The Vegetation Communities of Yanga National Park and the Lowbigee floodplain 2008

Rivers Environmental Restoration Program
2010

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Australian Government
Water for the Future

NSW GOVERNMENT
Environment, Climate Change & Water

Citation
This report can be cited as follows:

Bowen, S and Simpson, S. L. (2010) The Vegetation Communities of Yanga National Park and the Lowbidgee floodplain 2008: Report to the NSW Rivers Environmental Restoration Program. NSW Department of Environment Climate Change and Water: Sydney

Acknowledgements

Funding for this project was provided by the NSW Rivers Environmental Restoration Program, which was jointly funded by the NSW Government and the Australian Government's Water for the Future-Water Smart Australia program. The Program is delivered in partnership by the Department of Environment, Climate Change and Water, the NSW Office of Water, Industry and Investment NSW.

The authors would like to acknowledge the assistance of the Managers of Yanga National Park particularly; Ross McDonald, Narelle Jones and Paul Childs Various other people from the DECCW, Steve Cox, John Benson, Peter Bowen, Chris Togher, (DECCW), provided advice and comment. Jennifer Spencer, Rich Allman, Rob McCosker, Darren Shelley and Kylie Bollard assisted in the field.

Cover photographs: (clockwise L to R):
River red gum with spike-rush understorey Shaw's Swamp (S. Bowen 2009), Murrumbidgee River at Redbank Weir (S. Bowen 2009), Scalded red sand lunette with Blue Bush and Dillon Bush (R. McCosker 2008) Poor condition river red gums Tala Lake (R. McCosker 2008).

CONTENTS

EXECUTIVE SUMMARY

This research, a science project supported under Subprogram II of the NSW Rivers Environmental Restoration Program, outlines the extent and condition of the vegetation communities of the Lowbidgee Floodplain including Yanga National Park in 2008, and makes recommendations for adaptive monitoring of the response of vegetation communities to restoration management actions. This study mapped the current (2008) extent and condition of the vegetation communities of 222, 277 ha of the Lowbidgee Floodplain including; the Redbank System (Yanga National Park) north of Balranald, and the Nimmie Caira (Lowbidgee) Floodplain between Yanga National Park and Maude in South Western NSW. The floodplain and wetland communities that occur on the Lower Murrumbidgee (Lowbidgee) Floodplain have been in severe decline over their range since European settlement and this decline has accelerated in the last 30 years due to land clearing and altered hydrological regimes. The vegetation communities of these floodplains are highly fragmented and poorly conserved in NSW (Benson 1999). All remaining wetland and floodplain vegetation in the Lowbidgee Floodplain is of conservation significance and is important for the maintenance and restoration of the ecological health of this unique inland floodplain wetland complex.

Yanga National Park forms the western boundary of the Lowbidgee floodplain and contains significant contains areas of amphibious and floodplain wetland along the banks of the Murrumbidgee River. The 69,000 ha area of the National Park contains 20,000 ha of red gum forest and woodland. Prior to purchase by the NSW government in 2005 and gazettal under the NPW Act, Yanga National Park was a privately owned property “Yanga Station” managed for grazing, cropping and timber production. Many areas of River red gum woodlands in poor condition in 2008 were areas that had been formerly managed for timber production by artificially inundating higher ground using levee banks. This study found that in 2008 only 15 per cent of these river red gum communities were in good condition. Of the remaining 85 per cent, 11 per cent were in intermediate condition, 25 per cent are in intermediate/poor (declining) condition and 49 per cent of the river red gum communities were in poor condition.

1. Introduction

Funding for this project provided by the NSW Rivers Environmental Restoration Program, which aimed to restore the health of five iconic floodplain wetlands in the Murray-Darling Basin, including the Lower Murrumbidgee wetlands, Lachlan wetlands, Gwydir wetlands, Narran Lakes and Macquarie Marshes

1.1. Project Objectives

To identify the extent of all vegetation communities of the Lowbidgee floodplain including Yanga National Park (and Yanga Nature Reserve and Yanga State Conservation area) in 2008, and assess and map the canopy condition of river red gum communities in Yanga National Park.

The objectives of this study are:

- To create maps of the distribution of vegetation communities in Yanga National Park in 2008 using high resolution digital visual imagery captured under the LiDAR program.
- To define the condition of key vegetation communities.
- To establish a series of vegetation plots within key vegetation communities for more detailed floristic survey and as a benchmark for trend analysis.

1.2. Products

- a map of the extent of the vegetation communities of Yanga National Park (Bowen and Simpson 2010b) (see map 1) in 2008 – this is held in the DECCW vegetation information system (VIS)
- a map of the extent of the vegetation communities of the Lowbidgee floodplain Bowen and Simpson 2010c (see map 2), including Yanga National Park, in 2008 – this is held in the DECCW Vegetation Information System (VIS)
- benchmarking sites for baseline condition of the vegetation communities of the Lowbidgee floodplain (including Yanga National Park) in 2008 – this is held in the DECCW Vegetation Information System (Survey) (Formerly the YETI Database).

1.3. The Study area

The Lowbidgee floodplain is an area of 300,000 ha with anastomosing creeks, lakes and wetland complexes situated on the lower reaches of the Murrumbidgee River between the towns of Maude and Balranald. This study mapped the vegetation of 222 277 ha of the Lowbidgee floodplain a complex system of interconnected creeks flowing east to west (Kingsford and Thomas 2004). The Lowbidgee floodplain lies at the lowest part of the Murrumbidgee River catchment and mean rainfall is 320 mm $year^{-1}$ at Balranald (Scott 1992). The floodplain relies almost entirely on flows from the Murrumbidgee River.

Yanga National Park forms the western portion of the Lowbidgee Floodplain (Figure 1). Yanga National Park, (including) Yanga Nature Reserve and State Conservation Area) was gazetted under the National Parks and Wildlife Act (1974) in 2007. Yanga National Park is an inland floodplain wetland and dryland floodplain complex covering an area of 69,708 ha, located 20km north-west of Balranald in south-western NSW. Before gazettal of the National Park under the NSW National Parks and Wildlife Act (1974) these lands were part of a privately owned property called Yanga Station, managed for grazing, cropping and timber production (DEC 2005). Yanga National

Park contains approximately 34,200ha of riverine floodplains and includes representative vegetation communities of the Riverina Bioregion including; 20,000 ha of river red gum (*Eucalyptus camaldulensis*) woodlands and forests, amphibious wetlands dominated by spike rush (*Eleocharis* spp.), Black box (*Eucalyptus largiflorens*) woodlands and dryland shrubland (including saltbush *Atriplex* spp.) nitre goosefoot (*Chenopodium nitrariaceum*) and woodland communities, including weeping myall open woodlands (listed as an Endangered Ecological Community under both the Threatened Species Conservation Act 1995 and the commonwealth Environmental Protection of Biodiversity Act), and native grasslands. There are also semi-permanent open water lakes greater than 50 ha, including Piggery, Tala and Yanga Lakes.

The study area is within the Murrumbidgee and Lachlan Catchment Management Area in the Riverina IBRA bioregion Thackway & Creswell 1995), and is within the South West Plains Botanical Division.

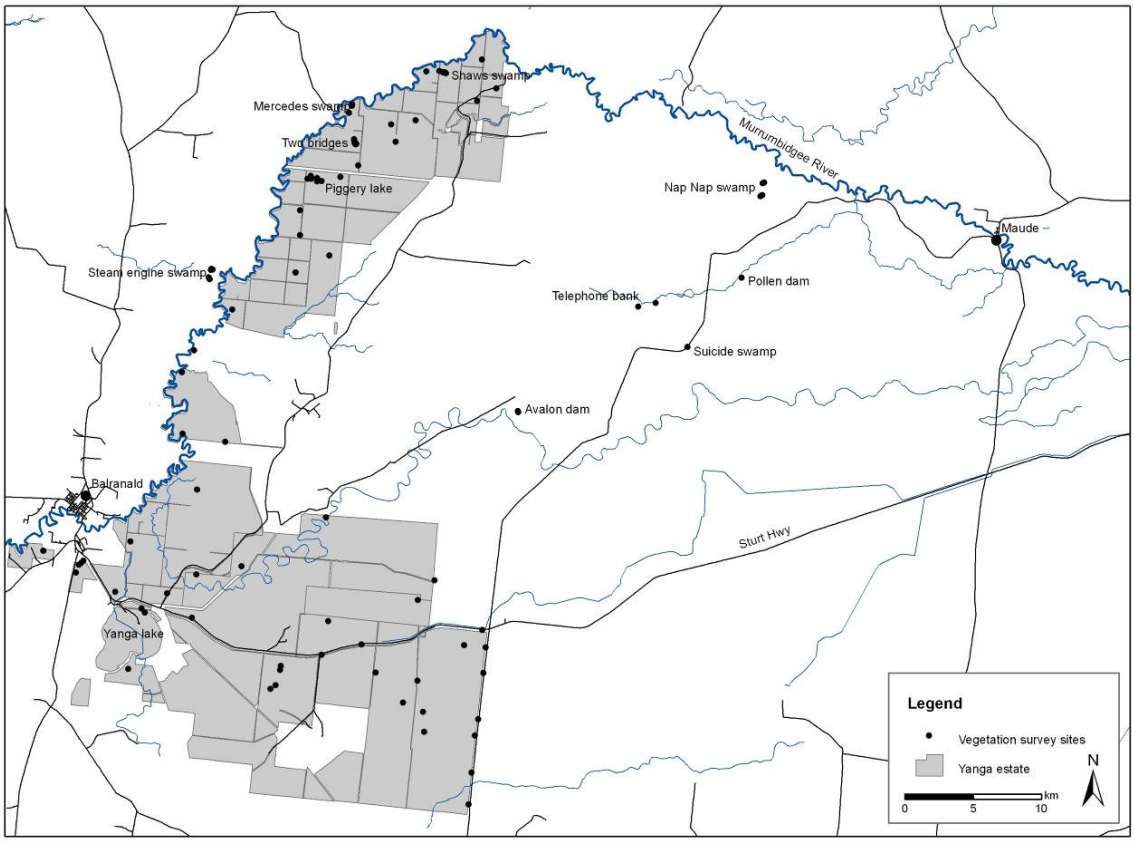


Figure 1. Yanga National Park and the Lowbidgee Floodplain.

2. METHODS

2.1 Digital vegetation mapping

A map of the extent of the vegetation communities in 2005 of Yanga National Park, was mapped for the NSW Department of Climate Change and Water as part of RERP from digitised contact prints of aerial photography flown in 2004/05 (McCosker 2008).

In 2010, the 2005 digital mapping boundaries were overlain on high-resolution digital aerial photography captured in 2008 as part of the LiDAR project (resolution 30 cm). The 2008 mapping followed the standards outlined in the DECCW Native vegetation interim type standard (Sivertsen 2009). All survey sites were geo referenced allowing floristics and community structure to be queried when amending vegetation community boundaries and interpreting vegetation community signatures on screen. Vegetation mapping units described by McCosker 2005 have been aligned with the Plant community Types described by the NSW Vegetation Classification and Assessment Database (Benson 2009)and these communities were compared with the Vegetation Map Units in the Native Vegetation Mapping Program Vegetation Map report series :Abridged version No. 2, (DNR 2002).

2.2 Targeted quantitative vegetation survey

Targeted quantitative field floristic surveys were undertaken during April and November 2009. Ninety three (93) sites were selected to sample all vegetation community types. Vegetation community types were based on the vegetation classification of NSW system of Benson et al (2006) Benson (2008) and the Vegetation formations of Keith (2004).

Information collected in the field included all species in each structural component of the vegetation (over-storey, mid-storey and ground cover), species cover and abundance for all vascular species recorded within a 20X20 metre square plot; location, physiography and habitat values for fauna including; presence of tree hollows, soil cracks and waterbodies were also recorded. Data was collected with reference to the DECCW Native vegetation interim type standard (Sivertsen 2009) and the methodologies outlined in Hnatiuk *et al* (2009).

2.3 River red gum health canopy condition mapping (Yanga National Park)

Decline in the heath and condition of river red gum communities is widespread throughout the Murray Darling Basin, (Chesterfield 1986; MDBC 2003, 2005; Cunningham *et al*. 2006; Cunningham *et al.* 2007). In many areas where the size and extent of periodic flooding has become severely reduced, the long term sustainability of inland riverine forests (including river red gum forests and woodland) is threatened as frequency of flooding determines the of regeneration from seed and ultimately the distribution of these communities (Keith 2004).

To manage and monitor of river red gum communities, for example; to target delivery of environmental flows or carry out forest management activities, it is important to both assess tree condition classes and to and define the spatial distribution of the condition classes within these vegetation communities. To define tree health parameters and assign condition classes to river red gum communities a number of researchers used a set of field collected tree health measures to define and model tree health 'condition classes' for management purposes (Cunningham et. al, 2007; Roberts 2007; Horner *et al.* 2009). These field measures of tree health have been used to assess time series changes in condition (MDBC 2003; MDBC 2005) or to model the condition classes, or spatial distribution of condition classes in the landscape with environmental parameters (Bacon *et al.*1993; Bacon 1994, 1996; DLWC 2000; Robertson *et al* 2000,). Others have used a combination of tree health measures to interpret the signatures from generated from satellite

imagery to model spatial distribution of condition classes using environmental parameters (Cunningham *et al*. 2006; Cunningham *et al* 2009). With the advent of high resolution digital aerial photography researchers have also used aerial photo interpretation (API) of tree canopy health measures (canopy cover, foliage cover, and canopy density) to map the spatial distribution of condition classes (McCosker 2008; Armstrong *et al*. 2009; Blackwood 2009).

For this study we used the approach of Blackwood (2009) and Armstrong *et al*. (2009) of assessing tree canopy condition from API of tree canopy density and tree health visible on high resolution aerial photography. River red gum canopy condition mapping was undertaken by overlaying the 2008 vegetation map on high-resolution digital aerial photography (LiDAR digital aerial photography resolution 30 cm) on screen in AcGIS 9.3. For each polygon of the 2008 vegetation map with river red gum as the dominant canopy species, the degree of denuding of boughs and limbs assessed and referenced against standard reference "benchmark" sites. Canopy condition classes were assigned on similarities in canopy cover, texture and colour to polygons containing benchmarking plots, and through the quantitative assessment of the percentage of dead or extremely stressed trees within squares of 100x100m (1ha) with the northeast corner on randomly generated points in each polygon. Measures of diameter at breast height (130 cm, dbh), per cent canopy cover and stem density collected at "benchmark" sites in river red gum communities during DECCW field survey and data supplied by the Tree health and population structure survey (R. Thomas field data 2009) were used to calibrate measurements from API assessment of tree health and canopy condition. Tree health measures collected at benchmarking sites included; tree height, diameter at breast height (dbh), projected canopy cover, number of dead trees and percentage dead canopy. The previous mapping of crown condition undertaken of the 2005 digitised aerial photography by McCosker (2008) was referred to. The polygons of the 2008 vegetation map were assigned to one of four condition classes based on the number of dead or extremely stressed trees at the points within each polygon:

good:	0-10 per cent,
intermediate:	11-40 per cent,
intermediate/poor (declining):	41-80 per cent and,
poor:	81-100 per cent.

2.4 River red gum stem density classifications

Tree stem density analysis was undertaken using high-resolution digital aerial photography flown LiDAR digital aerial photography (resolution 30 cm) (Fugro spatial solutions Pty Ltd). The quantitative assessment of the tree density was undertaken by counting the number of trees on screen within $100m^2$ (1 ha) squares, placed with the north east corner centred on randomly generated points in each polygon mapped as a river red gum community. The mean for each polygon was then used to give the number of stems ha^{-1} for that polygon.

Measures of diameter at breast height (130 cm, dbh), per cent canopy cover and stem density collected at "benchmark" sites in river red gum communities during DECCW field survey and data supplied by the Tree health and population structure survey (R. Thomas field data 2009) were used to calibrate measurements from API assessment of tree density. Resolution of the digital aerial photography did not allow the counting of stems from the imagery where stem density was greater than 800 stems ha^{-1}. Tree density classes for each polygon where stem density was greater than 800 stems ha^{-1} was assigned on similarities in canopy cover, texture and colour to polygons containing benchmarking plots where stem densities were measured on ground to be < 800.The polygons were classified into one of four stem density classes:

$^{<}$200 stems ha^{-1}

200 - 399 stems ha^{-1}

400 -800 stems ha^{-1}, and;

>800 stems ha^{-1}

3. RESULTS

3.1 Vegetation Communities in 2008

Vegetation communities of the Lowbidgee floodplain are determined by the frequency and duration of flooding, distribution of soil types and topography. They include non-woody amphibious (semi-permanent) wetland, flood dependant communities (flood dependant shrubland, forest and woodland), and dryland floodplain communities. In this study these "hydro-ecological functional groups" are described in terms of their constituent dominant species' response to flooding (Cassanova and Brock 2000), and are consistent with the definition of a wetland in the NSW Wetlands Policy DECCW (2010). These are:

Flood dependent vegetation communities are vegetation communities that occur on floodplains, in which the dominant species depend on (moist conditions) flooding for part or all of their life cycle.

Non-woody (Amphibious) wetland – (also described as "semi-permanent wetland"), are those communities that depend on frequent flooding (once per year), to maintain their structural integrity and community condition. Non-woody (Amphibious) wetland communities occur on heavy clay soils in channels or depressions subject to frequent inundation.

Flood dependant communities; (woody wetlands flood dependent woodlands and forest)- are those communities that depend on flooding for the dominant overstorey species to complete their lifecycle e.g.; river red gum (*Eucalyptus camaldulensis*) forest and woodland, river cooba (*Acacia stenophylla*) shrubland, lignum (*Muehlenbeckia florulenta*) shrubland and black box (*E. largiflorens*) woodland.

Non-flood dependent communities – vegetation communities that occur on floodplains, in which the dominant species do not depend on flooding to complete their life cycle and which occur on higher ground in the floodplain or on old floodplains and are flooded rarely. These are called Dryland floodplain communities. Dryland "floodplain" vegetation communities include very infrequently flooded communities of the Lowbidgee floodplain and communities on red solodic ridges such as white cypress pine (*Callitris glaucop*hylla) woodlands, Boree (*Acacia pendula*) woodlands, belah (*Casuarina cristata*) and bulloak (*C. pauper*) woodlands and various chenopod shrublands and native grasslands on higher ground. Although these communities are not dependent on flooding they are important assets in the floodplain and some such as belah and grasslands provide important feeding and nesting habitat for flood dependent fauna. They are also important for floodplain hydrological processes such as ground water recharge.

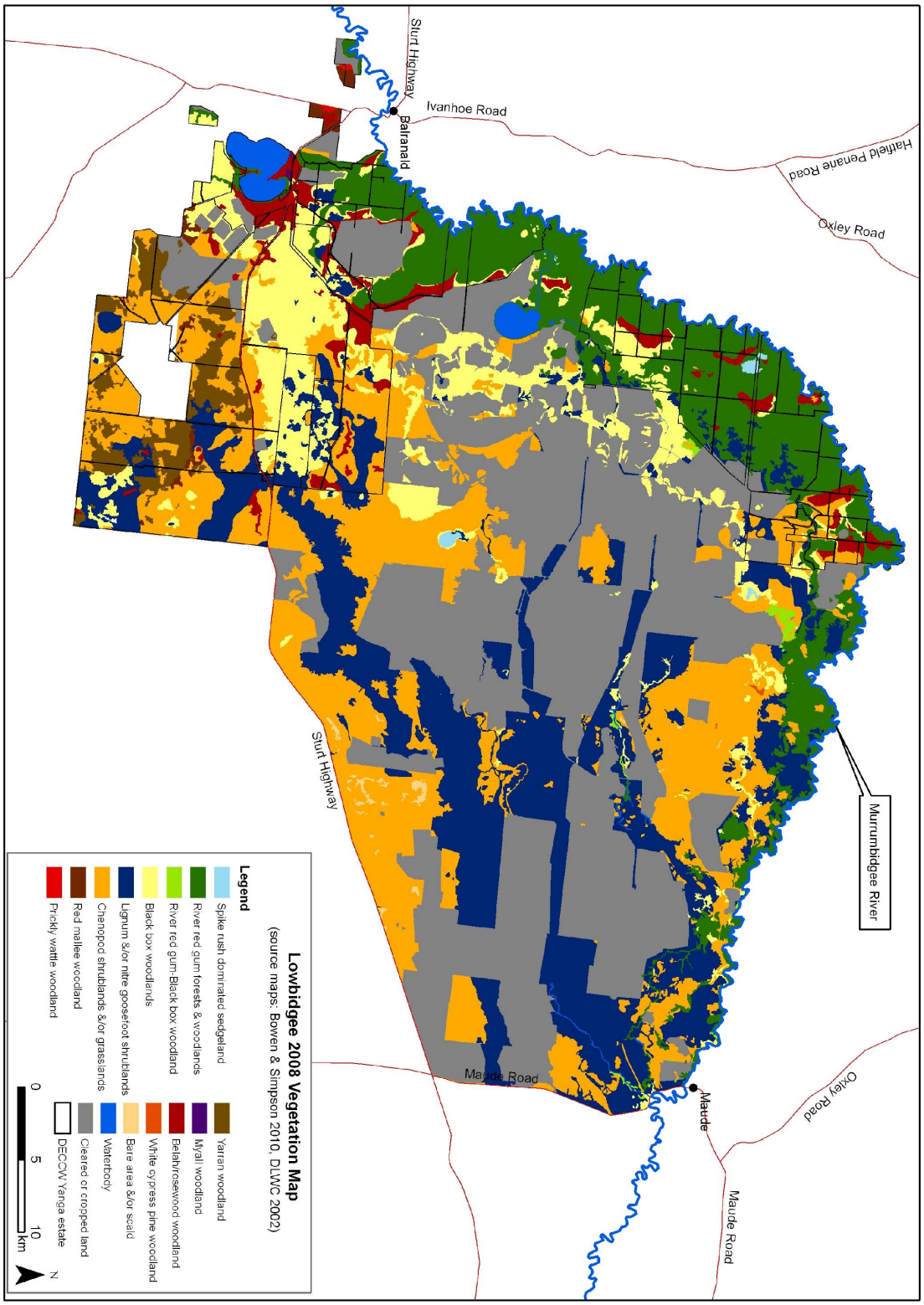
These hydro-ecological functional vegetation groups (Table 1) contain a number of vegetation communities listed in the NSW Vegetation Classification and Assessment Database (Benson et. al. 2006, Benson 2008) The vegetation communities mapped in the Lowbidgee (including Yanga National Park) are in Table 2 and Appendix 1. The maps of the vegetation communities of the Lowbidgee is at Figure 2 and Yanga National Park is at figure 3.

Table 1. Functional vegetation groups in the Lowbidgee (2008)

Flood dependent				Non Flood dependant	
Amphibious (Semi-permanent) wetland vegetation	Woody wetlands	River red gum communities	Flood dependent woodland	Floodplain vegetation	Developed Land
Spike rush dominated sedgelands	Lignum shrubland	River red gum grassy riparian forest	Black box woodland with lignum/nitre goosefoot/river cooba/chenopod shrub understorey	Dillon bush shrubland	Agricultural cleared land
	Lignum and nitre goosefoot shrubland	River red gum with spike rush understorey		Chenopod shrublands (old man saltbush,bladder saltbush, black bluebush, cotton bush, poverty bush, saltbush)	
	Cane grass mixed grassland/forbland	River red gum with herbaceous / chenopod understorey		Grassland (whitetop or rough spear grass)	
		River red gum with lignum/ nitre goosefoot/river cooba understorey		Yarran woodland	
				White cypress pine woodland	
				Red mallee woodland	
				Belah/rosewood woodland	

Table 2. Extent of the Vegetation communities of the Lowbidgee (Including Yanga National Park) 2008

Functional group	Vegetation community	NSW vegetation classification and assessment plant community (Benson 2008)	Yanga N P Area (in ha)	Lowbidgee Floodplain Area (in ha)	Total Area (in ha)
Flood-dependent vegetation					
Amphibious wetlands	Spikerush (*Eleocharis spp.)* dominated sedgeland	VCA ID 12 Shallow marsh of regularly flooded depressions on floodplains, largely in the semi-arid climatic zone; mainly in the Riverina and Murray–Darling Depression (MDD) bioregions	150	154	304
Shrubland wetland	Lignum (Muehlenbeckia florulenta) and nitre goosefoot (*Chenopodium nitrariaceum*) shrublands	VCA ID 17 Lignum shrubland of the semi-arid (warm) plains; mainly in the Riverina and MDD	1336	38 769	40 105
Open water	Waterbody	VCA ID 238 Permanent and semi-permanent freshwater lakes; inland slopes and plains	1980	205	2 195
Flood-dependant RRG forest and wood-land	River red gum *(Eucalyptus camaldulensis)* forests and woodlands	VCA ID 2 River red gum, sedge-dominated, very tall, open forest in frequently flooded sites along major rivers and floodplains; south-western NSW VCA ID 7 River red gum, warrego grass, herbaceous riparian, tall open forest; mainly in the Riverina VCA ID 9 River red gum, wallaby grass, tall woodland, on the outer river red gum zone; mainly in the Riverina VCA ID 11 River red gum woodland/shrubby lignum river cooba	21 307	5998	27 306
	River red gum–black box *(E camaldulensis – E. largiforens)* woodland	VCA ID 10 River red gum–black box woodland of the semi-arid zone; mainly in the Riverina and MDD	0	407	407
Flood-dependant woodland	Black box *E. largiforens* woodlands	VCA ID 13 Black box–lignum woodland of the inner floodplains in the semi-arid zone; mainly in the Riverina and MDD VCA ID 15 Black box open woodland with chenopod understorey, primarily on the outer floodplains in south-western NSW; mainly in the Riverina and MDD VCA ID 16 Black box, grassy open woodland of rarely flooded depressions in south-western NSW; mainly in the Riverina and MDD	9 346	18 365	19 299
Total			34 119	55 497	89 616
Non flood-dependent vegetation					
Floodplain vegetation	Chenopod shrublands (black bluebush (*Maireana pyramidata*), dillon bush (*Nitraria billardierei*), cottonbush (*M. aphylla*), old man saltbush (Atriplex nummularia), bladder saltbush (*A. vesicaria)*, poverty bush (*Sclerolaena divaricata*)&/or grasslands	VCA ID 153 Black bluebush, low open shrubland of the alluvial plains and sand plains; arid warm) climatic VCA ID 157 Bladder saltbush shrubland on alluvial plains; semi-arid (warm) zone, including Riverina VCA ID 159 Old man saltbush; mainly of the semi-arid (warm) zone, south-western NSW VCA 163 Dillon bush (Nitre bush) shrubland; semi-arid and arid zones VCA ID 164 Cottonbush open shrubland; semi-arid (warm) zone VCA ID 250 Derived tussock grassland; central western plains and lower slopes	13 509	33 642	47 151
	Red mallee (*Eucalyptus oleosa)* woodland	VCA ID 170 Chenopod sandplain, mallee woodland/shrubland of the arid and semi-arid (warm) zones	721	0	721
	Prickly wattle (*Acacia victoriae* woodland	VCA ID 139 Prickly wattle, tall, open shrubland of dunes and sandplains of semi-arid and arid regions	70	0	70
	Yarran (*Acacia melvillei*) woodland	VCA ID 23 Yarran, tall, open shrubland of the sandplains and plains of the semi-arid and arid zones (endangered ecological community TSC Act / EPBC Act)	4 879	0	4 879
	Weeping myall (*Acacia pendula)* open woodland	VCA ID 27 Weeping myall, open woodland; south-western slopes(critically endangered ecological community TSC Act / EPBC Act)	31	0	31
	Belah (*Casuarina cristata)* /rosewood (*Alectryon oleifolius*) woodland	VCA ID 58 Black oak–western rosewood, open woodland on deep sandy loams; mainly in the MDD	5 085	4	5 089
	White cypress pine (*Callitris glaucophylla*) woodland	VCA ID 54 Buloke–white cypress pine woodland; south-western slopes (endangered ecological community TSC Act / EPBC Actt)	0	32	32
	Bare areas and/or scalds	n/a	0	396	396
Total			24 290	34 079	58 369
Cleared or cropped land					
	Cleared or cropped land	n/a	6 049	68 243	74 292
Total			**64 458**	**157 819**	**222 277**


Sturt Highway
Ivanhoe Road
Balranald
Hatfield Penarie Road
Oxley Road
Sturt Highway
Murrumbidgee River
Maude Road
Maude
Oxley Road
Maude Road
Lowbidgee 2008 Vegetation Map
(source maps: Bowen & Simpson 2010, DLWC 2002)
Legend
Spike rush dominated sedgeland
River red gum forests & woodlands
Myall woodland
River red gum-Black box woodland
Belahrosewood woodland
Black box woodlands
White cypress pine woodland
Lignum &/or nitre goosefoot shrublands
Bare area &/or scald
Chenopod shrublands &/or grasslands
Waterbody
Red mallee woodland
Cleared or cropped land
Prickly wattle woodland
DECCW Yanga estate
Yarran woodland
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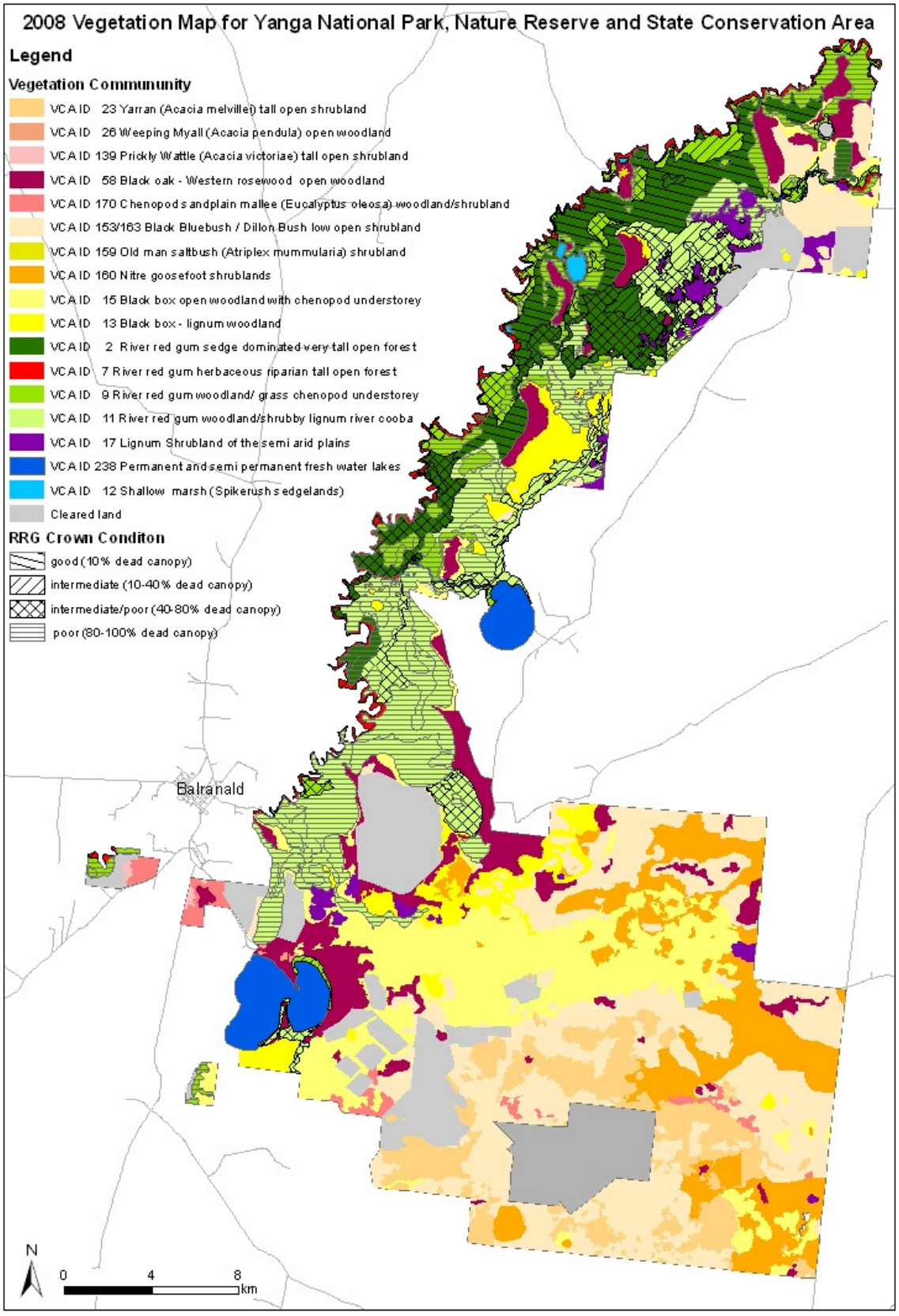

Figure 3. Vegetation communities of Yanga National Park (2008)

2.4 Yanga National Park River red gum health and condition

This study found that in 2008 the majority of the river red gum communities of Yanga National Park are in poor condition due to water stress particularly in areas of higher ground that are less frequently inundated. Researchers have found that reduced flooding in floodplains results in the replacement of aquatic species with vegetation that is less reliant on flooding (Kingsford, 1995, Bacon 1994, Blackwood 2009).

Historical time series vegetation mapping of Yanga National Park from aerial photography for each decade from 1965 to 2005 showed significant decline in the extent or change in spatial distribution of almost all the mapped river red gum communities in the period (McCosker 2008). In the period 1965 to 2005 there appeared to be a thickening of the in crown canopy in most areas of river red gum forest/woodland with grass/chenopod understorey and river red gum woodland with shrubby (lignum/river cooba) understorey, indicating that these area increased in tree density in this 40 year period. In 2005 these same areas were showing signs of stress (dead or severely defoliated trees) and may not have supported river red gum these densities prior to river regulation and water diversion (McCosker 2008).

Table 3. 2008 River Red Gum Community health

River red gum stem density	River red gum condition (areas in hectares) Total Area RRG 21 161 ha				
	Good (>10% DCC)	Intermediate (10 – 40% DCC)	Intermediate/poor (41-80% DCC)	Poor (>80% DCC)	**Total (% total)**
< 200	3 393	1 838	3 698	6 679	**15 608 (73.8%)**
200–399	10	879	778	243	**1 910 (9%)**
400–800	0	108	376	46	**530 (2.5%)**
> 800	0	0	154	2 959	**3 113 (14.7%)**
Total (% total)	**3 403 (16%)**	**2 825 (13.4%)**	**5 006 (23.6%)**	**9 927 (47%)**	**21 161**

In 2008, 47 % of the river red gum communities had poor canopy condition (>80% dead canopy) and 23.6 % were in declining condition (41-80% dead canopy) (Table 3). In total, 70.6 % of the river red gum communities in Yanga were in poor or declining condition in 2008. The results show that 14.7% of the area has a high stem density (>800 stems ha^{-1}) and 95 % of that area is in poor canopy condition. Also although 73.8% of the total area had a low stem density (<200 stems per ha^{-1}), 42.7% of that area of low stem density is in poor canopy condition

These areas are likely to be areas of the floodplain that have been managed by artificially flooding for timber production on Yanga Station in the last four decades. Some areas (14.7 %) of poor condition river red gum communities are areas of high density trees (>800 stems ha^{-1}).

4. DISCUSSION

The floodplain and wetland communities that occur on the Lower Murrumbidgee (Lowbidgee) Floodplain have been in severe decline over their range since European settlement and this decline has accelerated in the last 30 years due to land clearing and altered hydrological regimes. The vegetation communities of these floodplains are highly fragmented and poorly conserved in NSW (Benson 1999). All remaining wetland and floodplain vegetation in the Lowbidgee Floodplain is of conservation significance and is important for the maintenance and restoration of the ecological health of this unique inland floodplain wetland complex.

In order to restore and maintain the ecological health and function of the vegetation communities of the Lowbidgee floodplain, effective management of adequate environmental water is required by statutory water managers in co-operation with the managers of the Yanga National Park. Adaptive management of environmental water requires effective monitoring of the outcomes of environmental water delivery and it is vital to measure vegetation community response (changes in condition and extent) to environmental flows .

4.1 Endangered Ecological Communities

Lowbidgee floodplain supports three vegetation types that are listed as EEC's under the *Threatened Species Conservation Act 1995* such as 'Myall *Acacia pendula* Woodland', 'Sandhill Pine *Callitris glaucophylla* Woodland' and '*Acacia melvillei* Shrubland' (DECC 2005b; Benson *et al.* 2006).

4.2. Invasive Species

Lippia

Lippia (*Phyla canescens*) is an invasive species in many inland floodplain wetland systems in the Murray Darling Basin such as the the Gwydir Wetlands and the Macquarie Marshes. This study found the species in only a small percentage of the benchmarking site samples in Yanga National Park, however its extent should be monitored.

Terrestrial Weeds

The exotic terrestrial species Paterson's curse (*Echium plantagineum)* is very widespread in river red gum communities and can form the dominant species in the understorey in areas of disturbance or after short floods. White horehound (*Marrubium vulgare*) is also an exotic species prevalent in river red gum communities. African boxthorn (*Lycium ferocissimum*) is a noxious weed that forms impenetrable thickets in many areas particularly in river red gum communities. Other exoticspecies include; prickly pear (*Opuntia stricta*), cobblers peg (*Bidens pillosa*) and Noogoora burr (*Xanthium occidentale*).

5. Conclusion and Recommendations

As part of the RERP, this study has provided the following outcomes:

1. A map of the extent and a baseline condition of the vegetation communities of Yanga National Park in 2008 held in the NSW DECCW Vegetation Information System.

2. A map of the extent and a baseline condition of the vegetation communities of the Lowbidgee floodplain in 2008 held in the NSW DECCW Vegetation Information System.

3. Benchmarking sites for baseline condition of the vegetation communities of the Yanga National Park in 2008 held in the NSW DECCW Vegetation Survey Database (YETI).
4. Baseline data layer of the condition of river red gum communities of Yanga National Park.

This information is vital for the setting of restoration and management targets for key vegetation communities. These targets will largely be met though the targeted delivery of managed environmental flows by water managers in the Lowbidgee Floodplain and management actions by the mangers of Yanga National Park.

In an adaptive management framework, environmental water managers and policy makers need data on actual events as well as potential scenarios. This requires measuring vegetation community response (changes in condition and extent) to environmental flows and management regimes. Testing ecosystem response models and community resilience conceptual models using real data is also necessary. To meet these requirements, certain management actions are necessary and will be part of a vegetation monitoring strategy to be developed for the Lowbidgee including Yanga National Park:

1. The extent of vegetation communities are remapped from high resolution aerial photography every 5 -7 years to determine the changes in extent of wetland vegetation communities in response to environmental water management.

2. In addition to this benchmarking plots established in this study should be re-sampled every 5 years to determine the changes in the condition of these vegetation communities
3. Adaptive monitoring of amphibious and flood dependant vegetation community response to targeted environmental flows should be undertaken seasonally at key monitoring sites established during this study.

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Appendix 1. Vegetation Communities identified in Yanga National Park and the Lowbidgee (Nimmie Caira Floodplain) in 2008 (Bowen and Simpson 2010)

1. VCA ID -NSW Vegetation Classification and Assessment database Plant Community identification. Benson, J.S. (2008) New South Wales Vegetation Classification and Assessment: Part 2 Plant Communities of the NSW South Western Slopes Bioregion and update of NSW Western Plains plant Communities. Cunninghamia 9(3) 599- 673
2. McCosker 2005 Vegetation type – McCosker R. (2008) Yanga Vegetation Mapping: Historical Community Extent and Condition, Unpublished report to the NSW Department of Environment and Climate Change.
3. NVMP Community - NSW Department of Natural Resources (2002) Native vegetation map report series :Abridged version No. 2, Dry Lake, Gunbar, Hay, Moggumbill, One Tree and Oxley 1:100 000 Map Sheets

EEC - Endangered Ecological Community
EPBC Act - Australian Government *Environment Protection and Biodiversity Conservation Act 1999*
TSC Act - NSW *Threatened Species Conservation Act 1995*

Vegetation Ecological Functional Group / Wetland Type		NSW VCA ID Category / 2008 Vegetation Community	McCosker 2005/NVMP Vegetation type	NSW VCA Threat category/ TSC Act/ EPBC Act category
Non-Flood Dependant Vegetation	Floodplain dryland vegetation	VCA ID 27 Weeping Myall open woodland of the NSW South western slopes	Myall woodland (11) NVMP Map group 12 – Boree with a herbaceous understorey	Critically Endangered EEC TSC Act / EEC EPBC Act Weeping Myall open woodland
		VCA ID 23 Yarran tall open shrubland of the sandplains and plains of the semi arid (warm) and arid climate zones	*Acacia melvillei* woodland (7), NVMP map group 23 - Yarran	Endangered
		VCA ID 54 Buloke - White Cypress Pine woodland in the NSW South-western Slopes Bioregion	NVMP Map group 21 - White cypress pine -bulloak	Vulnerable.
		VCA ID 58 Black oak-Western rosewood open woodland on deep sandy loams mainly in the MDD	Belah/rosewood dominated woodland (6) NVMP Map group 22 – Belah tall open woodland	Near threatened
		VCA ID 153 Black blue bush low open shrubland of the alluvial plains and sand plains of the arid and semi arid zone	Scald areas with scattered blue bush/Dillon bush/grassland (5) NVMP Map group 15 –Black bluebush low open chenopod shrubland	Near threatened
		VCA ID 154 Pearl bluebush low open shrubland of the arid and semi arid plains	NVMP Map group 16 – Pearl bluebush/black bluebush low open chenopod shrubland	Near threatened
		VCA ID 156 Bladder saltbush shrubland on alluvial plains in the semi arid (warm) zone including Riverina Bioregion	NVMP map group 17 – Bladder saltbush low open chenopod shrubland	Vulnerable
		VCA ID 159 Old man saltbush mainly of the semi arid (warm) climate zone (south western NSW)	Saltbush (*Atriplex nummularia*) shrubland (10), NVMP Map group 13 – Oldman saltbush tall open chenopod shrubland	Critically endangered
		VCA 163 Dillon bush (Nitre bush) shrubland of the semi arid and arid zone	Dillon bush dominated shrubland (4), NVMP Map group 14 – Dillon bush tall open chenopod shrubland	Least concern
		VCA ID 164 Cotton bush open shrubland of the semi arid (warm) zone	NVMP Map Group 18 – Cottonbush low open chenopd shrubland	Least concern
		Not in NSW VCA Invasive chenopod shrubland (?)	NVMP Map group 19 – Poverty bush low open chenopod shrubland	n/a
		VCA ID 250 Derived tussock grassland of the central western plains and lower slopes of NSW	NVMP Map group 20- White top (rough spear grass) low open grassland	Least Concern

Appendix 1. (Cont.)

Vegetation Ecological Functional Group/Wetland type		NSW VCA ID Category / 2008 Vegetation Community	McCosker 2005 Vegetation type/NVMP Community type	NSW VCA Threat category
Flood dependant vegetation	Flood dependant vegetation (RRG Forest and woodland)	VCA ID 2 River red gum sedge dominated very tall open forest in frequently flooded sites along major rivers and floodplains in south western NSW.	RRG forest tall gallery forest (1a), RRG forest with spike rush ground cover (1b) NVMP map Group 2 – RRG very tall open forest with a an understorey of rushes and reeds	Near threatened
		VCA ID 7 River red gum Warrego grass herbaceous riparian tall open forest mainly in the Riverina bioregion	RRG forest with grass/chenopod shrub groundcover (1c) NVMP map Group 1 - RRG very tall open forest with a herbaceous understorey	Near threatened
		VCA ID 9 River red gum wallaby grass tall woodland on the outer river red gum zone mainly in the Riverina bioregion	RRG forest with grass/chenopod shrub groundcover (1c), NVMP map Group -	Vulnerable
		VCA ID 10 River red gum – black box woodland of the semi arid (warm) climatic zone (mainly Riverina and MDD)	RRG forest with shrubby (lignum/river cooba) understorey (1d), NVMP map group 3 – RRG very tall woodland with an understorey of tall shrubs and NVMP map group 5 RRG and Black box woodland	Near threatened
	Flood dependant woodland	VCA ID 13 Black box - lignum woodland of the inner floodplains in the semi arid (warm) climate zone mainly Riverina and MDD	Black box with lignum/nitre goosefoot understorey (2a) NVMP map group 4 –Black box tall woodland with an understorey of tall open shrubs	Vulnerable
		VCA ID 15 Black box open woodland with chenopod understorey mainly on the outer floodplains in south western NSW (mainly Riverina and MDD)	Black box with grass/chenopod shrub layer (2b)/ NVMP map group 4 – Black box tall woodland with an understorey of tall open shrubs	Near threatened
		VCA ID 16 Black box grassy open woodland of rarely flooded depressions in south western NSW (mainly Riverina and MDD)	Black box with grass/chenopod shrub layer (2b) no NVMP map group	Near threatened
	Flood dependant shrubland wetland	VCA ID 17 Lignum shrubland of the semi arid (warm) plains (mainly Riverina and MDD)	Lignum dominated shrubland (4a), NVMP Map group 6, 7 & 8	Vulnerable
	Amphibious wetland	VCA ID 24 Canegrass swamp tall grassland on drainage depression, lakes and pans on the inland plains	NVMP Map group	Least concern
		VCA ID 336 Rush - Sedge - Common Reed mainly lentic channel wetland of the Upper Murray and mid-Murrumbidgee River floodplains in the NSW South-western Slopes Bioregion	Included in RRG with spike rush ground cover (1b) NVMP map group 9(?)	Near threatened
		VCA ID 181 Common Reed – Bushy groundsel Amphibious tall grassland of inland river systems	NVMP Map group 9 – Phragmites and Cumbung	Least Concern
		VCA 182 Cumbungi rushland of shallow Amphibious water bodies of the inland river systems	NVMP Map group 9 – Phragmites and Cumbung	Least Concern