	Replaced – Managed
			4.3.1	5	Replaced – Managed
			4.3.2	5	Replaced – Managed
			4.3.3	5	Replaced – Managed
			4.3.6	5	Replaced – Managed
			4.3.8	5	Replaced – Managed
		Irrigated perennial horticulture	4.4.0	5	Replaced – Managed
			4.4.1	5	Replaced – Managed

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
			4.4.2	5	Replaced – Managed
			4.4.3	5	Replaced – Managed
			4.4.4	5	Replaced – Managed
			4.4.7	5	Replaced – Managed
		Irrigated seasonal horticulture	4.5.3	5	Replaced – Managed
			4.5.4	5	Replaced – Managed
		Irrigated land in transition	4.6.2	5	Replaced – Managed
	Intensive Uses	Intensive Uses	5.0.0	6	Removed
		Intensive horticulture	5.1.0	6	Removed
			5.1.1	6	Removed
		Intensive animal production	5.2.0	6	Removed
			5.2.1	6	Removed
			5.2.2	6	Removed
			5.2.3	6	Removed
			5.2.4	6	Removed
			5.2.5	6	Removed
			5.2.6	6	Removed
		Manufacturing and industrial	5.3.0	6	Removed
		Residential	5.4.0	2	Modified
			5.4.1	2	Modified
			5.4.2	2	Modified
			5.4.3	2	Modified
		Services	5.5.0	2	Modified
			5.5.1	2	Modified
			5.5.2	2	Modified
			5.5.3	2	Modified
			5.5.4	2	Modified
			5.5.5	2	Modified
		Utilities	5.6.0	2	Modified
			5.6.1	2	Modified

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
			5.6.2	2	Modified
		Transport and communication	5.7.0	2	Modified
			5.7.1	2	Modified
			5.7.2	2	Modified
			5.7.3	2	Modified
			5.7.4	2	Modified
			5.7.5	2	Modified
		Mining	5.8.0	2	Modified
			5.8.1	2	Modified
			5.8.2	2	Modified
			5.8.3	2	Modified
		Waste treatment and disposal	5.9.0	2	Modified
			5.9.1	2	Modified
			5.9.2	2	Modified
			5.9.5	2	Modified
	Water	Lake	6.1.0	6	Removed
			6.1.1	6	Removed
		Reservoir or dam	6.2.0	6	Removed
			6.2.1	2	Modified
			6.2.3	2	Modified
			6.2.4	2	Modified
		River	6.3.0	2	Modified
			6.3.3	2	Modified
		Channel/aqueduct	6.4.0	2	Modified
			6.4.1	6	Removed
			6.4.2	6	Removed
		Marsh/wetland	6.5.0	6	Removed
		Estuary/coastal waters	6.6.0	6	Removed
			6.6.2	2	Modified
			6.6.3	2	Modified
	Unknown	Unknown	9.9.9	9	Unknown

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
Native Derived	Conservation and Natural Environments	Nature conservation	1.1.3	3	Transformed
			1.1.7	3	Transformed
		Managed resource protection	1.2.0	3	Transformed
			1.2.2	3	Transformed
			1.2.4	3	Transformed
		Other minimal use	1.3.0	3	Transformed
			1.3.2	3	Transformed
			1.3.3	3	Transformed
			1.3.4	3	Transformed
	Relatively Natural Environments	Grazing natural vegetation	2.1.0	3	Transformed
		Production forestry	2.2.0	3	Transformed
			2.2.1	3	Transformed
	Dryland Agriculture and Plantations	Dryland Agriculture and Plantations	3.0.0	3	Transformed
		Plantation forestry	3.1.0	5	Replaced – Managed
			3.1.1	5	Replaced – Managed
			3.1.2	5	Replaced – Managed
			3.1.4	3	Transformed
		Grazing modified pastures	3.2.0	3	Transformed
			3.2.1	3	Transformed
			3.2.2	5	Replaced – Managed
		Cropping	3.3.0	5	Replaced – Managed
			3.3.2	5	Replaced – Managed
			3.3.3	5	Replaced – Managed
			3.3.5	5	Replaced – Managed
			3.3.6	5	Replaced – Managed
			3.3.8	5	Replaced – Managed
		Perennial horticulture	3.4.0	5	Replaced – Managed

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
			3.4.1	5	Replaced – Managed
			3.4.2	5	Replaced – Managed
			3.4.3	5	Replaced – Managed
			3.4.4	5	Replaced – Managed
		Seasonal horticulture	3.5.3	5	Replaced – Managed
			3.5.4	5	Replaced – Managed
		Land in Transition	3.6.1	4	Replaced – Adventive
			3.6.2	4	Replaced – Adventive
			3.6.3	4	Replaced – Adventive
			3.6.4	4	Replaced – Adventive
	Irrigated Agriculture and Plantations	Irrigated plantation forestry	4.1.0	5	Replaced – Managed
			4.1.1	5	Replaced – Managed
			4.1.2	5	Replaced – Managed
			4.1.4	5	Replaced – Managed
		Grazing modified pastures	4.2.1	5	Replaced – Managed
		Irrigated modified pastures	4.2.0	5	Replaced – Managed
		Irrigated cropping	4.3.0	5	Replaced – Managed
			4.3.1	5	Replaced – Managed
			4.3.3	5	Replaced – Managed
			4.3.6	5	Replaced – Managed
		Irrigated perennial horticulture	4.4.0	5	Replaced – Managed
			4.4.1	5	Replaced – Managed
			4.4.2	5	Replaced – Managed
			4.4.3	5	Replaced – Managed
			4.4.4	5	Replaced – Managed
			4.4.7	5	Replaced – Managed
		Irrigated seasonal horticulture	4.5.3	5	Replaced – Managed
			4.5.4	5	Replaced – Managed

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
		Irrigated land in transition	4.6.2	5	Replaced – Managed
	Intensive Uses	Intensive Uses	5.0.0	6	Removed
		Intensive horticulture	5.1.0	6	Removed
			5.1.1	6	Removed
		Intensive animal production	5.2.0	6	Removed
			5.2.1	6	Removed
			5.2.4	6	Removed
			5.2.5	6	Removed
			5.2.6	6	Removed
		Manufacturing and industrial	5.3.0	6	Removed
		Residential	5.4.0	3	Transformed
			5.4.1	3	Transformed
			5.4.2	3	Transformed
			5.4.3	3	Transformed
		Services	5.5.0	3	Transformed
			5.5.1	3	Transformed
			5.5.2	3	Transformed
			5.5.3	3	Transformed
			5.5.4	3	Transformed
			5.5.5	3	Transformed
		Utilities	5.6.0	3	Transformed
			5.6.1	3	Transformed
			5.6.2	3	Transformed
		Transport and communication	5.7.0	3	Transformed
			5.7.1	3	Transformed
			5.7.2	3	Transformed
			5.7.3	3	Transformed
			5.7.4	3	Transformed
			5.7.5	3	Transformed
		Mining	5.8.0	3	Transformed

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
			5.8.1	3	Transformed
			5.8.2	3	Transformed
			5.8.3	3	Transformed
		Waste treatment and disposal	5.9.0	3	Transformed
			5.9.1	3	Transformed
			5.9.2	3	Transformed
			5.9.5	3	Transformed
	Water	Lake	6.1.0	0	Naturally Bare
			6.1.1	0	Naturally Bare
		Reservoir or dam	6.2.0	6	Removed
			6.2.1	6	Removed
			6.2.3	6	Removed
			6.2.4	6	Removed
		River	6.3.0	0	Naturally Bare
			6.3.3	0	Naturally Bare
		Channel/aqueduct	6.4.0	6	Removed
			6.4.1	6	Removed
			6.4.2	6	Removed
		Marsh/wetland	6.5.0	3	Transformed
		Estuary/coastal waters	6.6.0	0	Naturally Bare
			6.6.2	0	Naturally Bare
			6.6.3	0	Naturally Bare
	Unknown	Unknown	9.9.9	9	Unknown
Native / Non-native mosaic	Conservation and Natural Environments	Nature conservation	1.1.3	3-4	Mosaic
			1.1.7	3-4	Mosaic
		Managed resource protection	1.2.2	3-4	Mosaic
			1.2.4	3-4	Mosaic
		Other minimal use	1.3.0	3-4	Mosaic
			1.3.2	3-4	Mosaic
			1.3.3	3-4	Mosaic

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
			1.3.4	3-4	Mosaic
	Relatively Natural Environments	Grazing natural vegetation	2.1.0	3-4	Mosaic
		Production forestry	2.2.0	3-4	Mosaic
			2.2.1	3-4	Mosaic
	Dryland Agriculture and Plantations	Dryland Agriculture and Plantations	3.0.0	3-4	Mosaic
		Plantation forestry	3.1.0	3-4	Mosaic
			3.1.1	3-4	Mosaic
			3.1.2	3-4	Mosaic
			3.1.3	3-4	Mosaic
			3.1.4	3-4	Mosaic
		Grazing modified pastures	3.2.0	3-4	Mosaic
			3.2.1	3-4	Mosaic
			3.2.2	3-4	Mosaic
		Cropping	3.3.0	5	Replaced – Managed
			3.3.2	5	Replaced – Managed
			3.3.3	5	Replaced – Managed
			3.3.5	5	Replaced – Managed
			3.3.6	5	Replaced – Managed
			3.3.8	5	Replaced – Managed
		Perennial horticulture	3.4.0	5	Replaced – Managed
			3.4.1	5	Replaced – Managed
			3.4.2	5	Replaced – Managed
			3.4.3	5	Replaced – Managed
			3.4.4	5	Replaced – Managed
		Seasonal horticulture	3.5.3	5	Replaced – Managed
			3.5.4	5	Replaced – Managed
		Land in Transition	3.6.1	3-4	Mosaic
			3.6.2	3-4	Mosaic
			3.6.3	3-4	Mosaic
			3.6.4	3-4	Mosaic

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
	Irrigated Agriculture and Plantations	Irrigated plantation forestry	4.1.0	5	Replaced –Managed
			4.1.1	5	Replaced – Managed
			4.1.4	5	Replaced – Managed
		Irrigated modified pastures	4.2.0	5	Replaced – Managed
		Irrigated cropping	4.3.0	5	Replaced – Managed
			4.3.1	5	Replaced – Managed
			4.3.2	5	Replaced – Managed
			4.3.3	5	Replaced – Managed
			4.3.6	5	Replaced – Managed
			4.3.8	5	Replaced – Managed
		Irrigated perennial horticulture	4.4.0	5	Replaced – Managed
			4.4.1	5	Replaced – Managed
			4.4.2	5	Replaced – Managed
			4.4.3	5	Replaced – Managed
			4.4.4	5	Replaced – Managed
			4.4.7	5	Replaced – Managed
		Irrigated seasonal horticulture	4.5.3	5	Replaced – Managed
			4.5.4	5	Replaced – Managed
		Irrigated land in transition	4.6.2	5	Replaced – Managed
	Intensive Uses	Intensive Uses	5.0.0	6	Removed
		Intensive horticulture	5.1.0	6	Removed
			5.1.1	6	Removed
		Intensive animal production	5.2.0	6	Removed
			5.2.1	6	Removed
			5.2.2	6	Removed
			5.2.4	6	Removed
			5.2.5	6	Removed
			5.2.6	6	Removed

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
		Manufacturing and industrial	5.3.0	6	Removed
		Residential	5.4.0	3-4	Mosaic
			5.4.1	3-4	Mosaic
			5.4.2	3-4	Mosaic
			5.4.3	3-4	Mosaic
		Services	5.5.0	3-4	Mosaic
			5.5.1	3-4	Mosaic
			5.5.2	3-4	Mosaic
			5.5.3	3-4	Mosaic
			5.5.4	3-4	Mosaic
			5.5.5	3-4	Mosaic
		Utilities	5.6.0	3-4	Mosaic
			5.6.1	3-4	Mosaic
			5.6.2	3-4	Mosaic
		Transport and communication	5.7.0	3-4	Mosaic
			5.7.1	3-4	Mosaic
			5.7.2	3-4	Mosaic
			5.7.3	3-4	Mosaic
			5.7.4	3-4	Mosaic
			5.7.5	3-4	Mosaic
		Mining	5.8.0	3-4	Mosaic
			5.8.1	3-4	Mosaic
			5.8.2	3-4	Mosaic
			5.8.3	3-4	Mosaic
		Waste treatment and disposal	5.9.0	3-4	Mosaic
			5.9.1	3-4	Mosaic
			5.9.2	3-4	Mosaic
			5.9.5	3-4	Mosaic
	Water	Lake	6.1.0	0	Naturally Bare
		Reservoir or dam	6.2.0	6	Removed
			6.2.1	6	Removed

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
			6.2.3	6	Removed
			6.2.4	6	Removed
		River	6.3.0	0	Naturally Bare
			6.3.3	0	Naturally Bare
		Channel/aqueduct	6.4.0	6	Removed
			6.4.1	6	Removed
			6.4.2	6	Removed
		Marsh/wetland	6.5.0	3-4	Mosaic
		Estuary/coastal waters	6.6.0	0	Naturally Bare
			6.6.2	0	Naturally Bare
			6.6.3	0	Naturally Bare
	Unknown	Unknown	9.9.9	9	Unknown
Non-vegetation	Conservation and Natural Environments	Nature conservation	1.1.3	5	Managed - Replaced
			1.1.7	5	Managed – Replaced
		Managed resource protection	1.2.0	5	Managed – Replaced
			1.2.2	5	Managed – Replaced
			1.2.4	5	Managed – Replaced
		Other minimal use	1.3.0	5	Managed – Replaced
			1.3.2	5	Managed – Replaced
			1.3.3	5	Managed – Replaced
			1.3.4	5	Managed – Replaced
	Relatively Natural Environments	Grazing natural vegetation	2.1.0	5	Managed – Replaced
		Production forestry	2.2.0	5	Managed – Replaced
			2.2.1	5	Managed – Replaced
	Dryland Agriculture and Plantations	Dryland Agriculture and Plantations	3.0.0	5	Managed – Replaced
		Plantation forestry	3.1.0	5	Managed – Replaced
			3.1.1	5	Managed – Replaced
			3.1.2	5	Managed – Replaced

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
			3.1.4	5	Managed – Replaced
		Grazing modified pastures	3.2.0	5	Managed – Replaced
			3.2.1	5	Managed – Replaced
		Cropping	3.3.0	5	Managed – Replaced
			3.3.2	5	Managed – Replaced
			3.3.3	5	Managed – Replaced
			3.3.5	5	Managed – Replaced
			3.3.6	5	Managed – Replaced
		Perennial horticulture	3.4.0	5	Managed – Replaced
			3.4.1	5	Managed – Replaced
			3.4.3	5	Managed – Replaced
			3.4.4	5	Managed – Replaced
		Seasonal horticulture	3.5.4	5	Managed – Replaced
		Land in Transition	3.6.1	5	Managed – Replaced
			3.6.2	5	Managed – Replaced
			3.6.3	5	Managed – Replaced
			3.6.4	5	Managed – Replaced
	Irrigated Agriculture and Plantations	Irrigated plantation forestry	4.1.2	6	Removed
			4.1.4	6	Removed
		Irrigated modified pastures	4.2.0	6	Removed
		Irrigated cropping	4.3.0	6	Removed
			4.3.1	6	Removed
			4.3.2	6	Removed
			4.3.3	6	Removed
			4.3.6	6	Removed
		Irrigated perennial horticulture	4.4.0	6	Removed
			4.4.1	6	Removed
			4.4.2	6	Removed
			4.4.3	6	Removed
			4.4.4	6	Removed

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
		Irrigated seasonal horticulture	4.5.4	6	Removed
		Irrigated land in transition	4.6.2	6	Removed
	Intensive Uses	Intensive Uses	5.0.0	6	Removed
		Intensive horticulture	5.1.0	6	Removed
			5.1.1	6	Removed
		Intensive animal production	5.2.0	6	Removed
			5.2.1	6	Removed
			5.2.2	6	Removed
			5.2.4	6	Removed
			5.2.6	6	Removed
		Manufacturing and industrial	5.3.0	6	Removed
		Residential	5.4.0	6	Removed
			5.4.1	6	Removed
			5.4.2	6	Removed
			5.4.3	6	Removed
		Services	5.5.0	6	Removed
			5.5.1	6	Removed
			5.5.2	6	Removed
			5.5.3	6	Removed
			5.5.4	6	Removed
			5.5.5	6	Removed
		Utilities	5.6.0	6	Removed
			5.6.1	6	Removed
		Transport and communication	5.7.0	6	Removed
			5.7.1	6	Removed
			5.7.2	6	Removed
			5.7.3	6	Removed
			5.7.4	6	Removed
			5.7.5	6	Removed
		Mining	5.8.0	6	Removed

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
			5.8.1	6	Removed
			5.8.2	6	Removed
			5.8.3	6	Removed
		Waste treatment and disposal	5.9.0	6	Removed
			5.9.1	6	Removed
			5.9.2	6	Removed
			5.9.5	6	Removed
	Water	Lake	6.1.0	0	Naturally Bare
			6.1.1	0	Naturally Bare
		Reservoir or dam	6.2.0	6	Removed
			6.2.1	6	Removed
			6.2.3	6	Removed
			6.2.4	6	Removed
		River	6.3.0	0	Naturally Bare
			6.3.3	0	Naturally Bare
		Channel/aqueduct	6.4.0	6	Removed
			6.4.1	6	Removed
			6.4.2	6	Removed
		Marsh/wetland	6.5.0	0	Naturally Bare
		Estuary/coastal waters	6.6.0	0	Naturally Bare
			6.6.2	0	Naturally Bare
			6.6.3	0	Naturally Bare
	Unknown	Unknown	9.9.9	9	Unknown
Exotic Vegetation	Conservation and Natural Environments	Nature conservation	1.1.3	5	Replaced – Managed
			1.1.7	5	Replaced – Managed
		Managed resource protection	1.2.2	5	Replaced – Managed
			1.2.4	5	Replaced – Managed
		Other minimal use	1.3.0	5	Replaced – Managed
			1.3.2	5	Replaced – Managed
			1.3.3	5	Replaced – Managed

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
			1.3.4	5	Replaced – Managed
	Relatively Natural Environments	Grazing natural vegetation	2.1.0	5	Replaced – Managed
		Production forestry	2.2.0	5	Replaced – Managed
			2.2.1	5	Replaced – Managed
	Dryland Agriculture and Plantations	Production from Dryland Agriculture and Plantations	3.0.0	5	Replaced – Managed
		Plantation forestry	3.1.0	5	Replaced – Managed
			3.1.1	5	Replaced – Managed
			3.1.2	5	Replaced – Managed
			3.1.3	5	Replaced – Managed
			3.1.4	5	Replaced – Managed
		Grazing modified pastures	3.2.0	5	Replaced – Managed
			3.2.1	5	Replaced – Managed
			3.2.2	5	Replaced – Managed
		Cropping	3.3.0	5	Replaced – Managed
			3.3.2	5	Replaced – Managed
			3.3.3	5	Replaced – Managed
			3.3.5	5	Replaced – Managed
			3.3.6	5	Replaced – Managed
			3.3.8	5	Replaced – Managed
		Perennial horticulture	3.4.0	5	Replaced – Managed
			3.4.1	5	Replaced – Managed
			3.4.2	5	Replaced – Managed
			3.4.3	5	Replaced – Managed
			3.4.4	5	Replaced – Managed
		Seasonal horticulture	3.5.0	5	Replaced – Managed
			3.5.3	5	Replaced – Managed
			3.5.4	5	Replaced – Managed
		Land in Transition	3.6.1	5	Replaced – Managed
			3.6.2	5	Replaced – Managed
			3.6.3	5	Replaced – Managed

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
			3.6.4	5	Replaced – Managed
	Irrigated Agriculture and Plantations	Irrigated plantation forestry	4.1.0	5	Replaced – Managed
			4.1.1	5	Replaced – Managed
			4.1.2	5	Replaced – Managed
		Irrigated modified pastures	4.2.0	5	Replaced – Managed
		Irrigated cropping	4.3.0	5	Replaced – Managed
			4.3.1	5	Replaced – Managed
			4.3.2	5	Replaced – Managed
			4.3.3	5	Replaced – Managed
			4.3.6	5	Replaced – Managed
			4.3.8	5	Replaced – Managed
		Irrigated perennial horticulture	4.4.0	5	Replaced – Managed
			4.4.1	5	Replaced – Managed
			4.4.2	5	Replaced – Managed
			4.4.3	5	Replaced – Managed
			4.4.4	5	Replaced – Managed
			4.4.7	5	Replaced – Managed
		Irrigated seasonal horticulture	4.5.3	5	Replaced – Managed
			4.5.4	5	Replaced – Managed
		Irrigated land in transition	4.6.2	5	Replaced – Managed
	Intensive Uses	Intensive Uses	5.0.0	6	Removed
		Intensive horticulture	5.1.0	6	Removed
			5.1.1	6	Removed
		Intensive animal production	5.2.0	6	Removed
			5.2.1	6	Removed
			5.2.2	6	Removed
			5.2.3	6	Removed
			5.2.4	6	Removed

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
			5.2.5	6	Removed
			5.2.6	6	Removed
		Manufacturing and industrial	5.3.0	6	Removed
		Residential	5.4.0	6	Removed
			5.4.1	6	Removed
			5.4.2	6	Removed
			5.4.3	6	Removed
		Services	5.5.0	6	Removed
			5.5.1	6	Removed
			5.5.2	6	Removed
			5.5.3	6	Removed
			5.5.4	6	Removed
			5.5.5	6	Removed
		Utilities	5.6.0	6	Removed
			5.6.1	6	Removed
		Transport and communication	5.7.0	6	Removed
			5.7.1	6	Removed
			5.7.2	6	Removed
			5.7.3	6	Removed
		Mining	5.8.0	6	Removed
			5.8.1	6	Removed
			5.8.2	6	Removed
			5.8.3	6	Removed
		Waste treatment and disposal	5.9.0	6	Removed
			5.9.1	6	Removed
			5.9.2	6	Removed
			5.9.5	6	Removed
	Water	Lake	6.1.0	0	Naturally Bare
		Reservoir or dam	6.2.0	6	Removed
			6.2.1	6	Removed
			6.2.3	6	Removed

Vegetation Extent	ALUM Primary	ALUM Major Category	ALUM Code	VAST Code	VAST State
			6.2.4	6	Removed
		River	6.3.0	0	Naturally Bare
			6.3.3	0	Naturally Bare
		Channel/aqueduct	6.4.0	6	Removed
			6.4.1	6	Removed
			6.4.2	6	Removed
		Marsh/wetland	6.5.0	0	Naturally Bare
		Estuary/coastal waters	6.6.0	0	Naturally Bare
	Unknown	Unknown	9.9.9	9	Unknown

www.environment.nsw.gov.au