Government of **Western Australia**
Department of **Water**

Waterway assessment for the Yilgarn River: Hines Hill to Lake Campion

Water resource management series
Looking after all our water needs

Report no. WRM 56
March 2009

Waterway assessment for the Yilgarn River: Hines Hill to Lake Campion

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Department of Water

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Summary

Management of water resources in the Avon River basin is a high priority under the Avon Catchment Council's *Avon River basin natural resource management strategy* and investment plans. Through the Avon Rivercare Project, the Department of Water has initiated a project to investigate the riparian condition and management needs of waterways in the Avon River basin within the zone of ancient drainage. This Yilgarn River waterway assessment is the fifth in a series, following assessments on reaches of the Salt, Yilgarn and Lockhart rivers.

The Yilgarn River originates north-east of Southern Cross from Lake Seabrook and Lake Deborah and flows to the south-west past Merredin to its confluence with the Lockhart River at the Caroline Gap, south of Kellerberrin. This study has focused on the section of the Yilgarn River between Hines Hill and Lake Campion.

The purpose of this waterway assessment is to investigate the river's current condition by recording a snapshot survey of 11 remnants in the Yilgarn River floodplain, identify threatening processes and propose management recommendations for improving its condition.

The key management issues identified in the study area are

- increased salinity, higher watertable and longer periods of inundation in the valley floor
- loss of fringing riparian vegetation
- pest species degrading riparian vegetation
- stock access, resulting in soil erosion
- weed invasion
- lack of corridors linking areas of remnant vegetation
- fire risk
- rubbish dumping in floodplain areas.

Of these, the most damaging is the hydrological change (increased salinity, higher watertable and longer periods of inundation) experienced in the valley floors. Management of these processes needs to be at a catchment scale, through partnerships between landholders, all levels of government and non-government agencies.

Waterway managers including the Avon Catchment Council, Department of Water, Department of Environment and Conservation, Avon Waterways Committee, local shires and landholders will use the information gained through this waterway assessment to plan and prioritise for the future management of the Yilgarn River.

1 Introduction

1.1 Avon River basin

The Avon River is one of Western Australia's major river systems, draining approximately 120 000 km^2 from Dalwallinu in the north, Southern Cross in the north-east and Lake King in the south-east, and entering the ocean at Fremantle after a name change to the Swan River.

There are four main subcatchments within the Avon River basin including:

- The Yilgarn River catchment, which drains an area of approximately 55 900 km^2. It originates north-east of Southern Cross from Lake Seabrook and Lake Deborah and flows to the south-west past Merredin to its confluence with the Lockhart River at the Caroline Gap, south of Kellerberrin.

- The Lockhart River catchment, which drains an area of approximately 28 400 km^2. It originates around the locality of Lake Biddy, near Newdegate, and flows north-west through Kondinin, Corrigin and Bruce Rock to the Caroline Gap. The catchment also includes the Pingrup River, which originates at Chinocup Lake south of Lake Grace, and the Camm River, which originates at Lake King.

- The Mortlock River system, which drains an area of approximately 16 770 km^2. The Mortlock River system consists of the Mortlock River, Mortlock River North, Mortlock River East and Mortlock River South, and joins the Avon River at Northam.

- The Avon River, which drains an area of approximately 15 500 km^2, and includes the Salt River, Avon River South Branch, Dale River, Mackie River, Toodyay Brook, Brockman River and Wooroloo Brook catchments.

Map 1 shows the major subcatchments of the Avon River basin and the location of the Yilgarn River study area.

1.2 Managing natural resources in the Avon River basin

The Avon Catchment Council (ACC) is the peak natural resource management (NRM) body in the diverse Avon River basin. The ACC has completed the *Avon River basin natural resource management strategy* (ACC 2005) and updated the *Avon investment plan* (ACC 2006), which provide direction and identify priorities for investment into actions to bring about change in the condition of water, land, vegetation and other landscape assets.

Supporting the Avon NRM strategy, the Ballardong NRM Working Group has completed *Ballardong Noongar Budjar: 'Healthy Country – Healthy People'* (2006),

which presents the Noongar perspective on caring for Country and involving the Ballardong people in the Avon NRM region.

The Avon Natural Diversity Alliance (ANDA) was formed to facilitate the delivery of projects from the *Avon investment plan*. The Department of Water, Department of Environment and Conservation (DEC), Greening Australia Western Australia (GAWA) and WWF-Australia (WWF) are working in partnership with ACC to deliver a range of natural diversity projects.

Management of water resources, including waterways and lakes, is a high priority. Through the Avon Rivercare Project, the Department of Water has initiated a project to investigate the riparian condition and management needs of waterways in the Avon River basin within the zone of ancient drainage. To date five waterway assessments have been completed on reaches of the Salt, Yilgarn and Lockhart rivers.

1.3 Aims of the Yilgarn River waterway assessment

The main aims of the Yilgarn River study are to:

- describe the nature of the waterway and floodplain
- identify and describe areas of riparian vegetation and areas of remnant vegetation closely linked to riparian vegetation
- identify threatening processes impacting on waterway health.

The study's results will lead to an understanding of the current riparian condition of the Yilgarn River from the Hines Hill Nature Reserve to Lake Campion, with the following benefits:

- informing river managers about the current condition of the Yilgarn River to aid in decision-making processes
- providing landholders with information on best-practice management of waterways.

Waterway managers including the Department of Water, DEC, ACC, Avon Waterways Committee (AWC), landholders and local shires will use the information gained through this waterway assessment to plan and prioritise for the future management of the Yilgarn River.

1.4 Nature of the Yilgarn River study area

1.4.1 Yilgarn River study area

The Yilgarn River originates north-east of Southern Cross from Lake Seabrook and Lake Deborah, and flows south-west past Kellerberrin to the confluence with the Lockhart River at the Caroline Gap.

Map 1
Avon River basin and subcatchments

LEGEND

River network
- Major river

Road network
- Main road

Boundaries
- Avon River basin
- Catchment

Other
- Major town
- Town

N

0 40 80

Kilometres

Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum:GDA 94
Projection: MGA 94 Zone 50
Spheroid:
Australian National Spheroid

Project Information
Client: Kate Gole
Map Author: Moses Gatenjwa
Task ID: 6979
Filepath:J:\gisprojects\Project\B_Series\B4148\0004_YilgarnRiver_wwa\mxd
Filename: Map1_Avon_River_basin_and _subcatchments.mxd
Compilation date: July 2008

SOURCES

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

Towns – Landgate – August 2004
Road Centrelines – Landgate – May 2004
Roads, 1M GA – DoW – June 2004
Hydrography, Linear (hierachy) – DoW – April 2005
Hydrographic Catchments – DoW – March 2005

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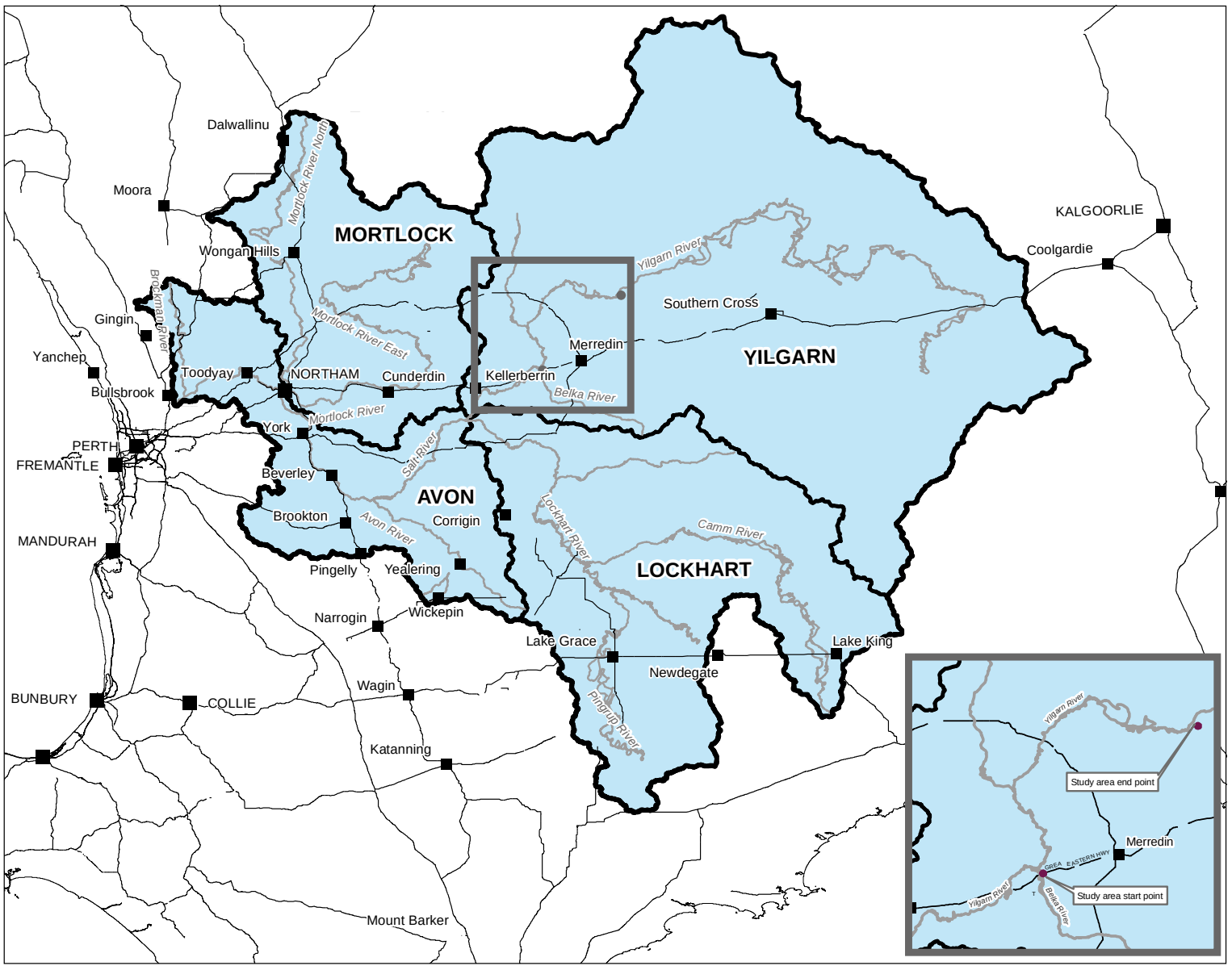

Map 2
Yilgarn River study area

LEGEND

Road network
- Highway
- Main road
- Local road

River network
- Major waterway
- Minor waterway
- Lake

Boundaries
- Yilgarn River catchment
- Nature reserve
- Local government authority

Other
- Town

N

0 4 8

Kilometres

Datum and Projection Information
Vertical Datum:
Australian Height Datum (AHD)
Horizontal Datum:
Geocentric Datum of Australia 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

Project Information
Client: Kate Gole
Map Author: Moses Gatenjwa
Task ID: 6979
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Compilation date: July 2008

SOURCES

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

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Hydrographic Catchments – DoW – March 2005
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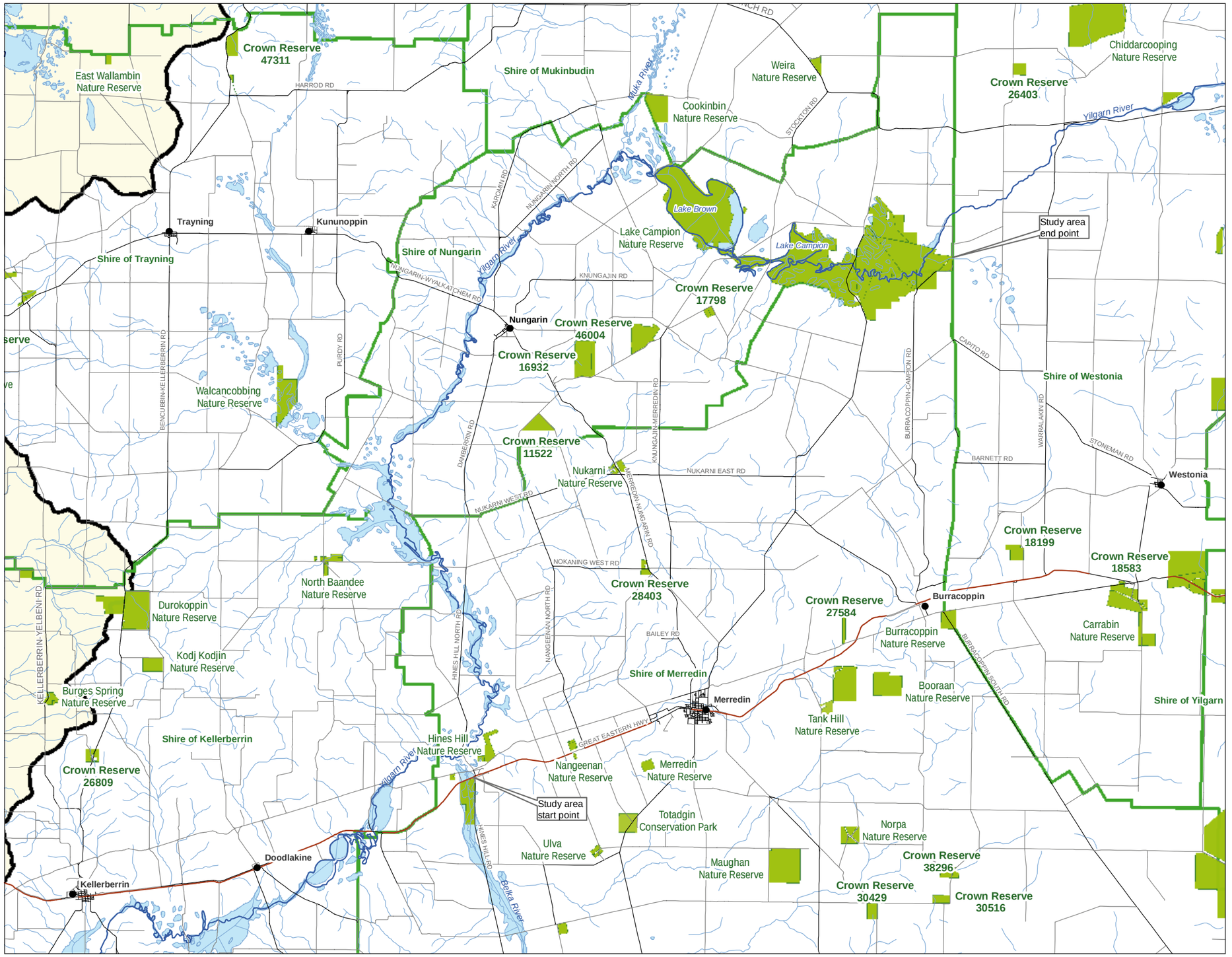

Map 3a
Yilgarn River survey site locations (YR01 to YR04)

LEGEND

- Major waterway
- Main road
- Local road
- Track
- Survey site
- Cadastre
- Local government authority

Imagery
Merredin imagery 2004
Dowerin imagery 1999

N

0 1 2
Kilometres

Datum and Projection Information
Vertical Datum:
Australian Height Datum (AHD)
Horizontal Datum:
Geocentric Datum of Australia 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

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Map Author: Moses Gatenjwa
Task ID: 6979
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SOURCES

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Road Centrelines – Landgate – May 2004
Hydrography, Linear (hierachy) – DoW – February 2004
Local Government Authorities – Landgate – July 2004
Cadastre – DoW – June 2007
Dowerin 1.4m Orthomosaic – Landgate – 1999
Merredin 50cm Orthomosaic – Landgate – 2004

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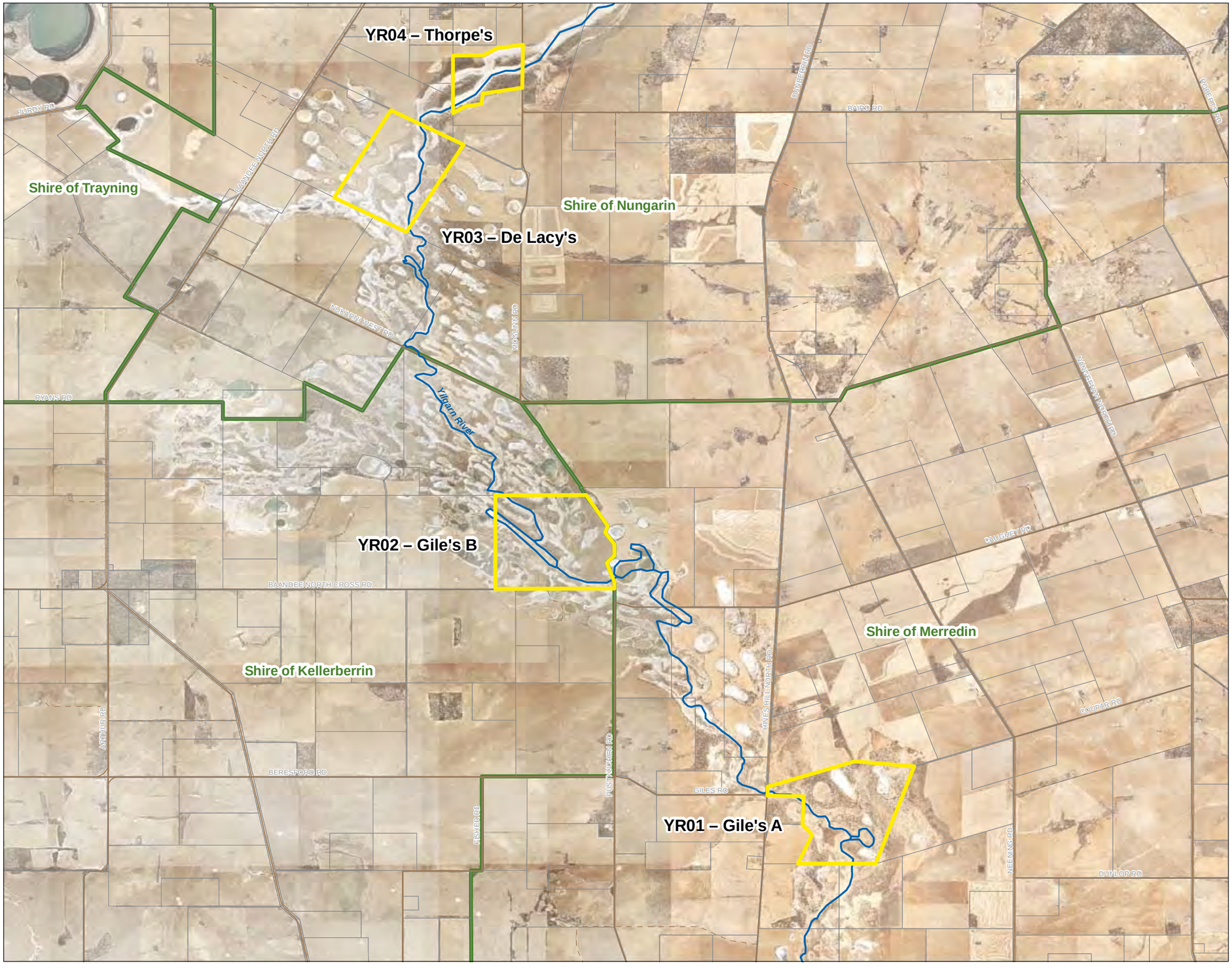

Map 3b
Yilgarn River survey site locations (YR05 to YR11)

LEGEND

Road network
- Main road
- Local road
- Track

River network
- Major waterway

Boundaries
- Survey site
- Local government authority
- Cadastre

Imagery

Merredin imagery 2004

N

0 2 4

Kilometres

Datum and Projection Information
Vertical Datum:
Australian Height Datum (AHD)
Horizontal Datum:
Geocentric Datum of Australia 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

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Map Author: Moses Gatenjwa
Task ID: 6979
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Filename: Map3b_Yilgarn_River_Surveysites_YR05_YR11.mxd
Compilation date: July 2008

SOURCES

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

Road Centrelines – Landgate – May 2004
Hydrography, Linear (hierachy) – DoW – February 2004
Local Government Authorities – Landgate – July 2004
Cadastre – DoW – June 2007
Merredin 50cm Orthomosaic – Landgate – 2004

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The study area includes the salt lakes, channels and floodplain of the Yilgarn River from Hines Hill Nature Reserve, just north of Great Eastern Highway, upstream approximately 90 km to the Lake Campion Nature Reserve.

The Department of Water has selected 11 survey sites, ranging in size from 53 ha to 3660 ha, to represent the range of riparian landscapes present on this section of the Yilgarn River.

Map 2 shows the study area's location and maps **3a** and **3b** show the survey sites.

1.4.2 Nature of the Yilgarn River landscape

Landscapes and soils

The Avon River basin forms part of the Great Plateau of Western Australia, with ancient crystalline rocks that have weathered to form deep (10–30 m) and shallow soils. The rocks are mostly granitic surrounded by gneisses, with dolerite dyke intrusions. The valleys are extensively in-filled with unconsolidated sediments.

The Yilgarn River system lies within the zone of ancient drainage. It is characterised by a very low relief landscape and sluggish drainage through salt lake systems in broad valley floors 5–8 km wide. Typically the crests and upper slopes are yellow sands, sandy earths and gravels: the original vegetation comprised diverse heaths. The lower slopes and valley floors have loamy earth and loamy duplex soils, both with calcareous subsoils. The original vegetation was salmon gum and gimlet woodland. Electrical conductivity of groundwater is about 5000 mS/m and is regularly hypersaline (greater than 6400 mS/m) and strongly acid in regional valley floors (Galloway 2004; Lantzke 1992).

A characteristic of the zone of ancient drainage is the low valley-floor gradients of less than 0.5 per cent (0.017 per cent in the salt lake chains in the Shire of Nungarin), which make drainage slow and mostly internal, with salt lake chains only joining and flowing in wetter years (Ohlsen & Murphy White 2005). However, despite the shallow gradient, the slope is reasonably uniform and is adequate for uninterrupted flow in wetter years (Beard 1999).

Broad vegetation communities

The Yilgarn River forms part of the boundary of the Mount Caroline, Muntadgin and Moorine-Rock subsystems in the Avon botanical district (Beard 1981). In these systems, the landscape is divided into residual sandplains often capped with laterite, dissected by shallow valleys, with granite rock outcrops. The proportions of each landform vary, and the density of vegetation cover decreases from south-west to north-east, however all subsystems feature mosaics of vegetation types.

Beard (1981) describes the sandplains on the uplands as having various combinations of kwongan heath and thickets, including *Acacia – Allocasuarina*

– *Melaleuca* (wattle – tamma – paperbark) thickets, *Banksia – Xylomelum* (banksia – woody pear) on sand, *Allocasuarina campestris* (tamma) or *A. acutivalvis – Acacia* spp. (black tamma – wodjil) thickets on laterite, or *Eucalyptus burracoppinensis* (mallee).

The valley floors have woodland vegetation dominated by *Eucalyptus loxophleba* (York gum or York gum mallee), *E. salmonophloia* (salmon gum), *E. salubris* (gimlet), *E. yilgarnensis* (yorrel, listed as *E. gracilis* by Beard), *E. longicornis* (red morrell) or *E. capillosa* (wandoo, listed as *E. wandoo* by Beard), and samphire vegetation associated with salt lakes and streamlines (Beard 1981).

Beard (1981) describes rock outcrops as having a mosaic of *Borya sphaerocephala* (pin grass, listed as *B. nitida*), *Allocasuarina campestris* (tamma), *Acacia lasiocalyx* (silver wattle), *Acacia acuminata* (jam), *Allocasuarina huegeliana* (rock sheoak) and *Eucalyptus loxophleba* (York gum).

Post-clearing changes to vegetation communities

This study has three sites located in the Shire of Merredin and nine sites in the Shire of Nungarin.

Clearing has been extensive in both of these shires, with only 11.8 per cent of pre-European vegetation remaining in the Merredin shire and 15.2 per cent remaining in the Nungarin shire. The average percentage within the Avon River basin is 13.5 per cent (Shepherd, Beeston & Hopkins 2002).

Further degradation of the existing vegetation has occurred since clearing, mainly as a result of grazing or hydrological change.

Although the Yilgarn River is naturally saline, clearing has led to a rise in the watertable, more periods of inundation and an increase in salinity. The naturally salt-tolerant native vegetation has struggled to adapt to these changes, leading to a decline in vegetation condition and plant death in some areas.

1.4.3 Hydrology and water quality

Salinity affects approximately 1.8 per cent of the upper Yilgarn catchment (north and east of Burran Rock), which includes the shires of Nungarin, Mukinbudin and Westonia, and parts of the Merredin, Trayning, Mt Marshall and Yilgarn shires. The area potentially at risk of rising groundwater is estimated at 27 per cent (Ohlsen & Murphy White 2005).

The lower Yilgarn catchment, which is south of Burran Rock and covers parts of the shires of Mt Marshall, Trayning, Kellerberrin, Nungarin, Narambeen and Merredin, has 3.8 per cent of its catchment area affected by salinity, with 20 per cent of the area potentially threatened by rising groundwater. Salinity is expected to increase in low-lying areas adjacent to existing saline areas (Cummins 2004).

Very little gradient exists in the Yilgarn River. Beard (1999) calculated the total fall of the 525 km-long Yilgarn River to be 200 m – a gradient of 0.38 m/km. A key feature of this grade is its interruption by large, relatively flat salt lakes (such as Lake Campion and Lake Brown), which store large volumes of water before they fill and overflow. The low gradient and high storage capacity within the floodplain means that the waterway does not flow as one linked system unless a major summer rainfall event occurs or there is a prolonged, wet winter.

The Department of Water's Northam office undertakes water quality monitoring at sites across the Avon River basin. Under the Avon River Catchment Water Quality and Nutrient Monitoring Program, fortnightly sampling is undertaken at 33 sites when the waterways are flowing and an annual snapshot sampling event is undertaken at 296 sites in September.

One of the fortnightly sampling sites is located in the Yilgarn River study area at Hines Hill North Rd. Flow was observed twice during the 2006 sampling program and once during the 2007 program. These results are summarised in Table 1. There is not enough data to indicate water quality trends but the results indicate that at the time of sampling, the water was hypersaline, had very high total suspended solids and high total nitrogen concentrations (Department of Water 2008).

Table 1 Median water quality readings for 2006 and 2007 at the Hines Hill sampling site (numbers in parentheses indicate the number of samples) (Department of Water 2008)

	2006		2007	
	Median result	**Classification**	**Median result**	**Classification**
Total nitrogen (mg/L)	3.250 (2)	Very high	4.800 (1)	Extreme
Total phosphorus (mg/L)	0.007 (2)	Low	0.029 (1)	Low
Total dissolved salts (mg/L)	41 651 (2)	Hypersaline	23 571 (1)	Highly saline
Total suspended solids (mg/L)	16.5 (2)	High	11.0 (1)	High
pH	4.2 (2)	Slightly acidic	4.4 (1)	Slightly acidic
Dissolved oxygen (mg/L)	9.7 (2)	–	9.2 (1)	–

A number of sites within the Yilgarn River study area were included in the annual Avon River basin snapshot sampling program. These results are summarised in Table 2. There is not enough data to indicate water quality trends, however, at the time of sampling, the results show that salinity at all sites was hypersaline (above 35 000 mg/L), total nitrogen ranged from moderate to extreme, total phosphorus at all sites was low and pH ranged from moderately acidic to neutral (Department of Water, undated).

Table 2 Water quality results for the 2006 and 2007 Avon River basin water quality snapshot (Department of Water, undated)

Site code	Site name	Nearest road	Sampling year	Total dissolved salts (mg/L)	Total nitrogen (mg/L)	Total phos-phorus (mg/L)	pH
YR28	Trayning north tributary	Hennessey Rd	2006	55 478	1.5	0.019	3.24
			2007	–	–	–	-
YR41	Muka River	Copeland Rd	2006	127 797	19.0	0.043	3.56
			2007	125 063	–	–	3.14
YR43A	Muka River	Bococoopin Lake	2006	110 161	3.9	0.055	3.23
			2007	65 603	–	–	3.19
YR43B	Muka River	Fence Rd	2006	59 182	5.0	0.030	3.41
			2007	67 497	–	–	2.99
YR46A	Mully Gully	Rabbit Proof Fence Rd	2006	87 217	12.0	0.033	3.38
			2007	99 921	–	–	3.20
YR47A	Yilgarn River	Chandler–Merredin Rd	2006	161 159	9.7	0.031	3.15
			2007	87 804	–	–	6.25

1.4.4 Land tenure

Most of the land in the Yilgarn River study area is freehold land and used for agriculture, however, a number of Crown reserves have been vested for conservation within or close to the floodplain (Table 3).

1.4.5 Post-clearing changes to naturally saline waterways

Naturally saline waterways still retain many natural, social, heritage and economic values. However, these are under increasing pressure from threats arising from widespread land clearing.

Changes in the water balance

Land clearing has been extensive throughout the Wheatbelt, with only 13.5 per cent of pre-European vegetation remaining. The shires that this section of the Yilgarn River pass through have a similar proportion of vegetation remaining: Merredin with 11.8 per cent and Nungarin with 15.2 per cent (Shepherd, Beeston & Hopkins 2002).

The remaining vegetation is now highly fragmented. Many of the threats facing this vegetation, including hydrological change, continue to modify these communities.

Table 3 Conservation reserves close to the floodplain in the study area and their distance and direction from each of the survey sites.

Survey site name	**Reserve name**	**Approx. distance and direction from the study site** (km)	**Reserve size** (ha)
Giles' A (YR01)	None within 10 km	–	–
Giles' B (YR02)	North Baandee Nature Reserve	8 km W	137
De Lacy's (YR03)	Walcancobbing Nature Reserve	10 km W	592
Thorpe's (YR04)	Walcancobbing Nature Reserve	10 km W	592
Herbert's (YR05)	CR16932	10 km SE	444
Jordina (YR06)	CR16932	10 km SE	444
William's (YR07)	Billyacatting Hill Nature Reserve	10 km NW	2059
Jolly's (YR08)	Cookinbin Nature Reserve	8 km NE	377
	Lake Campion Nature Reserve	9 km E	10 651
Lake Brown (Lake Campion Nature Reserve) (YR09)	Cookinbin Nature Reserve	9 km NW	377
Lake Campion Nature Reserve A (YR10)	Within a nature reserve	–	–
Lake Campion Nature Reserve B (YR11)	Within a nature reserve	–	–

Before clearing, the vegetation would have used most of the intercepted rainfall, including reserves of groundwater in summer. There was little surface runoff and it is likely that few well-defined drainage lines existed in areas that are now streams (Davis 2004; Hatton, Ruprecht & George 2003).

After clearing, the pattern of rainfall use has changed to winter use only in areas with annual crops and pastures. This has allowed runoff to increase fivefold and groundwater to recharge, filling deep sedimentary materials and bringing highly saline water to the surface (Davis 2004; Hatton, Ruprecht & George 2003).

Before clearing it is likely that salt lakes generally contained water for several months through winter and spring, although cyclonic rain occasionally filled the lakes in summer or autumn. Salinity levels would have been relatively low when the

lakes were filled and increased as the lakes dried (Halse, Ruprecht & Pinder 2003). Increased runoff and groundwater discharge as a result of land clearing now means that the lakes are wetter for longer periods.

The area potentially affected by rising groundwater, and therefore rising salinity, is greater than 20 per cent (Cummins 2004; Ohlsen & Murphy White 2005). It is predicted that groundwater equilibrium has not been reached in the lower Yilgarn catchment, with the majority of salinisation expected after 2030 and before 2075. Most additional salinisation is expected to take place in the tributary valleys that lie perpendicular to and meet in the Yilgarn River floodplain, with lateral expansion of salinity occurring because the surface water and groundwater systems are unable to deal with rainfall recharge (Cummins 2004).

Acidification

Although surface water tends to be neutral to alkaline (pH 7–8), groundwaters in the eastern Wheatbelt and other areas with abundant salt lakes can be acidic, with pH readings of less than 4.5 (Rogers & George 2005).

The causes of local groundwater acidification are poorly understood; however, it is believed that high concentrations of dissolved iron in the groundwater, which reacts with oxygen in the atmosphere and causes iron precipitates and acidic hydrogen ions, is the cause of most acidification (Fitzpatrick et al. 2005).

While there is a low risk of increasing groundwater acidification in the Carrabin subregion of the Avon River basin (McConnell et al. 2005), rising watertables increase the risk of acidic groundwater interacting with surface environments. Deep drainage and groundwater pumping can also accelerate discharge rates and the mixing of acidic groundwater and more neutral surface waters.

There are some naturally acidic lakes in the Avon Wheatbelt, but secondary acidification still poses a significant threat to biodiversity, both in aquatic and riparian ecosystems. Low pH waters can leach high concentrations of naturally-occurring heavy metals such as aluminium, cobalt, copper, zinc and lead from soils (Fitzpatrick et al. 2005), which can be transported to, and accumulate in, aquatic environments.

Impacts on fringing vegetation

Saline lakes and waterways are a natural feature of the Western Australian landscape and have led to a high diversity of salt-adapted flora and fauna.

Yet increased salinity and waterlogging, changed periods of inundation, increased nutrient loads and acidification have affected fringing and aquatic vegetation and their associated fauna.

Secondary salinisation has altered the environmental conditions of the fringing vegetation, which, before these changes, were adapted to fluctuating salinity and

water levels. Now, permanent saline groundwater close to the surface has caused a decline in vegetation health and has changed the composition of vegetation communities.

Before clearing, wetlands would have had sheoak (*Allocasuarina* and *Casuarina* species), paperbark (*Melaleuca* species) and teatree (*Leptospermum* species) forming a dense canopy over low shrubs. Many wetlands would have had beds of sedges and rushes, with some having aquatic vegetation (Sanders 1991).

Increased salinity and waterlogging have led to the death of much of the fringing vegetation, with salt and waterlogging-tolerant species colonising large areas: these would have previously been restricted to small patches. Samphire (*Halosarcia*) species have commonly replaced much of the fringing vegetation in the Wheatbelt.

Impacts on aquatic communities

Generally, the species richness of aquatic macroinvertebrate communities decreases with increasing salinity. This is not always a linear relationship, and changes in hydrology and water condition can also significantly affect these communities. Altered communities are relatively homogenous, having similar composition throughout, compared with freshwater or naturally saline wetlands (Pinder et al. 2004).

The types of aquatic vegetation present change with increasing salinity. Freshwater plants are first replaced by salt-tolerant submerged macrophytes, such as *Ruppia* and water-mat *Lepilaena* species. As salinity increases, these are replaced with phytoplankton-dominated communities, then with benthic microbial mat-dominated communities characterised by cyanobacteria (blue-green algae) and halophilic (salt tolerant) bacteria. This simplification tends to have a flow-on effect to other fauna in the food chain (Davis 2004; Strehlow et al. 2005).

2 Waterway assessment method

This waterway assessment uses a method that the Department of Water developed to evaluate the current riparian condition and management needs of waterways in the zone of ancient drainage (Department of Water 2007a).

The method of Keighery (1994) was used to assess the vegetation condition: this compares the current vegetation condition with the equivalent vegetation in pristine condition (with all structural layers intact, no impacts from threatening processes and all natural processes operating). All individual site assessments, found in **Appendix 1**, include a table of the Keighery bushland condition scores.

2.1 Site selection

Given the size of the floodplains in the zone of ancient drainage, which can be kilometres wide, the waterway assessment method relies on information collected at a number of representative sites rather than surveying the whole reach.

The Department of Water selected 11 survey sites along the Hines Hill to Lake Campion section of the Yilgarn River. These sites were selected to represent one or more of the following criteria:

- the full range of geomorphic features within the study area; for example, salt lakes, areas of braided channels and areas with more defined channels
- high environmental, social and/or cultural value, including nature reserves and lakes used for water-skiing
- vegetation communities in good or degraded condition.

Sites were selected using a number of tools, including aerial photography, cadastral information, anecdotal information and a reconnaissance survey.

The locations of the study sites are included in **Maps 3a** and **3b**. Descriptions of individual sites and their vegetation condition maps can be found in **Appendix 1**.

2.2 Recording of survey information

To ensure consistency, information for each site was recorded on a standard survey form, which is included in **Appendix 3**.

2.2.1 Floodplain features

Floodplain features define the physical nature of the waterway and give indications of habitat and potential management issues.

Natural and constructed features within the floodplain are identified, including playa lakes, channel forms, lunettes, tributaries, drains and dams. A list of definitions is included in the Glossary in **Section 4**, with illustrations of floodplain and channel forms available in Water and Rivers Commission Report No. RR17 (2002), which is available online.

2.2.2 Description of the riparian vegetation

Healthy undisturbed vegetation plays an important role in maintaining waterway health. The wide array of plant species that comprise the fringing vegetation and their accompanying animal species (including birds, mammals, reptiles, frogs and invertebrates) have significant biodiversity value. The fringing vegetation also helps provide habitat, including shade and shelter from exposed root systems, as well as food resources for aquatic ecosystems.

A comparison of the current condition and structure of riparian vegetation with its pristine state indicates how the waterway condition has changed over time. Identification of threatening processes affecting vegetation condition helps show why these changes have occurred, and how the vegetation may change in the future.

The Keighery (1994) bushland condition assessment method used for this survey, which was originally designed to assess vegetation on the Swan coastal plain and determine management priorities, was adapted for use in this area. The method does not require a high level of technical knowledge; however, the assessor's experience with a range of conditions for each vegetation type ensures a more accurate allocation of condition type and greater repeatability of the assessment.

Pre-European vegetation types

Beard vegetation associations (Beard 1980; Shepherd, Beeston & Hopkins 2002), evidence collected during the survey and anecdotes from landholders were used to gain an understanding of the original pre-European vegetation at each site. Put together, this information points to what the vegetation would have been like before clearing, and helps with assigning a vegetation condition score. As an example, a site that was once salmon gum woodland but is now a saltbush and bluebush shrubland, would indicate that the condition of the vegetation had declined significantly.

The Beard vegetation associations listed on the site survey report sheets have been mapped as the pre-European vegetation, and do not indicate that this vegetation still exists on the site.

Vegetation structure and cover

Vegetation structure is the plant form in each stratum, or layer, present in each vegetation community. Vegetation structures are combined with names of plant species to form a description of the vegetation community (vegetation association).

Crown cover is the percentage of the site that each vegetation layer would shade if the sun was directly overhead. To simplify the estimation of cover, cover classes are used rather than an actual percentage, which are then allocated a description: *closed* for 70–100 per cent vegetation cover, *open* for 30–70 per cent vegetation cover, *sparse* for 10–30 per cent vegetation cover and *very open* for 2–10 per cent vegetation cover. Vegetation with less than 2 per cent overall cover is not assessed.

A simplified version adapted from the vegetation descriptions of Muir (1977), omitting shrub height descriptions but retaining details of each stratum, are used throughout this report. Up to three dominant species are included in each stratum; however, if more than three species are dominant, the stratum is described as ‘mixed’.

For each site assessed, an overall cover of each stratum (trees, mallees, shrubs etc.) is included. This is a composite value estimated from all vegetated areas of the site, and does include a vegetation structure with an overall cover of less than 2 per cent if that structure occurs as a vegetation community. Bare areas, including lake beds, are not included in the overall cover estimate for the site.

Individual cover values for each vegetation association are included in the description for that vegetation.

Vegetation condition

Vegetation condition is assessed against an adapted version of the Keighery (1994) bushland condition scores, shown in Table 4 below. An additional category has been added to account for areas of revegetation.

Table 4 Vegetation condition scores, as adapted from Keighery (1994)

Condition	Description
Revegetation	An area of formerly cleared or otherwise degraded land that has been replanted.
Pristine	No obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affects individual species only and weeds are non-aggressive species.
Very good	Vegetation structure altered; obvious signs of disturbance.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate.
Degraded	Basic vegetation structure severely impacted by disturbance. Regeneration to good condition requires intensive management.
Completely degraded	Vegetation structure no longer intact and the area is without/almost without native species.

For each survey site, an estimated overall percentage of the vegetated areas that fall into each vegetation condition category has been calculated – with vegetation maps

also provided (see the assessments in **Appendix 1**). Note that only vegetated areas can be assessed for vegetation condition. Bare areas, such as salt lakes and stream channels, cannot be assessed for vegetation condition, unless there is evidence that vegetation once occurred there. It is therefore likely, in these salinised and silted landscapes, that the percentage of the site which is *completely degraded* is always underestimated – as it is not possible to assess aquatic vegetation that formerly existed when conditions were less saline. Cropped areas within each survey site were not assessed.

Examples of each vegetation condition are shown in **Appendix 4**.

Vegetation condition is linked to disturbance factors, which are listed for each site along with the degree of threat they pose. Common disturbance factors that lead to a decline in vegetation condition include salinity and waterlogging (which, when combined, can be described as hydrological change), clearing, weed invasion, fires, feral animals and stock access.

Presence of plant species

Plant species, both native and introduced, were also identified. This process indicated the plant species diversity at each site, and sought to identify potential species for riparian revegetation or potential management issues.

Where a plant could not be identified to species level, it was identified to the greatest level of certainty possible – such as its genus or family and then using the term ‘species’ – instead of a full dichotomous name. ‘Species’ is abbreviated to ‘sp.’ for a single species and ‘spp.’ for more than one species. Particular attention was given to identifying the dominant plants used in the vegetation description.

Extensive flora surveys were not undertaken and only common plants were listed. This gives a snapshot of species present, but not a full flora inventory.

Plant names quoted in this report are correct at the time of writing, and are sourced from the following:

- *FloraBase* (WA Herbarium & DEC 2008) for scientific names and occasional common names
- Bennett (1991) and Lefroy, Hobbs and Atkins (1991) for common names of native plants
- Hussey et al. (2007) for common names of weeds.

2.2.3 Links to protected remnant vegetation

The approximate distance and direction to protected remnant vegetation within 10 km of each site is recorded. Protected vegetation includes nature reserves and crown reserves vested for conservation purposes.

Links between remaining remnant vegetation is particularly important in a highly fragmented site like the Western Australian Wheatbelt. These links allow for the movement of fauna and flora around the landscape.

2.2.4 Aquatic vegetation

Aquatic vegetation in the Wheatbelt usually comprises salt-tolerant submerged macrophyte communities, phytoplankton communities or benthic microbial mat-dominated communities. The diversity of macroinvertebrates present is often linked to the type of aquatic vegetation present, with higher diversity often associated with submerged macrophyte communities (Davis 2004; Strehlow et al. 2005).

Where aquatic vegetation was identified as present, the type was identified if possible.

2.2.5 Water quality data

Where lake or flowing water was accessible, water quality data (pH, salinity and temperature) was collected. Data collected during the survey is a snapshot of water quality at the time of sampling and cannot be used to make comments on long-term trends.

2.2.6 Management

Information on current management activities such as fencing, revegetation and groundwater and surface water management was collected. Any issues identified as requiring management were noted.

2.2.7 Fauna species

Extensive fauna surveys were not undertaken as part of this study; however, where fauna was observed, it was noted. Fauna was observed either directly (by sight or sound) or indirectly (by the presence of scats, tracks or diggings).

Fauna observations provide a snapshot of the species present, but are unlikely to provide a comprehensive list of species. This was especially true for this study, as hot and windy conditions were experienced at the time of the survey and the birds were not moving around, making observation and identification difficult.

The identification of bird species present was the focus because they are easier to find and identify than other types of fauna, make up a major component of most ecosystems and are sensitive to many kinds of disturbance (Birds Australia 2005).

Where possible, birds were classified as remnant-dependent or priority species, based on a classification that Greening Australia Western Australia (2004) uses to indicate the importance of remnants for birds.

Fauna names used in this report are accurate at the time of writing and are taken from *FaunaBase* (Western Australian Museum 2008).

2.3 How is the information that is collected used?

In Chapter 3, the information collected during the survey is used to:

- draw conclusions about current riparian conditions
- identify issues impacting on current conditions
- make recommendations for management
- draw links with existing projects and programs in the Avon River basin that can help waterway managers to improve the condition of the Yilgarn River.

3 Main findings and management recommendations

The results for each survey site, including vegetation condition maps, are presented in **Appendix 1**. To allow easy comparison between sites, summary tables are provided in **Appendix 2**.

While it cannot be confirmed, it is generally considered that the number of samphire species present on each site may indicate the time since the area became suitable for colonisation by *Halosarcia* spp. Thus, while samphire species names were generally not identified, the number of these species on each site was estimated.

3.1 Vegetation condition

One site, YR11 (on the eastern side of Lake Campion Nature Reserve), had some areas assessed as *pristine* condition vegetation. These woodland areas showed no obvious signs of disturbance including having virtually no weeds or evidence of grazing by livestock or rabbits. The vegetation appeared to be intact, with high species diversity, a diverse age structure and no signs of disease or other stress. The *pristine* condition areas were on the lower valley slopes and raised areas of the floodplain, including the aeolian deposits supporting morrell (*Eucalyptus longicornis*) woodland.

Four sites, YR02 (Giles' B), YR05 (Herbert's), YR09 (Lake Brown) and YR11 (Lake Campion Nature Reserve B) had areas of *excellent* condition vegetation. All areas of *excellent* condition vegetation were raised from the floodplain, and were lower valley slopes, raised lunettes or an area of granite outcrop (Eaglestone Rock at Lake Brown). Most of these areas were ungrazed eucalypt woodlands, with the granite outcrop of Eaglestone Rock having a mosaic of vegetation types, including *Acacia* woodlands in the cracks and soil pockets on and around the rock.

Approximately 12.5 per cent (or one eighth) of the area surveyed had vegetation in *pristine* or *excellent* condition.

Good and *very good* condition vegetation tended to occur on the raised areas (lunettes and sandbars) within the valley floor. Higher lunettes with an elevation of over a metre tended to have vegetation in better condition than low lunettes, although this was not universal. Grazing also influenced the vegetation condition, with livestock grazing affecting soil surface condition and weed cover.

Almost half of the area surveyed (approximately 44 per cent) had vegetation in *good* or *very good* condition. *Degraded* or *completely degraded* condition vegetation occupied a similar area (approximately 43 per cent).

Most areas of low-lying floodplain vegetation were degraded, with most being samphire (*Halosarcia* spp.) dominated. Areas with sparse samphire and dead sticks – which indicate a former shrubby, probably *Melaleuca* spp. dominated vegetation – were assessed as *completely degraded*, as was vegetation that clearly had not

included samphire in its pre-European state. Dense areas of samphire, without evidence of other species previously occurring within the vegetation, or with other species among the samphire, were assessed as *degraded.* Before clearing, these areas may have already had samphire present although likely at lower densities.

Several sites had areas of abandoned farmland within the survey area. Some of these areas had been sown to saltbush and bluebush, while others had been allowed to regenerate naturally. These areas were largely devoid of trees or taller shrubs and were assessed as *degraded* or *completely degraded*.

Only 0.3 per cent of the vegetated areas consisted of revegetation. Revegetation occurred only on two sites: YR04 (Thorpe's) and YR06 (Jordina).

YR06 (Jordina) was the only site that did not have vegetation in *good* or better condition. This site consists largely of a broad floodplain, with only a small area of lower valley slope. The site is grazed, and has areas of revegetation within the uncleared area on the floodplain, and along the edges of the uncleared area on the lower valley slopes.

Sites illustrating the various vegetation conditions are displayed in **Plates A4.1–A4.6** in **Appendix 4**.

Areas without any vegetation were not assessed for vegetation condition. This included playa lakes and bare stream channels, which have undoubtedly become more degraded since clearing, but not in terms of terrestrial vegetation.

An estimate of the area of vegetation in each vegetation condition category is shown in **Figure 1** overleaf. Although this figure is an estimate (based on an estimate of the percentage of each condition category in each remnant and an estimate of the proportion of vegetated area in each remnant), it clearly shows that much of the vegetation surveyed in the study area is in *degraded* or *completely degraded* condition. In most cases, the vegetation has been assessed as *degraded* or *completely degraded* because of the loss of native species, which have either not been replaced by anything (largely bare areas formerly supporting vegetation), or have been replaced by salt-tolerant species (where they probably would not have been present or only at low densities) or weeds.

The amount of *degraded* and *completely degraded* vegetation present in the lower parts of the landscape indicates that significant changes affecting vegetation condition have occurred within the Yilgarn River system. Increases in salinity, changes to the watertable and changes to the period of inundation – all a result of widespread clearing for agriculture – are the most obvious causes of change.

Over half of the vegetation assessed is in *good* or better condition; however, with watertable rise and salinity increases expected to continue in the catchment (Cummins 2004), it can be expected that some of these areas, particularly in the valley floors, will degrade.

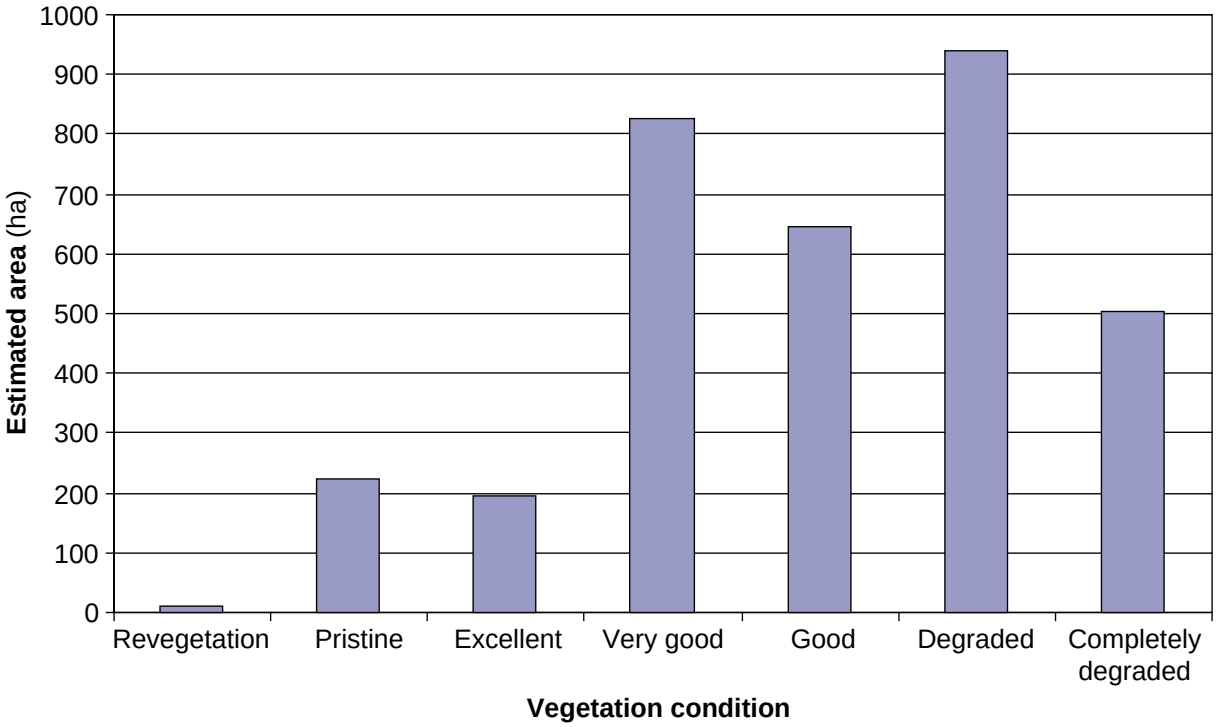

Figure 1 Estimated area of vegetation surveyed within each vegetation condition rating

Before clearing, the pre-European vegetation in these low-lying areas was mostly samphire (*Halosarcia* spp.) fringing the playa lakes and channels, often with *Melaleuca* spp. shrubland or woodland over saltbush slightly further upslope. Further upslope again were various woodlands including salmon gum (*Eucalyptus salmonophloia*), gimlet (*E. salubris*), morrell (*E. longicornis*) York gum (*E. loxophleba* subsp. *loxophleba*), or wandoo (*E. capillosa*) (Beard 1980; Shepherd, Beeston & Hopkins 2002).

Most of these vegetation types are still present, although often degraded, with many dead trees and shrubs present.

3.2 Management issues

Management issues impacting on the Yilgarn River, as identified from the site surveys, are:

- increased salinity, higher watertable and longer periods of inundation in the valley floor
- loss of fringing riparian vegetation, especially around the edges of the larger lakes
- pest species degrading riparian vegetation
- stock access, particularly causing soil erosion
- weed invasion

- lack of corridors linking areas of remnant vegetation
- fire risk
- rubbish dumping in floodplain areas.

The most challenging issues to address, and requiring the most management, are hydrological in nature (e.g. salinity, watertables, inundation).

These and other issues, together with management options and recommendations, are outlined below. Implementation of the management recommendations will be through partnerships between waterway managers including the Department of Water, DEC, ACC, AWC, landholders, local shires and community groups using a wide variety of funding sources.

Putting the management recommendations into action will have multiple benefits. For example, fencing tributaries, excluding livestock and revegetating along the Yilgarn River and its tributaries will improve bank stability, reduce sedimentation, improve water quality and contribute to biodiversity conservation by facilitating the distribution of flora and fauna through the landscape.

3.3 Salinity and waterlogging

Increasing salinity levels and waterlogging, including increased periods of inundation (hydroperiod), are the most significant threats in the Yilgarn River floodplain. These threatening processes affect the floodplain's vegetation condition, water quality, infrastructure and farm economics, and are expected to continue and get worse.

Research has shown that different approaches are required for different types of salinity impacts: there is no one-size-fits-all solution or management that is suitable for all situations.

An example of an integrated approach to managing salinity at a catchment scale is the Wallatin/O'Brien Catchment Demonstration Initiative (CDI), located in the Yilgarn River catchment near Kellerberrin. The CDI aims to demonstrate salinity management practices to recover saline land, reduce salinity risk and allow for the profitable use of saline areas. A number of projects are being implemented across the catchment including:

- investigation of groundwater yields and salinity from sand seams in the valley floor
- establishment of saltland pastures in the valley floor
- planting of deep-rooted fodder crops in recharge areas
- construction of a deep drain
- upgrading of a culvert on O'Brien Creek to reduce localised flooding and sedimentation problems

- surface water management
- revegetation of riparian zones.

The following sections give a brief overview of some options for salinity management, including engineering works and revegetation.

3.3.1 Engineering options

To reduce waterlogging and lower soil salinity, increasing numbers of land managers are considering engineering works, including deep drains, groundwater pumps and surface water management.

Opinions differ widely on the scale at which engineering options should be implemented. One point of conjecture is the eventual fate of the discharge water: some favouring containment on-farm; others advocating that significant arterial drainage networks be established for the eventual disposal of discharge into the ocean.

The Yilgarn River consists of low gradient slopes (the fall is less than 0.38 m/km), thus the risks associated with slow drainage – including salinity, rising watertables, waterlogging and surface flooding – are likely to be high in wetter years (Cummins 2004). The low gradient is likely to impose restrictions on engineering solutions to reduce the effects of salinity and waterlogging.

Notices of intent (NOI) to construct deep drains or pump groundwater are a legal requirement under the *Soil and Land Conservation Act 1945* (WA) and must be submitted to the Commissioner for Soil and Land Conservation. Recent changes to the *Environmental Protection Act 1986* (WA), which prevent environmental harm due to inappropriate disposal of drainage waters, must also be considered before construction.

The Department of Agriculture and Food (DAFWA) has developed a set of best-management-practice standards for conservation earthworks. These publications outline design criteria; suitable conditions for construction and placement; planning considerations; legal aspects; environmental aspects and operation; and maintenance and construction guidelines for various earthworks, including grade banks, grassed waterways and drains (Department of Agriculture, various).

Engineering evaluation and implementation in the Wheatbelt

The Engineering Evaluation Initiative (EEI) was a State government project to deliver better engineering approaches to managing salinity in the Wheatbelt. The main object of the EEI was to review current knowledge on engineering options to mitigate dryland salinity and clarify ‘best practice’ by establishing demonstration sites for a range of engineering options.

The EEI had three main programs:

- evaluation of specific engineering options, including groundwater pumping, siphon and relief bores, deep drains and surface water management
- safe disposal, including natural disposal sites and engineered disposal/re-use
- regional drainage planning.

Information on the EEI is available through the Department of Water website <www.water.wa.gov au>.

The Wheatbelt Drainage Evaluation (WDE) was established in 2005 as part of the National Action Plan for Salinity and Water Quality, and is due for completion in June 2009. Although the focus of the WDE is on the Yenyening and Yarra Yarra catchments, other parts of the project include a review of Wheatbelt drainage governance and management, a study of options for treatment of acidic groundwater discharge and a project to classify Wheatbelt wetlands.

The WDE project may have implications for water management in the Yilgarn catchment, especially because it is upstream from Yenyening.

Deep drainage

Deep drains collect and transport groundwater – and at times surface water – across the landscape to detention basins or into natural wetlands and waterways. They are typically used where the natural drainage system is unable to remove excess water and salt and the resultant waterlogging and salinity have a significant impact on agricultural production.

Deep drains are most effective where they are constructed to intercept the watertable, allowing groundwater to flow into the drain from the surrounding saturated soil. They are also more effective where they intercept more permeable soils (such as clay overlying permeable saprolite, sandy sediments and clays with preferred pathways such as sand seams) and where the groundwater recharge rate (the rate at which water reaches the watertable) is lower than the drainage rate (Department of Water 2007b; Leoni & Murphy White 2005).

Before constructing deep drains, it is important to consider drain design and the safe disposal of discharge waters to prevent downstream impacts on the environment, farmland, water supplies and infrastructure such as roads and bridges. If deep drains are to also conduct surface water, they must be designed to do so. Drainage works may require a Notice of Intent to Drain (NOI) from the Commissioner for Soil and Land Conservation.

Groundwater pumping

Groundwater in the Carrabin subregion of the Avon River basin is generally highly saline with salinities around 5000 mS/m; it is also regularly hypersaline (salinities

greater than 6400 mS/m). In addition, groundwater can be strongly acid in the regional valley floors (Galloway 2004).

Groundwater pumping to manage salinity aims to remove groundwater from the aquifer, maximising the drop in the watertable level while minimising the volume of groundwater that is pumped. Once the groundwater level has dropped, it stops discharging to the soil surface and into waterways and reduces the impacts of salinity and waterlogging (Department of Environment 2004).

The effectiveness of groundwater pumping in lowering the watertable depends mainly on the characteristics of the aquifer but also the number of bores installed. It is generally considered to be more effective on lighter-textured soils, where water and salts drain more quickly. Groundwater pumping can be very expensive but may be more economic than other engineering strategies in protecting high-value assets. As with the construction of deep drains, it is important to consider the safe disposal of the pumped groundwater to prevent downstream impacts (Leoni & Murphy White 2005; Department of Environment 2004). In addition, a Notice of Intent to Drain (NOI) may be required from the Commissioner for Soil and Land Conservation.

Surface water management

Surface water management uses earthworks (such as grade and interceptor banks, shallow drainage channels and dams) to capture surface runoff and subsurface flow higher in the landscape, with the aim to reduce recharge in the valley floors. Surface runoff is usually relatively fresh and can be intercepted and used to improve farm water supplies.

3.3.2 Revegetation

Revegetation can be used in a variety of ways to either intercept surface flows or use soil water reserves, thus reducing discharge. It is also used for biodiversity and conservation, as well as for agricultural and commercial reasons.

Strategic revegetation can be used to:

- reclaim hillside seeps and sandplain seeps by planting upslope, thus reducing groundwater recharge and discharge downslope
- provide linkages in the landscape between areas of remnant vegetation, which may then be used as wildlife corridors
- reduce soil erosion on stream banks, especially when combined with fencing and stock exclusion
- filter sediments and nutrients from surface flow
- provide buffers between existing vegetation and farmland, including intercepting agricultural sprays.

Biodiversity plantings

Planting local native species for biodiversity and conservation involves corridor planting to provide linkages in the landscape and to provide buffers between remnant vegetation and farmland. Many local native species are suitable for revegetation, and planting a diverse range of these – both in species and form (e.g. trees, shrubs, grasses and herbs) – provides a greater biodiversity benefit.

There are local species that are suitable for most conditions found in the catchment: a list of suggestions is found in **Appendix 5**.

Commercial plantings

Many species are suitable for commercial plantings on recharge areas in the Wheatbelt. These include *Eucalyptus* species, including oil mallee species, tagasaste (*Chamaecytisus palmensis*), *Acacia* species, *Melaleuca* species and sandalwood (*Santalum spicatum*), all of which have economic benefits either as a commercial crop for wood, brush or seed, or as fodder.

Commercial plantings in slightly saline to moderately saline discharge areas include saltland pastures, usually saltbush (*Atriplex* spp.) and bluebush (*Maireana* spp.). Understorey plants including puccinellia (*Puccinellia ciliata*), which is tolerant of waterlogging but less tolerant of salinity, and tall wheatgrass (*Thinopyrum elongatum*) are both planted to increase the nutritional value of saltland pastures.

There are some limitations associated with commercial plantings, including the potential placement of crops in terms of soil type and site conditions (including waterlogging, salinity, fertility and soil acidity). The commercial success of oil mallees depends on processing plants becoming established and currently there is only a small market for broombush fencing.

Appendix 6 contains a list of plants suitable for saltland grazing.

3.3.3 Recommendations for the management of salinity and waterlogging

Salinity and waterlogging are processes that require management at a catchment scale.

A variety of general management recommendations are proposed, which include:

- retention of surface water higher in the catchment, if suitable, to slow recharge in the valley
- revegetation along tributaries to:
  - slow movement of surface water onto the valley floor without increasing flood risk
  - trap sediment before it reaches the lower slopes

  - reduce sedimentation of the river (which impedes river flow)
- evaluation of revegetation options, including agroforestry and saltland pastures
- identification of recharge areas that are suitable for revegetation for local watertable control
- groundwater and surface water quality and quantity to continue to be monitored as part of ongoing water quality monitoring programs.

3.4 Flows being impeded by road crossings

Almost 40 per cent of sealed roads and more than 30 percent of unsealed roads in the lower Yilgarn catchment are within low-lying areas and may be susceptible to flooding, waterlogging and salinity. The annual cost of repairing and maintaining roads affected by salinity was assessed in 2003 as $20 000 per kilometre for main roads and $6 600 per kilometre for local roads (Cummins 2004).

Additional costs would apply to repairing roads washed away or damaged by flood events.

Low gradients contribute to slow streamflow through the Yilgarn River. Narrow road crossings may impede river flow and lead to ponding, exacerbating local waterlogging problems. Additionally, subsurface compaction to create a stable road base interferes with subsurface flows, which further contributes to ponding problems.

There are several road crossings within the Yilgarn River study area, and a few of these were examined for evidence of water flow being impeded. It is unlikely that any of the road crossings restrict flow during normal rainfall years; however, during flood events water flow may be impeded and result in structural damage to the roads. It is possible that ponding may occur after flood events.

3.4.1 Recommendations for the management of flood flows

Waterways in the zone of ancient drainage naturally retain water in the valley floors, including the lakes along the waterway; however, road crossings may contribute significantly to localised flooding. The recommendations proposed for flood management are to:

- evaluate road crossings in terms of flood risk
- analyse the costs and benefits associated with upgrading pipes and culverts to increase water flow through road crossings where significant flooding problems are evident.

3.5 Tributaries

Due to poor surface drainage and waterlogging, additional salinisation is expected to occur in the tributary valleys that lie perpendicular to, and converge with, the Yilgarn River floodplain (Cummins 2004).

Most tributaries observed during the field survey were well defined, with clear stream channels fringed with samphire (*Halosarcia* spp.). The wider and shallower channels showed obvious signs of sedimentation and silting, as did the main channel and side channels of the Yilgarn River.

All tributaries would benefit from revegetation using local native species and fencing from grazing. The plant roots would bind the soil and plant stems would slow the velocity of water flow into the tributary, decreasing water erosion and reducing sedimentation. Rocks or logs placed in the channel may also slow the velocity of water flow by providing a riffle effect.

3.5.1 Recommendations for tributary management

To reduce soil erosion and sedimentation, and increase the value of tributaries as landscape links, the following recommendations are proposed:

- revegetating along tributaries using local native species to provide corridors linking areas of remnant vegetation higher in the landscape with riparian areas
- fencing tributaries to avoid damage to the soil surface by livestock
- revegetating with local native species to improve bank stability and thus reducing soil erosion and sedimentation
- installing riffles, where appropriate, to reduce flow velocity and trap sediments before they reach the floodplain.

3.6 Management of remnant vegetation

The Western Australian Wheatbelt is a highly fragmented landscape, with remnant vegetation occupying only a small proportion of its previous extent. The size, shape and condition of patches of remnant vegetation vary considerably on both private and public land.

There have been significant changes in the composition of remnant vegetation since clearing, particularly in the floodplain where many species, such as *Melaleuca* and *Leptospermum*, have since disappeared and have been replaced with salt-tolerant species like *Halosarcia*. Changes in salinity and waterlogging are the main causes; however, other effects of land use change, such as grazing, may also be a factor.

Connections between remnants are very important to allow species to disperse across the landscape. In some cases linkages remain along the Yilgarn River,

although they are often degraded and narrow. However, there are few linkages higher in the landscape.

Remnant vegetation on public land vested for conservation is protected from clearing, but is not immune from degradation due to environmental conditions including salinity and waterlogging. Three of the study sites are vested for conservation and all occur in Lake Campion Nature Reserve (YR09, YR10 and YR11). Two sites include large areas of salt lake (Lake Brown in YR09 and Lake Campion in YR10). Within Lake Brown and along its edge are areas that have been excised and have a different vesting. The Brady's gypsum mine is located within the largest excised area near the eastern shores of the lake.

Pristine and *excellent* condition vegetation occurred on four sites, two of which were nature reserves. None of these sites have been grazed by livestock.

3.6.1 Recommendations for remnant vegetation management

To manage remnant vegetation and improve landscape linkages in the Yilgarn River catchment, the following recommendations are proposed:

- fence *good* or better condition vegetation to exclude livestock grazing
- strategically enhance remnant vegetation by planting tree and shrub seedlings within the remnant – if the causes of degradation have been reduced sufficiently to give the seedlings a good chance of survival, but natural regeneration has not occurred
- encourage landholders to value their remnant vegetation and suggest a suitable conservation covenant scheme for better condition vegetation
- control rabbits to allow natural regeneration of plant species, particularly if a fire is experienced in remnant vegetation
- plant additional vegetation along the edges of remnant vegetation – either mixed native species or species suitable for saltland grazing – to provide a buffer between the remnant vegetation and agricultural activities
- identify areas of private land that can be revegetated to create or enhance links between the remnant vegetation
- prevent future sand extraction
- investigate reconstruction of landscape links along public lands, such as road reserves.

3.7 Riparian vegetation

Riparian vegetation in the Yilgarn River catchment is mainly samphire (*Halosarcia* spp.); however, there are various combinations of *Eucalyptus* spp. woodlands occurring on lunettes and stream edges, and occasional areas where the previously common *Melaleuca* spp. shrublands still survive.

Revegetating floodplain areas with local native species can have a number of benefits, including:

- localised salinity control
- conservation and biodiversity benefits
- filtering and removing nutrients and sediment from surface runoff
- improved aesthetics.

Appendix 5 includes several species that are suitable for revegetation in the Yilgarn catchment; however, it is especially important to tailor selection of revegetation species in riparian areas to the current site conditions. It must be taken into account that increased salinity, waterlogging, changed periods of inundation, reduced water quality and weed cover have altered, and will continue to alter, site conditions. Time and budget constraints, including the costs of fencing and seedlings, are also factors to consider when undertaking a revegetation project.

3.7.1 Recommendations for riparian vegetation

Recommendations to enhance the condition of riparian vegetation, and to create and strengthen environmental linkages between good quality riparian areas and other remnant vegetation, are as follows:

- encourage natural regeneration and reduce soil degradation and erosion of riparian areas by using fences to exclude livestock
- investigate riparian areas suitable for revegetation with local native species
- consider strategic revegetation within riparian remnants
- fence revegetated areas to exclude livestock
- consider impacts on riparian vegetation from future gypsum or sand extraction from lunettes
- consider planting saltland grazing species adjacent to fenced riparian areas.

3.8 Fencing and stock access

Significant areas of the Yilgarn River catchment have been affected by soil degradation, with the greatest threats to the lower Yilgarn catchment (south of Burran Rock) being subsurface compaction and soil structure decline (Cummins 2004). Soil structure decline and soil acidification are the greatest threats in the upper Yilgarn catchment (Ohlsen & Murphy White 2005).

The greatest threats to the floodplain are soil structure decline and waterlogging, due to soil texture and landscape position. The other soil degradation threats (soil acidity, subsurface compaction, wind erosion and water repellence) are more likely to affect sandy or duplex soils higher in the landscape.

Wind erosion is the main form of soil movement in the wider catchment; however, valley floor soils and sloping sites, including lunettes, are also susceptible to water erosion. Fine soils, regardless of their position in the landscape, are susceptible to wind and water erosion, and subsequent deposition elsewhere in the landscape. Evidence of water erosion on lunettes was observed at several sites, as illustrated in **Plate 1** below.

Soil structure decline, wind erosion of fine soil particles and water erosion were all observed in the floodplain and are all exacerbated by livestock trampling.

Livestock grazed many of the surveyed areas for part of the year, particularly during summer and autumn, to fill the feed gap at that time. Damage to the soil surface, which leads to erosion, was observed. This compounds the soil structure decline that has resulted from increased salinity. Livestock grazing affects natural regeneration, while faeces and urine are likely to be adding to the nutrient loads in the waterways.

Plate 1 Water erosion on a lunette on the edge of a salt lake.

3.8.1 Recommendations for fencing

The following priority areas should be targeted for fencing:

- areas of good or better quality vegetation, to exclude livestock grazing and allow natural regeneration
- areas where soil degradation was observed, to exclude livestock grazing to prevent further degradation and erosion

- revegetated areas
- tributaries and lunettes associated with lakes, to exclude livestock and improve bank and dune stability.

Landholders interested in fencing the Yilgarn River floodplain or tributaries may be eligible to receive fencing materials through the Avon Fencing Project. Materials are limited. Contact the Department of Water in Northam on (08) 9690 2600 to register your interest.

3.9 Pest species

Introduced animal pest species are very common in the Wheatbelt. Rabbits (*Oryctolagus cuniculus*) were present on all sites. Signs of foxes (*Vulpes vulpes*) were commonly observed; however, foxes are likely to be present in all remnants – as are feral cats (*Felis catus*), which were not observed.

Introduced plant pests (weeds) were present on all sites with 16 species identified during the field survey. While there were no serious weeds as declared under the *Agriculture and Related Resources Protection Act 1976* (WA), there was one weed listed as high risk by the *Environmental weed strategy of Western Australia* (CALM 1999): wild turnip (*Brassica tournefortii*).

Field observations have indicated the most serious and common weeds to be slender ice-plant (*Mesembryanthemum nodiflorum*), red brome (*Bromus rubens*), false hair-grass (*Pentaschistis airoides*), silver grass (*Vulpia myuros*) and wild oat (*Avena fatua*).

Invasion of weed species is often a result of soil disturbance, and their presence can reduce natural regeneration of native species. Slender ice-plant is an indicator of a salinising landscape, and will persist in salty situations.

A list of all weed species encountered during the field survey can be found in **Appendix 7** (Table A7.2).

3.9.1 Recommendations for the management of pest species

The following recommendations for the management of pest species are proposed:

- monitor and manage rabbit and fox populations by using a co-ordinated baiting program on both private and public lands
- target local rabbit populations after any fire in remnant vegetation to allow natural regeneration
- remove weeds from an area before revegetation using appropriate soil preparation and weed control methods in the year before planting.

3.10 Flora and fauna

Approximately 133 commonly occurring native plants were identified during the field survey. While this is not a high number, it is only for commonly occurring plants and is not a complete flora list. It does not identify many genera to species level including *Halosarcia* (of which there were approximately six species) and many of the native grasses that did not have the seeds required for identification at the time of survey.

Common species included samphires (*Halosarcia* spp.), broombush (*Melaleuca hamata*), mallee lovegrass (*Eragrostis dielsii*), saltbushes (*Atriplex* spp., particularly *A. paludosa*), cottony bluebush (*Maireana carnosa*), ruby saltbush (*Enchylaena tomentosa*), rhagodia *(Rhagodia preissii*), and various wattles (*Acacia* spp., particularly wait-a-while *Acacia colletioides*), with *Eucalyptus myriadena* the most common eucalypt.

Several areas of regenerating vegetation were observed. In most cases these areas of germination could be attributed to germination after a flood or fire; however, several eucalypt tree saplings were observed with no obvious disturbance event leading to their occurrence. In all cases the sites where regeneration was observed were not grazed.

One Declared Rare species, under the *Wildlife Conservation Act 1950* (WA), was observed on four of the sites. The species, which cannot be listed or its location disclosed due to restrictions imposed by the DEC under this Act, was found in slightly raised areas within the floodplain, on stream banks and lunettes. Some of the sites were grazed. This plant is highly threatened by rising watertables and salinity, and can be trampled by livestock – although it is not likely to be grazed (DEC pers. comm.). The presence of a Declared Rare plant, which was previously unknown in this area, indicates that potentially unknown biological assets may be present in these riparian areas.

Thirty-four bird species were identified during the field survey. It should be noted that the field survey was conducted in November during a period of particularly hot weather, and in several sites very few birds were observed.

The most common birds encountered were the Australian ringneck parrot, also known as the twenty-eight parrot (*Platycercus zonarius*), crested pigeon (*Ocyphaps lophotes*), black-faced woodswallow (*Artamus cinereus*) and emu (*Dromaius novaehollandiae*) – all of which are common farmland species.

Five priority bird species – the inland thornbill (*Acanthiza apicalis*), brown goshawk (*Accipiter fasciatus*), a fairy wren species (*Malurus* sp.), crested bellbird (*Oreoica gutturalis*) and red-capped robin (*Petroica goodenovii*) – were observed. Priority birds are those that will be lost from the landscape if nothing is done to protect and enhance their habitat (GAWA 2004).

Birds listed as remnant-dependent include several thornbill species (such as the yellow-rumped thornbill *Acanthiza chrysorrhoa*), the red wattlebird (*Anthochaera carunculata*), black-faced woodswallow (*Artamus cinereus*), grey butcherbird (*Cracticus torquatus*), striated pardalote (*Pardalotus striatus*), common bronzewing (*Phaps chalcoptera*) and white-browed babbler (*Pomatostomus superciliosus).* Remnant-dependent species are those that are likely to decline in number if remnant vegetation is lost or degrades (GAWA 2004).

Birds listed as declining and resident species by Saunders and Ingram (1995) are all species of thornbills (*Acanthiza* sp.), brown goshawk (*Accipiter fasciatus*), red wattlebird (*Anthochaera carunculata*), grey butcherbird (*Cracticus torquatus*), emu (*Dromaius novaehollandiae*), Australian kestrel (*Falco cenchroides*), some fairy wrens (*Malurus* sp.), crested bellbird (*Oreoica gutturalis*), striated pardalote (*Pardalotus striatus*), hooded robin (*Petroica cucullata*), red-capped robin (*Petroica goodenovii*), common bronzewing (*Phaps chalcoptera*) and white-browed babbler (*Pomatostomus superciliosus*).

One bird, the rainbow bee-eater (*Merops ornatus*), is listed federally for special protection under the *Environment and Biodiversity Conservation Act 1999* (Cwlth) as a migratory species.

The presence of these species indicates that the remaining remnant vegetation, including riparian vegetation, is important for bird habitat.

Three native mammals were observed during the survey. They were the western grey kangaroo (*Macropus fuliginosus)* and the euro or wallaroo (*Macropus robustus*), which are described as *abundant* in Strahan (1995), and the echidna (*Tachyglossus aculeatus*), which is described as *common*. Western grey kangaroos were observed, or signs of their presence were noted, on every site.

A full list of native flora and fauna species can be found in **Appendix 7**.

3.10.1 Recommendations for flora and fauna conservation

The following recommendations for the conservation of native flora and fauna are proposed:

- preserve areas of *good* or better condition vegetation and fence from grazing, as these are likely to have the most plants and native animal species
- identify areas suitable for revegetation to provide links between areas of good quality remnant vegetation
- use local native species, including trees, understorey and groundcover plants, where possible and appropriate for revegetation
- retain fallen logs and branches within remnants to provide habitat for birds and reptiles

- avoid moving loose sheets of granite from exposed rocks as these provide habitat for reptiles
- plant buffer areas of revegetation beside remnant vegetation to protect the remnant from agricultural chemical sprays
- control weeds adjacent to, and within, patches of remnant vegetation
- eradicate pest animal species.

3.11 Fire risk

Fires originating from stubble fires or started by lightning strikes can threaten remnant vegetation. It is unlikely that samphire vegetation will burn, but woodlands and shrublands are vulnerable. Several observations of burnt areas on lunettes around salt lakes were made. In many cases there was only a small area of burnt vegetation, however in two cases a larger area had been burnt (see **Plate 2** below). None of the landholders questioned were aware of the burnt areas, indicating that the ignition location was unlikely to have been on farmland. The likely cause was lightning, possibly on white cypress pine trees, as several of these had been burnt although often the fire had not spread from an individual tree, or had not spread any significant distance (**Plate 3**).

Through the *Bush Fires Act 1954* (WA) and local government fire plans, landholders are responsible for maintaining fire breaks on their property, while DEC is responsible for fire breaks and fire access tracks on DEC-managed land.

Plate 2 Large burnt area within YR07 (William's)

Plate 3 Burnt white cypress pine. The fire had not spread far from the individual tree

3.12 Rubbish

Several areas of dumped rubbish were observed during the field survey. In most cases the dumps were of old fencing and building material which, while unsightly, did not pose an environmental hazard.

Dumping of chemicals, chemical containers, household refuse, fuels and oils or vehicles may pose a threat to the environment, especially in waterways where pollutants can be spread through the environment. An example of farm chemical containers dumped close to the Yilgarn River in one of the survey sites is shown in **Plate 4**.

Any dumped rubbish may be washed downstream during a flood event and may be hazardous if it blocks water flow; therefore dumping of any rubbish in or close to waterways should be prevented.

Plate 4 Farm chemical containers dumped close to the Yilgarn River

3.12.1 Advice for rubbish management

Under the *Litter Act 1979* (WA), dumping of rubbish on Crown lands, including road reserves, council lands and nature reserves, is illegal and can be reported to the local shire or DEC office.

Clean, rinsed, empty farm chemical containers can be disposed of through the *drumMUSTER* program. Merredin and Nungarin shire councils both participate in *drumMUSTER* and can be contacted for details.

4 Glossary

Acid(ic)	See pH.
Aeolian	Wind-blown.
Alkaline	See pH.
Alluvial	Transported by water flow processes, for example ‘alluvial plain’.
Alluvium	Sediment deposited by flowing water.
Anabranching	Anabranching rivers are characterised by a network of diverging and converging channels separated by large, long-lived islands that are inundated only by floodwaters.
Aquifer	A layer of rock or soil capable of receiving, storing and transmitting quantities of water.
Braided river / channel	A braided river is characterised by numerous, interlaced channels that divide and rejoin around unstable bars and small islands.
Catchment	An area of land that intercepts rainfall and contributes the collected water to a common point through surface water and groundwater.
Confluence	Flowing together or intermingling; for example, where a tributary joins the main river channel.
Discharge	Volumetric outflow rate of water, typically measured in cubic metres per second. Applies to both groundwater and surface water.
Discharge area or zone	Area where groundwater discharges to the surface.
Deep drain	Deep excavated channel that conveys groundwater, and sometimes surface water, from agricultural land.
Ecosystem	A biological community of interacting organisms and their physical environment.
Floodplain	A broad, flat, low-lying area of land within the valley floor that is inundated during a 100-year flood. Includes the floodfringe and floodway.

Flood – 100 year	The 100-year flood has a statistical probability of occurring, on average, once every 100 years. The 100-year flood level is the contour to which this flood will rise.
Floodfringe	The area of the floodplain, outside of the floodway, that is affected by flooding.
Floodway	The river channel and portion of the floodplain which forms the main flow path for flood waters once the main channel has overflowed.
Geomorphology	The study of the origin, characteristics and development of landforms.
Gigalitre (GL)	1 000 000 000 litres or 1 million cubic metres or 1 million kilolitres (kL).
Gilgai	An area where the land surface is irregular with alternating mounds (puffs) and depressions (hollows) and is commonly referred to as ‘crab hole’ country. Gilgai microrelief is formed due to clay horizons shrinking and swelling with alternate drying and wetting cycles.
Groundwater	Water that occupies the pores and crevices of rock or soil.
Gypsum	Hydrated calcium sulphate. Gypsum has been deposited in many saline lakes and blown into lunettes on the leeward side of the lakes. ‘Kopi’ or ‘copi’ gypsum is found in lunettes. Can be used as a soil conditioner.
Hydrology	The study of water, its properties, distribution and use, on and below the earth’s surface.
Kilolitres (kL)	1000 litres or one cubic metre.
Kilotonne (kt)	1 000 000 kilograms or 1000 tonnes.
Lunettes	Wind-blown deposits of sand and/or gypsum that form on the edge of salt lakes.
Macroinvertebrates	Aquatic invertebrates (animals without backbones) that are retained on a 0.25 mm mesh net and therefore big enough to be seen with the naked eye.
Natural resource management	The ecologically sustainable management of the land, water, air and biodiversity resources for the benefit of existing and future generations.

Nutrient load	The amount of nutrient (usually nitrogen and/or phosphorus) reaching a waterway over a given time period from its catchment area.
pH	The concentration of hydrogen ions in solution that indicates the acidity or alkalinity in water. A pH value of 7 is neutral, above 7 is alkaline and below 7 is acidic.
Playa lake	Also known as a salt lake. A shallow depression in the floodplain that intermittently fills with saline water and is generally covered with a salt crust when dry.
Recharge	Volumetric inflow rate of water to an aquifer, typically measured in cubic metres per second.
Recharge area or zone	An area through which water percolates to replenish (recharge) an aquifer. Unconfined aquifers are recharged through rainfall. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.
Remnant vegetation	An area of vegetation remaining after a major disturbance, such as land clearing.
Riparian zone	The riparian zone includes the floodplain and adjacent verge. The width of the riparian zone varies greatly, from tens of metres to kilometres, depending on the type of waterway and its catchment.
Riparian vegetation	Vegetation growing within the riparian zone.
River basin	The area drained by a waterway and its tributaries (see Catchment).
Runoff	Water that flows over the soil surface when rainfall is greater than the infiltration capacity of the soil. Flow in waterways results from rainfall runoff.
Salinity	A measure of the total soluble (dissolved) salts in water. Commonly measured in terms of total dissolved salts (TDS) in milligrams per litre (mg/L), or electrical conductivity, in millisiemens per metre (mS/m) or millisiemens per centimetre (mS/cm). Water resources are classified as fresh, marginal, brackish or saline on the basis of salinity.
Salinisation	An increase in the concentration of soluble salts in soil or water.

Sediment load	The amount of sediment reaching a waterway over a given time period from its catchment area. Also refers to the amount of sediment being transported by a waterway.
Sp.	Species (singular): usually used when the plant or animal is identified to genus level but not identified to species level.
Spp.	Species (plural): a group of plants or animals of the same genus.
Surface water	Water flowing or held in waterways.
Tributary	A waterway that flows into a larger waterway.
Verge	Upland area adjacent to the floodplain.
Water quality	The physical, chemical and biological measures of water.
Waterlogging	Excess water close to the soil surface.
Watertable	Saturated level of unconfined groundwater. Wetlands in low-lying areas may be surface expressions of groundwater.
Waterway	Surface water bodies, including streams, rivers, lakes, wetlands, estuaries, coastal lagoons and inlets. Can be seasonally or permanently inundated.

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Appendix 1 Site survey reports

Site YR01 — Giles' A

General details	
Site name	Giles' A
Landholder	Brad and Vicki Giles
Surveyed by	Lyn Atkins and Natalie Randall (Ecoscape)
Date	19.11.2007

Site description	
Landform	The site is located on the floodplain of the Yilgarn River. The river channel is meandering and braided with some anabranching with permanent 'islands'. There are seasonally wet playa lakes connected to the main channel, at least in times of high water flow. There are also some playa lakes that are not connected to the main channel: some of these have minor tributaries into them, but they only flow into the main system in times of extreme flood. There are lunettes around the lakes and along the channels, often over 1 m high.
Site size	376 ha

Beard vegetation description
Beard vegetation association 356: Succulent steppe with open woodland; eucalypts over saltbush.
Beard vegetation association 631: Succulent steppe with woodland and thicket; York gum over *Melaleuca thyoides* and samphire.
Beard vegetation association 955: Shrublands; *Melaleuca uncinata* thicket with scattered York gum.

Overall vegetation structure and cover (for vegetated areas only)

Vegetation layer	**Canopy cover class**	**Dominant species**
Trees	< 2%	*Eucalyptus salicola*
mallees	0	
Shrubs	2–10%	*Melaleuca lateriflora, Halosarcia* spp.
Grasses	< 2%	*Eragrostis dielsii*
Herbs	< 2%	*Mesembryanthemum nodiflorum*
Rushes and sedges	< 2%	*Lomandra collina*
Litter	< 2%	
Bare ground	70–100%	
Rock outcrop	0	

Summary

The lower-lying areas, including along the stream channels and edges of salt lakes, are largely *Halosarcia* spp. shrublands. Upslope, and on islands in the channel, are *Melaleuca* spp. shrublands, often with *Halosarcia* spp. understorey. Occasionally these shrublands are dense around the lakes. The higher areas, including on the lunettes and raised areas between lakes, have various combinations of *Eucalyptus* spp. woodlands with a sparse shrubby understorey.

Individual vegetation association descriptions

Vegetation 1	*Melaleuca lateriflora* very sparse shrubland over *Halosarcia* spp. very sparse shrubs over *Mesembryanthemum nodiflorum* sparse herbs.
Vegetation 2	*Halosarcia* spp. sparse shrubland.
Vegetation 3	*Eucalyptus salicola* very sparse woodland over *Olearia dampieri, Westringia cephalantha* and *Rhagodia preissii* very sparse shrubs.

Native species

Scientific name	Common name
Acacia colletioides	Wait-a-while
Acacia hemiteles	Tan wattle
Acacia sp.	Wattle
Amyema miquelii	Stalked mistletoe
Atriplex nana	Saltbush
Atriplex paludosa	Marsh saltbush
Callitris canescens	White cypress pine
Casuarina obesa	Swamp sheoak
Dianella revoluta	Blueberry lily
Disphyma crassifolium	Round pig face
Eragrostis dielsii	Mallee lovegrass
+ *Eucalyptus myriadena*	Eucalypt
+ *Eucalyptus salicola*	Salt gum
Eucalyptus salubris	Gimlet
Eucalyptus sargentii	Salt River gum
Frankenia spp.	Frankenia
Hakea preissii	Needle tree
Halosarcia spp.	Samphire (4–5 species)
Lomandra collina	Matrush
Maireana brevifolia	Small-leaf bluebush
Maireana carnosa	Cottony bluebush
Maireana sp.	Bluebush
Melaleuca brevifolia	Paperbark
Melaleuca hamata	Broombush
Melaleuca lateriflora	Gorada
Melaleuca thyoides	Paperbark
Olearia dampieri subsp. *eremicola*	Daisy-bush
Ptilotus sp.	Mulla mulla
Rhagodia preissii	Rhagodia
Sclerolaena diacantha	Grey copper-burr
Tecticornia lylei	Samphire
Templetonia sulcata	Centipede bush
Westringia cephalantha	Westringia

+ Regeneration noted

Weed species

Scientific name	Common name
Bromus rubens	Red brome
Carpobrotus edulis	Hottentot fig
Mesembryanthemum nodiflorum	Slender ice-plant
Pentaschistis airoides	False hair-grass

Other plant lists for the general area

Beard (1979)
Beard (1980)
Lefroy et al. (1991)

Vegetation condition

Condition	Description	% of site
Revegetation	An area of formerly cleared or otherwise degraded land that has been replanted	0
Pristine	No obvious signs of disturbance	0
Excellent	Vegetation structure intact, disturbance affecting individual species only and weeds non-aggressive species	0
Very good	Vegetation structure altered, obvious signs of disturbance	25
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate	25
Degraded	Basic vegetation structure severely impacted by disturbance. Regeneration to good condition requires intensive management	20
Completely degraded	Vegetation structure no longer intact and the area is without/almost without native species	30

Disturbance factors contributing to vegetation condition score

Disturbance factor	Level of threat			Disturbance factor	Level of threat		
	H	M	L		H	M	L
Salinity	x			Rubbish			x
Waterlogging	x			Plant disease			
Ponding from road crossing				Erosion			x
Drainage		x		Service corridors			
Clearing		x		Feral animals			x
Fire risk			x	Recreation			
Weed invasion			x	Point source discharge		x	
Stock access			x	Other: gypsum/sand extraction			x
Vehicle access			x				

Comments
The major disturbance factors affecting this site are hydrological, primarily increased salinity and waterlogging. The north-eastern corner of the site, and low-lying areas associated with the lake (which is not connected to the main channel), has been degraded due to a flood event in 1994, which was caused by straw building up against a pipeline and redirecting flow into this lake. There are also at least two drains or channels directing water onto the site (not sighted): these may be a source of threat for this site.

Links to protected areas of remnant vegetation		
Name	**Area** (ha)	**Approximate distance and direction from site**
None within a 10 km radius		

Management
The area is fenced and has not been grazed for 10 years. There are some surface water management issues, mostly associated with flow into the northern part of the site: it is unknown if there are any degradation issues associated with surface drains or redirected flow. There appears to be some soil structure decline associated with the increased salinity, which has increased the erodibility of the soil. Revegetating the cleared area near the south-western corner may provide biodiversity benefits, however it is unlikely to have any significant hydrological benefit. The main threats to the site (salinity and watertable rise) must be managed at a catchment scale.

Fauna	
Scientific name	**Common name**
Birds	
Cacatua roseicapilla	Galah
Cracticus nigrogularis	Pied butcher bird
Dromaius novaehollandiae	Emu
Elanus caeruleus	Black-shouldered kite
Ocyphaps lophotes	Crested pigeon
Platycercus zonarius	Australian ringneck parrot
Mammals	
Macropus fuliginosus	Western grey kangaroo

Other fauna lists for the general area
Lefroy et al. (1991)

Notes:

From field observations:

- Mistletoe was observed on Salt River gum, indicating good tree health (dead mistletoes indicate declining tree health or lack of dispersing agents (birds) and old mistletoes).

- Previously cleared paddock near south-eastern corner has regenerated but with limited species and largely without trees.
- Discharge into north-east corner has caused large-scale tree and shrub deaths.
- Possible sand or gypsum mine on small area near centre of site. It hasn't been worked for a long period.
- Some *very good* condition woodland vegetation was observed on higher areas: this area is in unusually good condition for a previously grazed site.
- Cryptogams on soil surface indicate good soil condition and lack of grazing.

From discussion with Brad Giles 13 Feb 2008:

- The site has been fenced for about 10 years but wasn't grazed before fencing.
- It is not currently grazed.
- The area is regarded as a private sanctuary and Brad is quite proud that it is the only patch of bush on the channel (on either side), and that the vegetation is in generally good condition. However he is disappointed that it seems to be degrading, and he is especially disappointed with the condition of the north-east corner.
- The degraded area in the north-east corner is a result of a flood in 1974 when rainwater washed straw onto the pipeline to the east, which redirected water into the lake. The lake does not connect with the main channel, and remained full for a long time. Tree death is a result of this.
- There is a small cleared area in the middle: this was cropped for about 12 years before it became too salty (there was no indication of when this was).
- The last big flow in the channel was in 1999, however it ran in 2003.
- In 1989 there was a big flood and floodwaters spread up to 1 km wide in the channel.
- In the 1960s a bank was cut through from the property north of this site.
- Recently there has been a drain put in on the property to the north (Kerryn Hardy's), which drains into the degraded area (the drain was not observed during the field survey). There is no indication if it is causing damage.

Plate A1.5 YR01 completely degraded *condition vegetation association 1:* Melaleuca lateriflora *shrubland*

Plate A1.6 YR01 completely degraded *condition vegetation association 2:* Halosarcia *spp. shrubland*

Plate A1.7 YR01 good *condition vegetation association 3:* Eucalyptus salicola *woodland*

Plate A1.8 YR01 good *condition vegetation adjacent to salt lake*

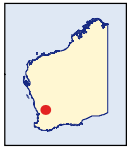
Plate A1.9 YR01 previously cleared and cropped area

Plate A1.10 YR01 completely degraded *area near north-eastern corner*

Plate A1.11 YR01 former sand or gypsum removal site

Map A1
Vegetation condition for survey site YR01 Gile's A

LOCALITY MAP



LEGEND

Vegetation condition

- Revegetation
- Pristine
- Excellent
- Very good
- Good
- Degraded
- Completely degraded

Boundary

- Yilgarn survey site

Imagery

Merredin imagery 2004

N

0 100 200 300

Metres

Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum:GDA 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

Project Information
Client: Kate Gole
Map Author: Moses Gatenjwa
Task ID: 6979
Filepath: J:\gisprojects\Project\B_Series\B4148\0004_YilgarnRiver_wwa\mxd
Filename: YR01_vegetation-condition.mxd
Compilation date: August 2008
Edition: 1

SOURCES

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

Yilgarn vegetation condition – DoW – 2008
Yilgarn survey sites – DoW – 2008
Merredin 50cm Orthomosaic – Landgate – 2004

Government of **Western Australia**
Department of **Water**

This map is a product of the Department of Water Spatial Analysis Division and was completed in August 2008.

This map was produced with the intent that it be used for display purposes at the scale of 1:15 000 when printing at A4.

While the Department of Water has made all reasonable efforts to ensure the accuracy of this data, the department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.

Site YR02 — Giles' B

General details	
Site name	Giles' B
Landholder	Murray and Heather Giles
Surveyed by	Lyn Atkins and Natalie Randall (Ecoscape)
Date	20.11.2007

Site description	
Landform	The site is located on the floodplain of the Yilgarn River. What appeared to be the main channel is straight, but the streambed is divided by raised sand bars, which create a beaded pattern. There are several subsidiary channels, largely connected to the main channel, and some low-lying areas that may hold water in wet winters. There are a few seasonally wet lakes, connected to the main channels, and a few slightly raised areas between the channels. These raised areas are approximately a metre above the valley floor, although a few are higher than this.
Site size	413 ha

Beard vegetation description

Beard vegetation association 631: Bare areas; salt lakes.

Overall vegetation structure and cover (for vegetated areas only)

Vegetation layer	Canopy cover class	Dominant species
Trees	<2%	*Eucalyptus salicola, E. myriadena*
mallees	0	
Shrubs	10–30%	Mixed
Grasses	2–10%	*Eragrostis dielsii*
Herbs	2–10%	Mixed
Rushes and sedges	< 2%	*Lomandra effusa*
Litter	10–30%	
Bare ground	30–70%	
Rock outcrop	0	

Summary

The low-lying areas of site YR03 are dominated by *Halosarcia* spp. shrubland, with some bare areas associated with stream channels or lakes. Upslope, and areas along the edges of the lakes and channels, are either *Casuarina obesa* or *Melaleuca* spp. shrubland. The raised areas between the lakes and channels is characterised by *Melaleuca* spp. shrubland, and further upslope, *Acacia/ Santalum/Hakea* spp shrubland occur, with *Eucalyptus* spp. woodland on higher areas.

Individual vegetation association descriptions	
Vegetation 1	*Eucalyptus salicola* and *E. myriadena* very sparse woodland over *Pittosporum angustifolia* very sparse shrubs over *Atriplex* spp sparse shrubs over very sparse mixed annuals.
Vegetation 2	*Halosarcia* spp sparse shrubland.
Vegetation 3	*Acacia* sp., *Santalum acuminatum* and *Hakea preissii* sparse shrubland over *Rhagodia preissii* and *Enchylaena tomentosa* very sparse shrubs over *Maireana carnosa* very sparse herbs.
Vegetation 4	*Casuarina obesa* very sparse shrubland over *Templetonia sulcata* and *Exocarpos aphyllus* very sparse shrubs over *Maireana carnosa* and *Mesembryanthemum nodiflorum* very sparse herbs.
Vegetation 5	*Melaleuca lateriflora* and *M. hamata* sparse shrubland over *Rhagodia preissii* and *Frankenia* sp. sparse shrubs over *Eragrostis dielsii* very sparse grass over mixed sparse herbs.

Native species	
Scientific name	**Common name**
Acacia colletioides	Wait-a-while
Acacia sp.	Wattle
Angianthus tomentosus	Camel-grass
Aristida contorta	Bunched kerosene grass
Atriplex paludosa	Marsh saltbush
Atriplex nana	Saltbush
Austrostipa spp.	Speargrass
Calocephalus multiflorus	Yellow-top
Casuarina obesa	Swamp sheoak
Chenopodiaceae sp.	
Darwinia halophila	Darwinia
Disphyma crassifolium	Round pig face
Dodonaea viscosa subsp. angustissima	Sticky hopbush
Enchylaena tomentosa	Ruby saltbush
Eragrostis dielsii	Mallee lovegrass
Eucalyptus loxophleba	York gum
Eucalyptus myriadena	Eucalypt
Eucalyptus salicola	Salt gum
Eucalyptus sp.	Eucalypt
Exocarpos aphyllus	Leafless ballart
Frankenia spp.	Frankenia
Gunniopsis intermedia	Yellow salt star
Hakea preissii	Needle tree
Halosarcia spp.	Samphire (4-5 species)
Lomandra effusa	Scented matrush
Lycium australe	Australian boxthorn, water bush
Maireana carnosa	Cottony bluebush
Maireana georgei	Satiny bluebush

Native species (contimued)	
Scientific name	**Common name**
Melaleuca hamata	Broombush
Melaleuca lateriflora	Gorada
Melaleuca thyoides	Paperbark
Pittosporum angustifolium	Native apricot, native willow
Podolepis capillaris	Wiry podolepis
Podotheca gnaphalioides	Sticky longheads
Ptilotus sp.	Mulla mulla
Rhagodia preissii	Rhagodia
Roycea spinescens	
Santalum acuminatum	Quandong
Sclerolaena diacantha	Grey copper-burr
Siloxerus pygmaeus	

Weed species	
Scientific name	**Common name**
Bromus rubens	Red brome
Mesembryanthemum nodiflorum	Slender ice-plant
Pentaschistis airoides	False hair-grass
Vulpia myuros	Silver grass

Other plant lists for the general area
Beard (1979)
Beard (1980)
Lefroy et al. (1991)

Vegetation condition

Condition	**Description**	**% of site**
Revegetation	An area of formerly cleared or otherwise degraded land that has been replanted	0
Pristine	No obvious signs of disturbance	0
Excellent	Vegetation structure intact, disturbance affecting individual species only and weeds non-aggressive species	5
Very good	Vegetation structure altered, obvious signs of disturbance	10
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate	35
Degraded	Basic vegetation structure severely impacted by disturbance. Regeneration to good condition requires intensive management	40
Completely degraded	Vegetation structure no longer intact and the areas is without/almost without native species	10

Disturbance factors contributing to vegetation condition score							
Disturbance factor	**Level of threat**			**Disturbance factor**	**Level of threat**		
	H	**M**	**L**		**H**	**M**	**L**
Salinity	x			Rubbish			
Waterlogging	x			Plant disease			
Ponding from road crossing				Erosion		x	
Drainage				Service corridors			
Clearing			x	Feral animals			x
Fire risk				Recreation			
Weed invasion			x	Point source discharge			
Stock access		x		Other: sedimentation of channels		x	
Vehicle access							

Comments

The main threats to this site are associated with salinity and waterlogging. Sedimentation of channels and local soil erosion, caused by livestock access, are also threats but at a lower level. The site is only lightly grazed, and shows few signs of erosion; however changes to grazing pressure would increase this threat.

Links to protected areas of remnant vegetation

Name	**Area** (ha)	**Approximate distance and direction from site**
North Baandee Nature Reserve	137	8 km W

Management

The site is not fenced from grazing: although the grazing pressure is very light, it would be preferable to not graze the site. Saltland grazing pastures established in the adjacent paddock may reduce stock pressure, but only if the same stocking rate and period were kept. Sediment management may also be of benefit. The major threats of salinity and watertable rise must be managed at a catchment scale.

Fauna

Scientific name	**Common name**
Birds	
Acanthiza sp.	Thornbills
Anthus australis	Australian pipit
Artamus cinereus	Black-faced woodswallow
Cracticus tibicen	Magpie

Epthianura tricolor	Crimson chat
Malurus sp.	Fairy wren
Manorina flavigula	Yellow throated miner
Ocyphaps lophotes	Crested pigeon
Oreoica gutturalis	Crested bellbird
Pardalotus striatus	Striated pardalote
Platycercus zonarius	Australian ringneck parrot
Pomatostomus superciliosus	White-browed babbler
Rhipidura leucophrys	Willy wagtail
Mammals	
Macropus fuliginosus	Western grey kangaroo

Other fauna lists for the general area
Lefroy et al. (1991)

Notes:

From field observations:

- The site is not fenced.
- Cryptogams were observed on the soil surface, indicating good soil condition, lack of salinity on higher areas, and a low level of grazing.
- The adjacent paddock doesn't appear to have been recently cultivated. There is good *Eragrostis dielsii* cover and some *Maireana brevifolia*.
- The main channel is a series of ponds with a channel connecting them through the sandbanks between ponds. The higher banks have sparse samphire. Low lying areas associated with old channels and lakes are bare or covered in samphire.
- Most areas of shrubland are either *Melaleuca* or *Casuarina obesa/Templetonia sulcata/Exocarpos aphyllus* or mixed spp. The drainage channels have samphire vegetation. There are few woodland areas.
- DRF species found.

Discussion with Murray Giles 12 Feb 2008.

- Murray has been farming here for approximately 30 years: his impression of the site is that it has become more salty since then.
- He thinks the adjacent land was cleared about 35 years ago but it may have been as many as 50 years.

- The site is grazed every year from March-August by approximately 600-700 sheep.
- The adjacent paddock is not cultivated, and was last cropped approximately 20 years ago.
- 2003 was the last year the site was wet, but there was not enough water to backfill the lakes.
- 1992 was the last flood.
- Minimum tillage and surface water management means there is less runoff than previously.
- The sandbanks in the main channel are relatively recent: he recalls rounding up sheep on a motorbike and the banks weren't there.
- The only part of the site that hasn't shown signs of increasing salinity is the raised woodland area along Baandee North Cross Road.
- He is comfortable with reporting Declared Rare Flora to DEC. They are welcome to survey the area and fence off small areas, but to fence the whole site would be a major imposition.

Plate A1.12: YR02 excellent *condition vegetation association 1:* Eucalyptus salicola *and* E. myriadena *woodland*

Plate A1.13: YR02 good *condition vegetation association 2:* Halosarcia *spp. shrubland*

Plate A1.14: YR02 good *condition vegetation association 3:* Acacia *sp.,* Santalum acuminatum *and* Hakea preissii *shrubland*

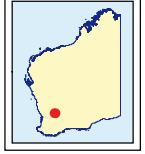
Plate A1.15: YR02 good *condition vegetation association 4:* Casuarina obesa *shrubland*

Plate A1.16: YR02 very good *condition vegetation association 5:* Melaleuca lateriflora *and* M. hamata *shrubland*

Plate A1.17 YR02 main river channel, showing sand banks

Map A2
Vegetation condition for survey site YR02 Gile's B

LOCALITY MAP



LEGEND

Vegetation condition

- Revegetation
- Pristine
- Excellent
- Very good
- Good
- Degraded
- Completely degraded

Boundary

- Yilgarn survey site

Imagery

Merredin imagery 2004

N

0 100 200 300

Metres

Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum:GDA 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

Project Information
Client: Kate Gole
Map Author: Moses Gatenjwa
Task ID: 6979
Filepath: J:\gisprojects\Project\B_Series \B4148\0004_YilgarnRiver_wwa\mxd
Filename: YR02_vegetation_condition.mxd
Compilation date: August 2008
Edition: 1

SOURCES

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

Yilgarn vegetation condition – DoW – 2008
Yilgarn survey sites – DoW – 2008
Merredin 50cm Orthomosaic – Landgate – 2004

Government of **Western Australia**
Department of **Water**

This map is a product of the Department of Water Spatial Analysis Division and was completed in August 2008.

This map was produced with the intent that it be used for display purposes at the scale of 1:13 000 when printing at A4.

Site YR03 — De Lacy's

General details	
Site name	de Lacy's
Landholder	Frank de Lacy, Ian de Lacy
Surveyed by	Lyn Atkins and Natalie Randall (Ecoscape)
Date	20.11.2007

Site description	
Landform	The site is largely within the valley floor, and includes an area of lower valley slope on the north-east corner and a tributary along the southern side. The main river channel is well defined and only slightly sinuous. There are some secondary channels in low-lying areas, one connecting to a playa lake, and seasonally wet playa lakes not connected to the stream channel. Some of the lunettes around the lakes are up to 2m high.
Site size	329 ha

Beard vegetation description

Beard vegetation association 631: Succulent steppe with woodland and thicket: York gum over *Melaleuca thyoides* and samphire.

Beard vegetation association 1053: Shrublands; *Melaleuca uncinata* thicket with scattered York gum.

Overall vegetation structure and cover (for vegetated areas only)

Vegetation layer	Canopy cover class	Dominant species
Trees	2–10%	*Eucalyptus salubris, E. salicola, E. myriadena*
mallees	0	
Shrubs	2–10%	*Melaleuca lateriflora, Halosarcia* spp.
Grasses	2–10%	*Eragrostis dielsii*
Herbs	2–10%	*Maireana carnosa, Mesembryanthemum nodiflorum*
Rushes and sedges	< 2%	*Lomandra effusa*
Litter	10–30%	
Bare ground	30–70%	
Rock outcrop	0	

Summary

Most of the site is *Melaleuca lateriflora* shrubland, with *Halosarcia* spp and *Atriplex* shrublands on the lower-lying areas. There is an area of *Eucalyptus salubris* woodland on the north-eastern corner, and small areas of *Eucalyptus salicola* and *Pittosporum angustifolium* woodland on lunettes.

Individual vegetation association descriptions	
Vegetation 1	*Eucalyptus salubris* very sparse woodland over *Acacia colletioides, Hakea preissii and Exocarpos aphyllus* very sparse shrubs over *Scaevola spinescens, Rhagodia preissii* and *Templetonia sulcata* very sparse shrubs over *Maireana carnosa* and *Disphyma crassifolia* very sparse herbs.
Vegetation 2	*Melaleuca lateriflora* sparse shrubland over *Sclerolaena diacantha, Maireana georgei* and *Halosarcia* spp very sparse shrubs over *Maireana carnosa, Mesembryanthemum nodiflorum* and *Rhodanthe citrina* sparse herbs.
Vegetation 3	*Halosarcia* spp and *Atriplex nana* very sparse shrubland over *Mesembryanthemum nodiflorum* very sparse herbs.

Native species	
Scientific name	**Common name**
Acacia acuaria	Wattle
Acacia colletioides	Wait-a-while
Acacia erinacea	Spiny wattle
Acacia hemiteles	Tan wattle
Acacia merrallii	Merrall's wattle
Acacia sp.	Wattle
Atriplex nana	Saltbush
Austrostipa elegantissima	Feather speargrass
Callitris canescens	White cypress pine
Casuarina obesa	Swamp sheoak
Disphyma crassifolium	Round pig face
Dodonaea viscosa subsp*. angustissima*	Sticky hopbush
Eragrostis dielsii	Mallee lovegrass
Eremophila decipiens	Slender fuschia
Eremophila oppositifolia	Weeooka
Eucalyptus myriadena	Eucalypt
Eucalyptus salicola	Salt gum
Eucalyptus salubris	Gimlet
Exocarpos aphyllus	Leafless ballart
Frankenia sp.	Frankenia
Hakea preissii	Needle tree
Halosarcia spp.	Samphire (~3 spp.)
Lomandra effusa	Scented matrush
Lycium australe	Australian boxthorn, water bush
Maireana georgei	Satiny bluebush
Melaleuca lateriflora	Gorada
Olearia dampieri subsp*. eremicola*	Daisy-bush
Pittosporum angustifolium	Native apricot, native willow
Ptilotus sp*.*	Mulla mulla
Rhagodia preissii	Rhagodia
Rhodanthe citrina	Everlasting
Santalum acuminatum	Quandong
Scaevola spinescens	Maroon bush
Sclerolaena diacantha	Grey copper-burr
Tecticornia lylei	Samphire
Templetonia sulcata	Centipede bush

Weed species	
Scientific name	Common name
Mesembryanthemum nodiflorum	Slender ice-plant
Parapholis incurva	Coast barbgrass

Other plant lists for the general area
Beard (1979)
Beard (1980)
Lefroy et al. (1991)

Vegetation condition

Condition	**Description**	**% of site**
Revegetation	An area of formerly cleared or otherwise degraded land that has been replanted	0
Pristine	No obvious signs of disturbance	0
Excellent	Vegetation structure intact, disturbance affecting individual species only and weeds non-aggressive species	0
Very good	Vegetation structure altered, obvious signs of disturbance	15
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate	55
Degraded	Basic vegetation structure severely impacted by disturbance. Regeneration to good condition requires intensive management	25
Completely degraded	Vegetation structure no longer intact and the area is without/almost without native species	5

Disturbance factors contributing to vegetation condition score

Disturbance factor	**Level of threat**			**Disturbance factor**	**Level of threat**		
	H	**M**	**L**		**H**	**M**	**L**
Salinity	x			Rubbish			
Waterlogging	x			Plant disease			
Ponding from road crossing				Erosion			
Drainage				Service corridors			
Clearing			x	Feral animals			x
Fire risk				Recreation			
Weed invasion			x	Point source discharge			
Stock access		x		Other			
Vehicle access			x				

Comments
The major threats affecting this site are increased salinity and waterlogging levels. The site is grazed and there are numerous stock trails throughout, especially on the western side which is unfenced from the paddock. There is a causeway across the main channel near the centre of the site which may cause ponding, although there is no evidence of this and backflow would probably be into the lake just upstream. It appears that water flow is around the western end of this causeway.

Links to protected areas of remnant vegetation		
Name	**Area** (ha)	**Approximate distance and direction from site**
Walcancobbing Nature Reserve	592	10 km W

Management
The western side is unfenced and the site is grazed. It is a management recommendation to fence the site. If the causeway across the main channel is causing ponding or back-flow, it should be removed, however it appears to not be causing this problem. The major threats of increasing salinity and watertable rise must be managed at a catchment scale.

Fauna	
Scientific name	**Common name**
Birds	
Anthus australis	Australian pipit
Artamus cinereus	Black-faced woodswallow
Ocyphaps lophotes	Crested pigeon
Platycercus zonarius	Australian ringneck parrot
Mammals	
Macropus fuliginosus	Western grey kangaroo

Other fauna lists for the general area
Lefroy et al. (1991)

Notes:

From field observations:

- The elevated causeway near the middle over the main channel may cause some backup of water and flow into the adjacent lake, however most flow would be around the western side as the causeway does not continue across the entire width of the channel.
- The eastern side is fenced from the adjacent paddock: this side is in better condition as the sheep don’t appear to reach this side as frequently as the western side.
- The west side is low-lying and more degraded. It is open to grazing.
- The main channel is well defined.
- A few Declared Rare plants occur around the eastern edge of the eastern lake.

Plate A1.18: YR03 very good *condition vegetation association 1:* Eucalyptus salubris *woodland. Note animal trails.*

Plate A1.19: YR03 very good *condition vegetation association 2:* Melaleuca lateriflora *shrubland*

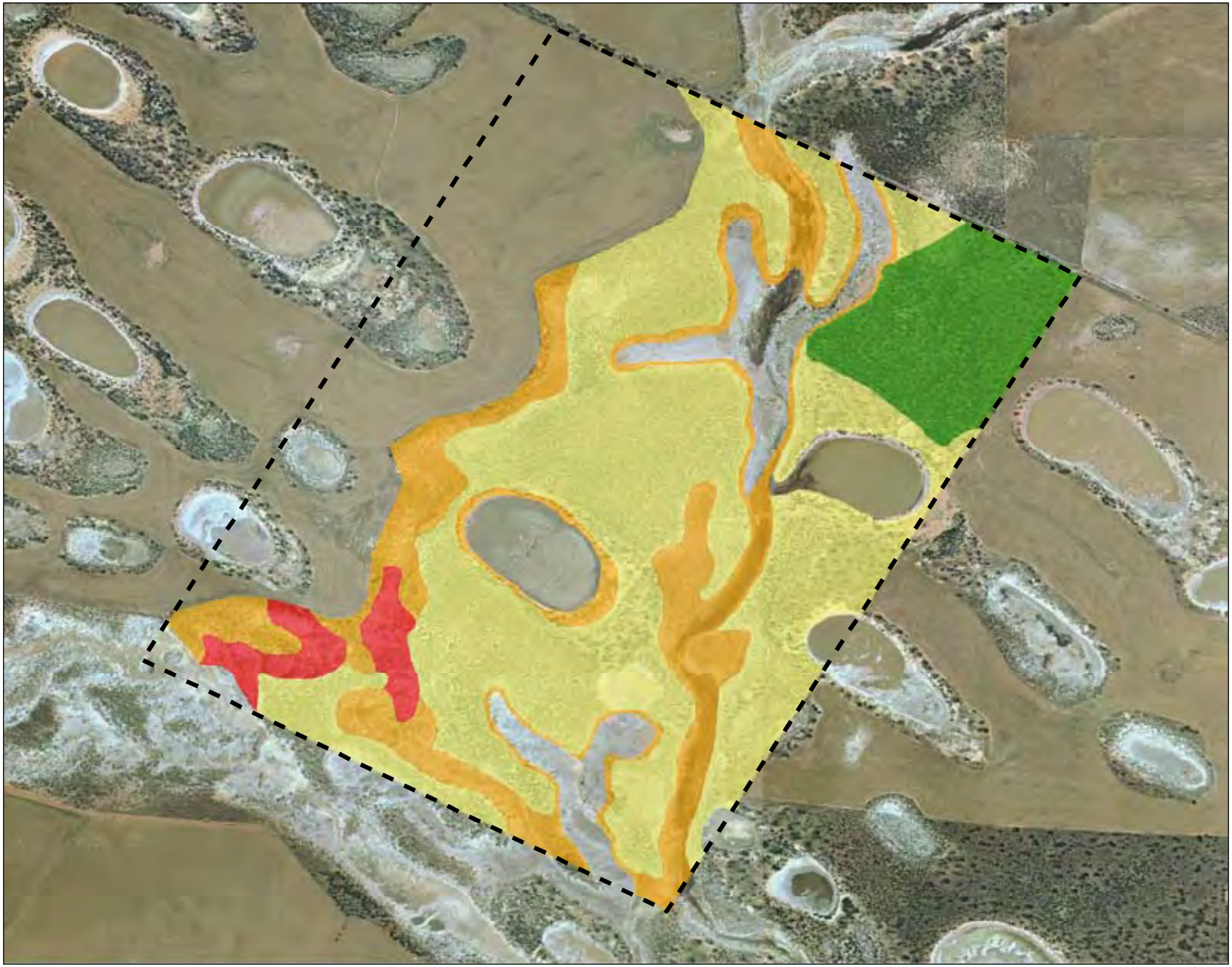
Plate A1.20: YR03 near degraded *condition vegetation association 3:* Halosarcia *spp. shrubland. Note: this view is over a* completely degraded *area*

Plate A1.21: YR03 river channel

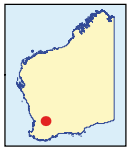
Plate A1.22: YR03 lake edge

Plate A1.23 YR03 good *condition vegetation, similar to vegetation association 2 (Plate A1.19 above). This is the more usual condition of this vegetation type*

Map A3
Vegetation condition for survey site YR03 De Lacy's



LOCALITY MAP



LEGEND

Vegetation condition

- Revegetation
- Pristine
- Excellent
- Very good
- Good
- Degraded
- Completely degraded

Boundary

- Yilgarn survey site

Imagery

Dowerin imagery 1999

N

0 100 200 300

Metres

Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum:GDA 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

Project Information
Client: Kate Gole
Map Author: Moses Gatenjwa
Task ID: 6979
Filepath: J:\gisprojects\Project\B_Series \B4148\0004_YilgarnRiver_wwa\mxd
Filename: YR03_vegetation-condition.mxd
Compilation date: August 2008
Edition: 1

SOURCES

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

Yilgarn vegetation condition – DoW – 2008
Yilgarn survey sites – DoW – 2008
Merredin 50cm Orthomosaic – Landgate – 2004

Government of **Western Australia**
Department of **Water**

This map is a product of the Department of Water Spatial Analysis Division and was completed in August 2008.

This map was produced with the intent that it be used for display purposes at the scale of 1:17 000 when printing at A4.

While the Department of Water has made all reasonable efforts to ensure the accuracy of this data, the department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.

Site YR04 — Thorpe's

General details	
Site name	Thorpe's
Landholder	Doug and Jill Thorpe
Surveyed by	Lyn Atkins and Natalie Randall (Ecoscape)
Date	20.11.2007

Site description	
Landform	The site is on the floodplain and lower valley slopes of the Yilgarn River. The river is relatively straight, with two anabranches converging near the centre of the site. There are no lakes or secondary channels. The islands resulting from the anabranching are very low, with an elevation of less than 1 m above the channel.
Site size	124 ha

Beard vegetation description

Beard vegetation association 8: Medium woodland; salmon gum and gimlet (on fringe).

Beard vegetation association 1053: shrublands; *Melaleuca uncinata* thicket with scattered York gum.

Overall vegetation structure and cover (for vegetated areas only)

Vegetation layer	Canopy cover class	Dominant species
Trees	< 2%	*Eucalyptus salicola, E. myriadena*
mallees	0	
Shrubs	10–30%	*Halosarcia* spp., *Melaleuca* spp.
Grasses	2–10%	*Eragrostis dielsii*
Herbs	2–10%	*Mesembryanthemum nodiflorum*
Rushes and sedges	0	
Litter	2–10%	
Bare ground	70–100%	
Rock outcrop	0	

Summary

The vegetation fringing the river edges is *Halosarcia* spp. Upslope is woodland, often *Eucalyptus salmonophloia*, or *Melaleuca* spp. shrubland, both with sparse understorey. There is a small cleared area on the northern edge of the site and small areas of revegetation (*Eucalyptus salicola* on the north and *Atriplex nummularia* on the south).

Individual vegetation association descriptions

Vegetation 1	*Melaleuca hamata* and *M. lateriflora* very sparse shrubland over mixed chenopod very sparse shrubs over *Erymophyllum tenellum* very sparse herbs.

Individual vegetation association descriptions (continued)	
Vegetation 2	*Halosarcia* spp. and *Tecticornia* sp. sparse shrubs.
Vegetation 3	*Eucalyptus salmonophloia* very sparse woodland over *Eragrostis dielsii* very sparse grass over *Mesembryanthemum nodiflorum* very sparse herbs.

Native species

Scientific name	**Common name**
Acacia sp.	Wattle
Atriplex nummularia (planted)	Old man saltbush
Atriplex paludosa	Marsh saltbush
Austrodanthonia spp.	Wallaby grass
Disphyma crassifolium	Round pig face
Enchylaena tomentosa	Ruby saltbush
Eragrostis dielsii	Mallee lovegrass
Erymophyllum tenellum	Everlasting
Eucalyptus myriadena	Eucalypt
Eucalyptus sargentii (planted)	Salt River gum
Eucalyptus salubris	Gimlet
Eucalyptus salmonophloia (planted)	Salmon gum
Exocarpos aphyllus	Leafless ballart
Hakea preissii	Needle tree
Halosarcia spp.	Samphire (2 species)
Lycium australe	Australian boxthorn, water bush
Maireana brevifolia	Small-leaf bluebush
Maireana carnosa	Cottony bluebush
Maireana georgei	Satiny bluebush
Melaleuca hamata	Broombush
Melaleuca lateriflora	Gorada
Pittosporum angustifolium	Native apricot, native willow
Podolepis capillaris	Wiry podolepis
+ *Ptilotus* sp.	Mulla mulla
Rhagodia preissii	Rhagodia
Santalum acuminatum	Quandong
Sclerolaena diacantha	Grey copper-burr
Tecticornia sp.	Samphire
Templetonia sulcata	Centipede bush

+ Regeneration noted

Weed species

Scientific name	**Common name**
Avena fatua	Wild oat
Bromus rubens	Red brome
Lolium rigidum	Annual ryegrass
Mesembryanthemum nodiflorum	Slender ice-plant

Other plant lists for the general area
Beard (1979)
Beard (1980)
Lefroy et al. (1991)

Vegetation condition		
Condition	**Description**	**% of site**
Revegetation	An area of formerly cleared or otherwise degraded land that has been replanted	5
Pristine	No obvious signs of disturbance	0
Excellent	Vegetation structure intact, disturbance affecting individual species only and weeds non-aggressive species	0
Very good	Vegetation structure altered, obvious signs of disturbance	10
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate	30
Degraded	Basic vegetation structure severely impacted by disturbance. Regeneration to good condition requires intensive management	35
Completely degraded	Vegetation structure no longer intact and the areas is without/almost without native species	20

Disturbance factors contributing to vegetation condition score							
Disturbance factor	**Level of threat**			**Disturbance factor**	**Level of threat**		
	H	**M**	**L**		**H**	**M**	**L**
Salinity	x			Rubbish			x
Waterlogging	x			Plant disease			x
Ponding from road crossing				Erosion		x	
Drainage				Service corridors			x
Clearing			x	Feral animals			x
Fire risk			x	Recreation			x
Weed invasion		x		Point source discharge			
Stock access		x		Other			
Vehicle access			x				

Comments
The major threats to this site are from increasing salinity and waterlogging levels, however this site is grazed thus soil erosion and weed invasion are also threats. There is a raised road on the eastern (upstream) edge of the site, and road surface material has been deposited onto the site. It is possible that the road causes some ponding on the land to the east of the site, however the effects of increases in salinity appear to be greater on this site than the land to the east.

Links to protected areas of remnant vegetation		
Name	**Area** (ha)	**Approximate distance and direction from site**
Walcancobbing Nature Reserve	592	10 km W

Management
The major threats to this site are from increases in salinity and waterlogging, which require addressing on a catchment basis. The site is grazed, and would benefit from fencing, especially of the stream channels and vegetation on the islands between the anabranches. The small amount of revegetation does not appear to have had an impact on the site, however planting the formerly cleared area on the northern edge to saltland grazing species would probably provide more livestock fodder than is currently available from the site.

Fauna	
Scientific name	**Common name**
Birds	
Acanthiza apicalis	Inland thornbill
Aquila audax	Wedge-tailed eagle
Cacatua roseicapilla	Galah
Dromaius novaehollandiae	Emu
Ocyphaps lophotes	Crested pigeon
Platycercus zonarius	Australian ringneck parrot
Mammals	
Macropus fuliginosus	Western grey kangaroo
**Vulpes vulpes*	Fox

* *Introduced species*

Other fauna lists for the general area
Lefroy et al. (1991)

Notes:

From field observations:

- Declared Rare plants were found within the site, in greater numbers and in healthier condition than at other sites.
- Most of the *Melaleuca* shrublands have no understorey or only sparse herbs. Some areas of salmon gum have sparse or no understorey, except very sparse herbs.
- Samphire areas are mostly single species and in either degraded or completely degraded condition.

- Spoil from the road crossing has washed onto the site. Salinity appears to be worse downstream (this site) than upstream (to the east of the road).
- The small cleared area along the northern edges is isolated shrubs over pasture weeds and *Eragrostis dielsii*. If planted to saltbush this area may make a substitute grazing area if the stream edges and islands were to be fenced.
- There are rows of planted trees (*Eucalyptus sargentii* and *E. salmonophloia*) along the northern edge. Rows of planted saltbush (*Atriplex nummularia*) near the south-eastern corner are not performing well.
- Although the whole area is grazed, sheep don't appear to make it to the western 'island' very often (and this is where the DRF plants are).

Plate A1.24: YR04 very good *condition vegetation association 1:* Melaleuca *spp. shrubland*

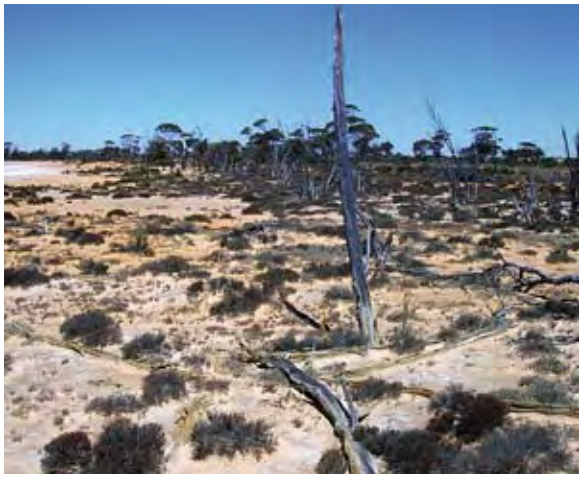


Plate A1.25: YR04 degraded *condition vegetation association 2:* Halosarcia *spp. shrubland*

Plate A1.26: YR04 good *condition vegetation association 3:* Eucalyptus salmonophloia *woodland*

Plate A1.27: YR04 cleared area

Map A4
Vegetation condition for survey site YR04 Thorpe's

LOCALITY MAP

LEGEND

Vegetation condition

- Revegetation
- Pristine
- Excellent
- Very good
- Good
- Degraded
- Completely degraded

Boundary

- Yilgarn survey site

Imagery

Merredin imagery 2004

N

0 60 120 180

Metres

Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum:GDA 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

Project Information
Client: Kate Gole
Map Author: Moses Gatenjwa
Task ID: 6979
Filepath: J:\gisprojects\Project\B_Series \B4148\0004_YilgarnRiver_wwa\mxd
Filename: YR04_vegetation-condition.mxd
Compilation date: August 2008
Edition: 1

SOURCES

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

Yilgarn vegetation condition – DoW – 2008
Yilgarn survey sites – DoW – 2008
Merredin 50cm Orthomosaic – Landgate – 2004

Government of **Western Australia**
Department of **Water**

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Site YR05 — Herbert's

General details	
Site name	Herbert's
Landholder	Bob Herbert
Surveyed by	Lyn Atkins and Natalie Randall (Ecoscape)
Date	21.11.2007

Site description	
Landform	The site is within the valley floor and lower valley slopes of the Yilgarn River, with some low-lying areas and lakes. The main stream channels are wide and open, although meandering, with an anabranch at the northern (inflow) end of the site. There are two backfill lakes, and a playa lake removed from the main channel. There are few lunettes, which are over 1 m in height, near the northern end of the site.
Site size	148 ha

Beard vegetation description
Beard vegetation association 8: Medium woodland; salmon gum and gimlet (on fringe).
Beard vegetation association 1053: Shrublands; *Melaleuca uncinata* thicket with scattered York gum.

Overall vegetation structure and cover (for vegetated areas only)

Vegetation layer	Canopy cover class	Dominant species
Trees	< 2%	*Eucalyptus salmonophloia, E. salubris*
Mallees	< 2%	*Eucalyptus capillosa* subsp. *polyclada*
Shrubs	10–30%	*Melaleuca lateriflora, M. hamata, Halosarcia* spp.
Grasses	< 2%	*Eragrostis dielsii*
Herbs	2–10%	Mixed
Rushes and sedges	< 2%	*Lomandra effusa*
Litter	2–10%	
Bare ground	70–100%	
Rock outcrop	0	

Summary

Stream channel edges and other low-lying areas have *Halosarcia* spp. shrubland. Upslope is *Melaleuca* spp. shrubland, including extensive areas of regenerating shrubs. On higher ground, including lunettes and lower valley slopes on the eastern edge of the site, is Eucalypt woodland, mainly *Eucalyptus salmonophloia*, although other species including *E. salubris, E, loxophleba* and *E. capillosa* are also present.

Individual vegetation association descriptions	
Vegetation 1	*Melaleuca lateriflora* and *M. hamata* sparse shrubland over mixed sparse herbs.
Vegetation 2	*Eucalyptus salmonophloia* very sparse woodland over *Westringia cephalantha* and *Eremophila* sp. very sparse shrubs over *Lomandra effusa* sparse sedges over mixed very sparse herbs.
Vegetation 3	*Halosarcia* spp. sparse shrubland.

Native species

Scientific name	**Common name**
+ *Acacia hemiteles*	Tan wattle
Austrodanthonia spp.	Wallaby grass
Callitris canescens	White cypress pine
Darwinia halophila	Darwinia
Disphyma crassifolium	Round pig face
Elymus scaber	Common wheatgrass
Enchylaena tomentosa	Ruby saltbush
Eragrostis dielsii	Mallee lovegrass
Eremophila sp.	Eremophila
Erymophyllum tenellum	Everlasting
Eucalyptus capillosa subsp. *capillosa*	Wandoo
Eucalyptus capillosa subsp. *polyclada*	Mallee wandoo
Eucalyptus loxophleba	York gum
Eucalyptus myriadena	Eucalypt
+ *Eucalyptus salmonophloia*	Salmon gum
Eucalyptus salubris	Gimlet
Exocarpos aphyllus	Leafless ballart
Gnephosis tenuissima	Gnephosis
Hakea preissii	Needle tree
Halosarcia spp.	Samphire (approx 4 species in total)
Lomandra effusa	Scented matrush
Maireana carnosa	Cottony bluebush
Maireana georgei	Satiny bluebush
+ *Melaleuca hamata*	Broombush
Melaleuca lateriflora	Gorada
Podolepis canescens	Bright podolepis
Podolepis capillaris	Wiry podolepis
Ptilotus gaudichaudii	Mulla mulla
Rhagodia preissii	Rhagodia
Santalum acuminatum	Quandong
Sclerolaena diacantha	Grey copper-burr
Tecticornia lylei	Samphire
Templetonia sulcata	Centipede bush
Westringia cephalantha	Westringia

+ *Regeneration noted*

Weed species

Scientific name	**Common name**
Mesembryanthemum nodiflorum	Slender ice-plant
Pentaschistis airoides	False hair-grass
Vulpia myuros	Silver grass

Other plant lists for the general area
Beard (1979)
Beard (1980)
Lefroy et al. (1991)

Vegetation condition

Condition	**Description**	**% of site**
Revegetation	An area of formerly cleared or otherwise degraded land that has been replanted	0
Pristine	No obvious signs of disturbance	0
Excellent	Vegetation structure intact, disturbance affecting individual species only and weeds non-aggressive species	15
Very good	Vegetation structure altered, obvious signs of disturbance	15
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate	25
Degraded	Basic vegetation structure severely impacted by disturbance. Regeneration to good condition requires intensive management	35
Completely degraded	Vegetation structure no longer intact and the area is without/almost without native species	10

Disturbance factors contributing to vegetation condition score

Disturbance factor	**Level of threat**			**Disturbance factor**	**Level of threat**		
	H	**M**	**L**		**H**	**M**	**L**
Salinity	x			Rubbish			x
Waterlogging	x			Plant disease			
Ponding from road crossing				Erosion			x
Drainage				Service corridors			x
Clearing			x	Feral animals			x
Fire risk			x	Recreation			x
Weed invasion			x	Point source discharge			
Stock access			x	Other			
Vehicle access			x				

Comments

The factors contributing most the to the vegetation condition score are salinity and waterlogging. The site is not fenced from grazing, although there does not seem to be any stock usage, and consequently there is little weed invasion or soil erosion.

Links to protected areas of remnant vegetation		
Name	**Area** (ha)	**Approximate distance and direction from site**
Crown Reserve 16932	444	10 km SE

Management
The greatest threats to this site are salinity and waterlogging, which must be managed at a catchment scale. The site is unfenced but not grazed.

Fauna	
Scientific name	**Common name**
Birds	
Acanthiza apicalis	Inland thornbill
Artamus cinereus	Black-faced woodswallow
Cacatua roseicapilla	Galah
Corvus coronoides	Australian raven
Cracticus nigrogularis	Pied butcher bird
Cracticus tibicen	Magpie
Ocyphaps lophotes	Crested pigeon
Pardalotus striatus	Striated pardalote
Phaps chalcoptera	Common bronzewing
Platycercus zonarius	Australian ringneck parrot
Mammals	
Macropus fuliginosus	Western grey kangaroo

Other fauna lists for the general area
Lefroy et al. (1991)

Notes:

From field observations:

- The main channel is clear, with no vegetation. Streamflow should be uninterrupted.
- *Melaleuca* shrublands in low-lying areas are suffering from soil structure decline and erosion, with runoff evident.
- In a localised area near the site centre, *Lomandra effusa* has been burnt, most likely as the result of a lightening strike.
- There is a small localised burnt area on the north-central dune north-central.
- There are areas of regenerating *Melaleuca hamata* and occasional *Acacia hemiteles* along the western fence. There is no obvious reason for regeneration. There are no signs of clearing or other disturbance, and it is not particularly low-lying, therefore flooding is unlikely to have triggered germination.
- There are areas of recently dead *Melaleuca* on low-lying land.
- The site doesn’t appear to be grazed.

Plate A1.28: YR05 good *condition vegetation association 1:* Melaleuca *spp. shrubland*

Plate A1.29: YR05 very good *condition vegetation association 2:* Eucalyptus salmonophloia *woodland*

Plate A1.30: YR05 degraded *condition vegetation association 3:* Halosarcia *spp. shrubland*

Plate A1.31: YR05 stream channel

Plate A1.32: YR05 recently dead Melaleuca *spp. on low-lying area*

Plate A1.33: YR05 regenerating Melaleuca *spp.*

Map A5
Vegetation condition for survey site YR05 Herbert's

LOCALITY MAP

LEGEND

Vegetation condition

- Revegetation
- Pristine
- Excellent
- Very good
- Good
- Degraded
- Completely degraded

Boundary

- Yilgarn survey site

Imagery

Merredin imagery 2004

N

0 70 140 210

Metres

Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum:GDA 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

Project Information
Client: Kate Gole
Map Author: Moses Gatenjwa
Task ID: 6979
Filepath: J:\gisprojects\Project\B_Series \B4148\0004_YilgarnRiver_wwa\mxd
Filename: YR05_vegetation-condition.mxd
Compilation date: August 2008
Edition: 1

SOURCES

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

Yilgarn vegetation condition – DoW – 2008
Yilgarn survey sites – DoW – 2008
Merredin 50cm Orthomosaic – Landgate – 2004

Government of **Western Australia**
Department of **Water**

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This map was produced with the intent that it be used for display purposes at the scale of 1:10 000 when printing at A4.

Site YR06 — Jordina

General details	
Site name	Jordina
Landholder	Geoff Dayman
Surveyed by	Lyn Atkins and Natalie Randall (Ecoscape)
Date	21.11.2007

Site description	
Landform	The site is on the floodplain of the Yilgarn River, which is wide and straight.
Site size	53 ha

Beard vegetation description

Beard vegetation association 8: Medium woodland; salmon gum and gimlet (on fringe).

Beard vegetation association 1053: Shrublands; *Melaleuca uncinata* thicket with scattered York gum.

Overall vegetation structure and cover (for vegetated areas only)

Vegetation layer	Canopy cover class	Dominant species
Trees	< 2%	
mallees	0	
Shrubs	< 2%	
Grasses	< 2%	
Herbs	2–10%	
Rushes and sedges	0	
Litter	2–10%	
Bare ground	10–30%	
Rock outcrop	0	

Summary

Most of the site is bare and salt-crusted unvegetated river channel. Near the fringes of the channel are a few scattered *Halosarcia* spp. or *Melaleuca* spp. shrubs, but are insufficient to form a vegetation association: there are dead sticks indicating that this area was formerly shrubby. Slightly upslope but still on the valley floor is *Eucalyptus salmonophloia* and *E. myriadena* woodland over *Melaleuca acuminata* shrubs over weeds: in some places the tree stratum is missing and only very sparse shrubs and weeds remain. Much of the vegetated part of the site is revegetation over weeds.

Individual vegetation association descriptions

Vegetation 1	*Eucalyptus salmonophloia* and *E. myriadena* very sparse woodland over *Melaleuca acuminata* very sparse shrubs over *Maireana brevifolia* sparse shrubs over mixed introduced herbs.

Native species	
Scientific name	**Common name**
Atriplex paludosa	Marsh saltbush
Austrostipa spp.	Speargrass
Enchylaena tomentosa	Ruby saltbush
Eragrostis dielsii	Mallee lovegrass
Eucalyptus myriadena	Eucalypt
Eucalyptus salmonophloia	Salmon gum
Exocarpos aphyllus	Leafless ballart
Halosarcia spp.	Samphire species
Maireana brevifolia	Small-leaf bluebush
Maireana carnosa	Cottony bluebush
Melaleuca acuminata	Paperbark
Melaleuca hamata	Broombush
Pittosporum angustifolium	Native apricot, native willow
Templetonia sulcata	Centipede bush

Weed species	
Scientific name	**Common name**
Avena fatua	Wild oat
Bromus rubens	Red brome
Hordeum leporinum	Barley grass
Mesembryanthemum crystallinum	Common ice-plant
Mesembryanthemum nodiflorum	Slender ice-plant
Oncosiphon piluliferum	Matricaria
Vulpia myuros	Silver grass

Revegetation species	
Scientific name	**Common name**
Eucalyptus loxophleba subsp. lissophloia	York gum mallee (oil mallee)
Eucalyptus sargentii	Salt River gum
Eucalyptus spp.	Eucalypts (several species)
Melaleuca acuminata	Paperbark
Melaleuca thyoides	Paperbark

Other plant lists for the general area
Beard (1979)
Beard (1980)
Lefroy et al. (1991)

Vegetation condition

Condition	Description	% of site
Revegetation	An area of formerly cleared or otherwise degraded land that has been replanted	10
Pristine	No obvious signs of disturbance	0
Excellent	Vegetation structure intact, disturbance affecting individual species only and weeds non-aggressive species	0
Very good	Vegetation structure altered, obvious signs of disturbance	0
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate	0
Degraded	Basic vegetation structure severely impacted by disturbance. Regeneration to good condition requires intensive management	15
Completely degraded	Vegetation structure no longer intact and the area is without/almost without native species	75

Disturbance factors contributing to vegetation condition score

Disturbance factor	Level of threat			Disturbance factor	Level of threat		
	H	M	L		H	M	L
Salinity	x			Rubbish			x
Waterlogging	x			Plant disease		x	
Ponding from road crossing				Erosion		x	
Drainage				Service corridors			
Clearing				Feral animals		x	
Fire risk				Recreation			
Weed invasion	x			Point source discharge			
Stock access	x			Other			
Vehicle access		x					

Comments

The major threats to the small areas of vegetation remaining on site are increasing salinity and waterlogging, weed invasion, grazing by livestock (including horses), and soil erosion as a result of the lack of vegetation cover and disturbance by livestock. It is possible that the road crossing on the southern (downstream) side of the site may cause ponding by impeding water flow in times of flood, however the culverts are wide and this is likely to occur only in times of extreme flow.

Links to protected areas of remnant vegetation

Name	Area (ha)	Approximate distance and direction from site
Crown Reserve 16932	444	10 km SE

Management
There has been some revegetation within and adjacent to this site, some of which appears stressed and unhealthy. The site is unfenced and grazed and may benefit from fencing and stock exclusion, however the site is almost completely degraded and the cost associated with this may far outweigh any potential benefits. Saltland grazing plantings on the western side may be beneficial. The major threats to the site (salinity and watertable rise) must be managed on a catchment scale.

Fauna	
Scientific name	**Common name**
Birds	
Artamus cinereus	Black-faced woodswallow
Cacatua roseicapilla	Galah
Platycercus zonarius	Australian ringneck parrot
Mammals	
Macropus fuliginosus	Western grey kangaroo
**Oryctolagus cuniculus*	Rabbit

* Introduced species

Other fauna lists for the general area
Lefroy et al. (1991)

Notes:

From field observations:

- Revegetation has been undertaken on both sides of channel. The eastern side (which is slightly upslope) is largely *Eucalyptus* spp., including *Eucalyptus loxophleba* subsp. *lissophloia* (largely not included in the ‘site’ proper) and the western side (on the flatter valley floor) is mixed Salt River gum, salmon gum, *Melaleuca acuminata* and *M. thyoides*.
- Some of the revegetation is showing signs of stress, but is largely healthy.
- It is possible that the road culverts may cause ponding, but only during extreme events.

Plate A1.34: YR06 degraded *condition vegetation association 1:* Eucalyptus salmonophloia *and* E. myriadena *woodland*

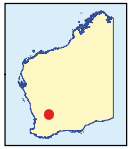
Plate A1.35: YR06 revegetation

Plate A1.36: YR06 view of completely degraded *area*

Plate A1.37: YR06 view of completely degraded *river channel*

Map A6
Vegetation condition for survey site YR06 Jordina

LOCALITY MAP



LEGEND

Vegetation condition

- Revegetation
- Pristine
- Excellent
- Very good
- Good
- Degraded
- Completely degraded

Boundary

- Yilgarn survey site

Imagery

Merredin imagery 2004

N

0 100 200

Metres

Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum:GDA 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

Project Information
Client: Kate Gole
Map Author: Moses Gatenjwa
Task ID: 6979
Filepath: J:\gisprojects\Project\B_Series\B4148\0004_YilgarnRiver_wwa\mxd
Filename: YR06_vegetation-condition.mxd
Compilation date: August 2008
Edition: 1

SOURCES

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

Yilgarn vegetation condition – DoW – 2008
Yilgarn survey sites – DoW – 2008
Merredin 50cm Orthomosaic – Landgate – 2004

Government of **Western Australia**
Department of **Water**

This map is a product of the Department of Water Spatial Analysis Division and was completed in August 2008.

This map was produced with the intent that it be used for display purposes at the scale of 1:8 500 when printing at A4.

Site YR07 — William's

General details	
Site name	Williams
Landholder	Fred Williams (leased by Greg Jolly)
Surveyed by	Lyn Atkins and Natalie Randall (Ecoscape)
Date	21.11.2007

Site description	
Landform	The site is largely within the floodplain of the Yilgarn River, with the western side on the lower valley slopes. The main river channel is meandering and has backfill lakes that are now attached to the main channel. There are some low-lying areas and playa lakes not connected to the main channel. The lunettes around the larger lakes are greater than 1 m elevation, and the lunettes along the main channels are less than 1 m elevation. There are some raised areas between the bends of the main river channel. There is a minor tributary entering the site from the west.
Site size	270 ha

Beard Vegetation description

Beard vegetation association 8: Medium woodland; salmon gum and gimlet (on fringe).

Beard vegetation association 1061: Mosaic; medium sparse woodland; salmon gum and yorrel/ succulent steppe; saltbush and samphire.

Overall vegetation structure and cover (for vegetated areas only)

Vegetation layer	Canopy cover class	Dominant species
Trees	< 2%	*Eucalyptus salicola*
mallees	2–10%	*Eucalyptus loxophleba* subsp. *lissophloia*
Shrubs	10–30%	Mixed: largest area *Atriplex* spp.
Grasses	2–10%	*Eragrostis dielsii, Chloris truncata*
Herbs	2–10%	Mixed
Rushes and sedges	0	
Litter	2–10%	
Bare Ground	30–70%	
Rock Outcrop	0	

Summary

The area to the east of the main channel was largely cleared approximately 25 years ago. It has now regenerated to an *Atriplex* spp. and *Maireana brevifolia* shrubland where it was previously woodland. The raised areas between bends in the river channel and higher areas on the western side of the channel are either *Acacia* sp and *Melaleuca lateriflora* shrubland or *Hakea preissii* and *Templetonia sulcata* shrubland. The banks of the main channel have a narrow band of *Eucalyptus salicola* woodland, with the lower-lying areas adjacent to the main channel having *Halosarcia* spp. and *Atriplex nana* shrublands. There is a small area of *Eucalyptus loxophleba* subsp. *lissophloia* mallee on the southern side of Johnson Road.

Individual vegetation association descriptions

Vegetation 1	*Acacia* sp. and *Melaleuca lateriflora* very sparse shrubland over *Rhagodia preissii* very sparse shrubs over *Maireana* spp. very sparse shrubs over *Eragrostis dielsii* very sparse grass over very sparse mixed herbs.
Vegetation 2	*Atriplex paludosa* and *Maireana brevifolia* sparse shrubland over *Eragrostis dielsii, Chloris truncata* and *Austrodanthonia* sp. sparse grass over sparse mixed herbs.
Vegetation 3	*Eucalyptus salicola* very sparse woodland over *Callitris canescens* and *Melaleuca* spp. very sparse shrubs over *Templetonia sulcata* and *Rhagodia preissii* very sparse shrubs over *Halosarcia* spp and *Atriplex nana* sparse shrubs over *Eragrostis dielsii* very sparse grasses.
Vegetation 4	*Halosarcia* spp. and *Atriplex nana* sparse shrubland.
Vegetation 5	*Hakea preissii* and *Templetonia sulcata* sparse shrubland over mixed chenopod very sparse shrubs over *Maireana carnosa* and *Mesembryanthemum nodiflorum* very sparse herbs.
Vegetation 6	*Eucalyptus loxophleba* subsp. *lissophloia* very sparse tree mallee over mixed *Melaleuca* spp. and *Acacia* spp. very sparse shrubs over *Rhagodia preissii* and *Atriplex nana* very sparse shrubs over *Austrostipa elegantissima* very sparse grass over *Maireana carnosa* and *Sclerolaena diacantha* sparse herbs.

Native species

Scientific name	**Common name**
Acacia assimilis	Wodjil
Acacia colletioides	Wait-a-while
Acacia sp.	Wattle
Argyroglottis turbinata	Daisy
Atriplex nana	Saltbush
Atriplex paludosa	Marsh saltbush
Austrodanthonia spp.	Wallaby grass
Austrostipa elegantissima	Feather speargrass
Austrostipa spp.	Speargrass
Callitris canescens	White cypress pine
Chloris truncata	Windmill grass
Dodonaea viscosa subsp*. angustissima*	Sticky hopbush
Eragrostis dielsii	Mallee lovegrass
Eremophila decipiens	Slender fuchsia
Eucalyptus loxophleba subsp. *lissophloia*	York gum mallee
Eucalyptus myriadena	Eucalypt
Eucalyptus salicola	Salt gum
Eucalyptus salubris	Gimlet
Frankenia setosa	Bristly frankenia
Gunniopsis intermedia	Yellow salt star
+ Hakea preissii	Needle tree
Halosarcia spp.	Samphire
Jacksonia sp.	Jacksonia
Lycium australe	Australian boxthorn, water bush
Maireana brevifolia	Small-leaf bluebush
Maireana carnosa	Cottony bluebush
Maireana triptera	Threewinged bluebush

Native species (continued)	
Scientific name	**Common name**
Melaleuca brevifolia	Paperbark
+ *Melaleuca hamata*	Broombush
+ *Melaleuca lateriflora*	Gorada
Olearia muelleri	Dusky daisy bush
Podolepis capillaris	Wiry podolepis
Rhagodia preissii	Rhagodia
Roycea spinescens	
Salsola australe	Prickly saltwort, roly-poly
Santalum acuminatum	Quandong
Scaevola spinescens	Maroon bush
Sclerolaena diacantha	Grey copper-burr
Templetonia sulcata	Centipede bush
Threlkeldia diffusa	Coast bonefruit

+ *Regeneration noted*

Weed species	
Scientific name	**Common name**
Mesembryanthemum nodiflorum	Slender ice-plant
Oncosiphon piluliferum	Matricaria
Pentaschistis airoides	False hair-grass

Other plant lists for the general area
Beard (1979)
Beard (1980)
Lefroy et al. (1991)

Vegetation condition

Condition	Description	% of site
Revegetation	An area of formerly cleared or otherwise degraded land that has been replanted	0
Pristine	No obvious signs of disturbance	0
Excellent	Vegetation structure intact, disturbance affecting individual species only and weeds non-aggressive species	0
Very good	Vegetation structure altered, obvious signs of disturbance	5
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate	15
Degraded	Basic vegetation structure severely impacted by disturbance. Regeneration to good condition requires intensive management	70
Completely degraded	Vegetation structure no longer intact and the area is without/almost without native species	10

Disturbance factors contributing to vegetation condition score

	Level of threat				Level of threat		
Disturbance factor	**H**	**M**	**L**	**Disturbance factor**	**H**	**M**	**L**
Salinity	x			Rubbish			x
Waterlogging	x			Plant disease			
Ponding from road crossing			x	Erosion		x	
Drainage				Service corridors			
Clearing	x			Feral animals			x
Fire risk		x		Recreation			
Weed invasion		x		Point source discharge			
Stock access		x		Other			
Vehicle access			x				

Comments

The greatest threats to the site are from increasing salinity and waterlogging. The site is lightly grazed as a source of feed during. This appears to have had little impact on the regenerated area, although more grazing may have a greater impact on shrub regeneration and soil erosion. There is a burnt area on the lunettes: this appears to have been a lightening strike, and has burnt into the shrubland. The lunettes show signs of soil erosion.

Links to protected areas of remnant vegetation

Name	**Area (ha)**	**Approximate distance and direction from site**
Billyacatting Hill Nature Reserve	2059	10 km NW

Management

The site is fenced from the adjacent paddocks, however it is lightly grazed in times of drought. Fencing the channel and lake area on the west from the rest of the site may have a beneficial effect by reducing soil erosion on the lunettes and allowing greater regeneration of shrubs after the fire, whilst still allowing grazing in the regenerated area. Alternatively, replanting tree species on the regenerated area may be beneficial to hydrology and as habitat. Sediment management may also be beneficial. The major threats of salinity and watertable rise must be managed at a catchment scale.

Fauna

Scientific name	**Common name**
Birds	
Acanthiza chrysorrhoa	Yellow-rumped thornbill
Anthus australis	Australian pipit
Dromaius novaehollandiae	Emu
Epthianura tricolor	Crimson chat
Falco cenchroides	Australian kestrel, nankeen kestrel

Fauna (continued)	
Scientific name	**Common name**
Birds	
Lichenostomus virescens	Singing honey-eater
Malurus sp.	Fairy wren
Ocyphaps lophotes	Crested pigeon
Mammals	
Macropus fuliginosus	Western grey kangaroo
**Oryctolagus cuniculus*	Rabbit
**Vulpes vulpes*	Fox

** Introduced species*

Other fauna lists for the general area
Lefroy et al. (1991)

Notes:

From field observations:

- Lunettes and adjacent areas around big lakes have been burnt, with very little regeneration (only a small areas on the edge of burnt area has *Melaleuca* seedlings), and mobile sand is eroding. The fire scar can be seen on the 1994 aerial photo supplied.
- Most of the site is bluebush/saltbush, where it would previously have been woodland, most likely salmon gum with morrell or gimlet. The area has plough lines evident on aerial photo but replanting doesn't appear to have been deliberate.
- The samphire area is in generally good condition along the drainage channel. Behind this, the thin strip of *Eucalyptus salicola* woodland is also in good condition.
- The raised area of shrubland near the north-west corner has *Hakea preissii* seedlings.

From discussions with Fred Williams 13 Feb 2008:

- Fred owns the land but leases the property to Greg Jolly.
- Fred farmed for 63 years but has since retired.
- The site was grazed during drought only, and then only lightly, so it has been grazed very little since clearing.
- Fred's father started farming in 1908. At the time the area was uncleared or had just been cleared in the past year.
- In 1908 the watertable was 30 feet (9 m) down to salt water, apparently at virtually all sites on the farm.
- 70–80 years later the watertable was still at 30 feet (9 m), and is still salty.

- The lake system has silted up since his earliest memories.
- The lake system has dried up in the last 20 years.
- There were serious floods in 1963, 1995 and 2001. 1963 was the wettest year with a neighbour reporting 25 inches of rain that year (~625 mm).
- The ski lake dam (on site YR08) broke in 1963.
- The 'regenerated' area east of the river channel was cleared approximately 25 years ago. It was topdressed and sown to barley and bluebush approximately 12 years ago but was never harvested as the surface was too rough. Since then the bluebush has taken over on the site, and spread through the district: this was one of the first sites sown to bluebush, which wasn't present in the area before.
- The water does back up against Johnson Road but only in really wet times. The road used to continue in a straight line along the cadastral boundary, across a wider part of the lake but after this was washed away the shire put a kink in the road and put a bridge over a narrower channel. There is talk about straightening the road again.
- Neither Fred, nor his son Mark, have any knowledge of the burnt area.

Plate A1.38: YR07 good *condition vegetation association 1:* Acacia *sp. and* Melaleuca lateriflora *shrubland*

Plate A1.39: YR07 degraded *condition vegetation association 2:* Atriplex paludosa *and* Maireana brevifolia *shrubland (regenerated)*

Plate A1.40: YR07 good *condition vegetation association 3:* Eucalyptus salicola *woodland*

Plate A1.41: YR07 good *condition vegetation association 4:* Halosarcia *spp. and* Atriplex nana *shrubland*

Plate A1.42: YR07 very good condition *vegetation association* 5: Hakea preissii *and* Templetonia sulcata *shrubland*

Plate A1.43: YR07 good *condition vegetation association 6:* Eucalyptus loxophleba *subsp.* lissophloia *tree mallee*

Plate A1.44: YR07 burnt area

Plate A1.45: YR07 soil erosion on lunettes

Plate A1.46: YR07 view of largest salt lake Melaleuca *spp.*

Map A7
Vegetation condition for survey site YR07 William's

LOCALITY MAP

LEGEND

Vegetation condition

- Revegetation
- Pristine
- Excellent
- Very good
- Good
- Degraded
- Completely degraded

Boundary

- Yilgarn survey site

Imagery

Merredin imagery 2004

N

0 100 200 300

Metres

Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum: GDA 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

Project Information
Client: Kate Gole
Map Author: Moses Gatenjwa
Task ID: 6979
Filepath: J:\gisprojects\Project\B_Series\B4148\0004_YilgarnRiver_wwa\mxd
Filename: YR07_vegetation-condition.mxd
Compilation date: August 2008
Edition: 1

SOURCES

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

Yilgarn vegetation condition – DoW – 2008
Yilgarn survey sites – DoW – 2008
Merredin 50cm Orthomosaic – Landgate – 2004

Government of **Western Australia**
Department of **Water**

This map is a product of the Department of Water Spatial Analysis Division and was completed in August 2008.

This map was produced with the intent that it be used for display purposes at the scale of 1:14 500 when printing at A4.

Site YR08 — Jolly's

General details	
Site name	Jolly's
Landholder	Greg Jolly
Surveyed by	Lyn Atkins and Natalie Randall (Ecoscape)
Date	27.11.2007

Site description	
Landform	The site is on the floodplain and lower valley slope of the Yilgarn River. There is a large, now dry, salt lake on the original main channel, the inflow to which now appears to be blocked by the road to the east, and braided secondary, now main, channels to the north. There are also some low-lying areas and a dry playa lake. The lunettes around the lake are greater than 2 m elevation. There are two minor tributary channels entering the site from the north. The lake has been dammed in the past, but this has now broken.
Site size	267 ha

Beard vegetation description

Beard vegetation association 8: Medium woodland; salmon gum and gimlet (on fringe).

Beard vegetation association 1061: Mosaic; medium sparse woodland; salmon gum and yorrel/ succulent steppe; saltbush and samphire.

Overall vegetation structure and cover (for vegetated areas only)

Vegetation layer	Canopy cover class	Dominant species
Trees	2–10%	*Eucalyptus salubris*
mallees	0	
Shrubs	30–70%	*Atriplex nana, Maireana* spp.
Grasses	< 2%	*Eragrostis dielsii*
Herbs	< 2%	Mixed
Rushes and sedges	< 2%	*Lomandra effusa*
Litter	2–10%	
Bare ground	30–70%	
Rock outcrop	0	

Summary

The valley slopes have *Eucalyptus salmonophloia* and *E. myriadena* woodland. The valley floors and lower slopes are *Eucalyptus salubris* woodland. The lower areas near the stream channels are now *Halosarcia* spp. and *Frankenia* sp shrubland, with dead sticks indicating that formerly there was woodland or *Melaleuca* spp. shrubland covering much of this area. The lunettes have *Callitris canescens* and *Melaleuca hamata* shrubland, which merges into the *Eucalyptus salubris* woodland. Much of the site south of the river and surrounding the lake on the valley floor has been cleared in the past and has regenerated to *Atriplex* spp. and *Maireana* spp. shrubland. This would probably have been gimlet woodland before clearing.

Individual vegetation association descriptions	
Vegetation 1	*Eucalyptus salmonophloia* and *E. myriadena* sparse woodland over *Pittosporum angustifolium* very sparse shrubs over *Atriplex* spp. sparse shrubs.
Vegetation 2	*Eucalyptus salubris* very sparse woodland over *Acacia* sp. and *Exocarpos aphyllus* very sparse shrubs over *Eremophila scoparia, E. oppositifolia* and *Grevillea acuaria* sparse shrubs over *Atriplex* spp., *Olearia muelleri* and *Scaevola spinescens* very sparse shrubs.
Vegetation 3	*Callitris canescens* and *Melaleuca hamata* very sparse shrubland over *Jacksonia* sp., *Grevillea huegelii* and *Darwinia halophila* sparse shrubs.
Vegetation 4	*Atriplex* spp. and *Maireana* spp. open shrubland.
Vegetation 5	*Halosarcia* spp. and *Frankenia* sp. sparse shrubland.

Native species	
Scientific name	**Common name**
Acacia erinacea	Spiny wattle
Acacia merrallii	Merrall's wattle
Acacia sp.	Wattle
Amphipogon strictus	Greybeard grass
Aristida contorta	Bunched kerosene grass
Atriplex nana	Saltbush
Atriplex paludosa	Marsh saltbush
Austrodanthonia spp.	Wallaby grass
Austrostipa elegantissima	Feather speargrass
+ *Callitris canescens*	White cypress pine
+ *Darwinia halophila*	Darwinia
Disphyma crassifolium	Round pig face
Dodonaea viscosa subsp. angustissima	Sticky hopbush
Enchylaena tomentosa	Ruby saltbush
Eremophila oppositifolia	Weeooka
Eremophila scoparia	Broom bush
Eucalyptus loxophleba	York gum
Eucalyptus myriadena	Eucalypt
Eucalyptus salmonophloia	Salmon gum
Eucalyptus salubris	Gimlet
+ *Eucalyptus sargentii*	Salt River gum
Exocarpos aphyllus	Leafless ballart
Frankenia sp.	Frankenia
Grevillea acuaria	Grevillea
+ *Grevillea huegelii*	Grevillea
Gunniopsis quadrifida	Sturts pigface
Halosarcia spp.	Samphire
+ *Jacksonia* sp.	Jacksonia
Lomandra effusa	Scented matrush
Maireana carnosa	Cottony bluebush

Native species (continued)	
Scientific name	**Common name**
Maireana triptera	Threewinged bluebush
Melaleuca hamata	Broombush
Melaleuca pauperiflora	Boree
Olearia muelleri	Dusky daisy bush
Pittosporum angustifolium	Native apricot, native willow
Ptilotus exaltatus	Tall mulla mulla
Santalum acuminatum	Quandong
Scaevola spinescens	Maroon bush
Sclerolaena drummondii	
Sclerolaena diacantha	Grey copper-burr
Tecticornia lylei	Samphire

+ Regeneration noted

Weed species	
Scientific name	**Common name**
Bromus rubens	Red brome
Cotula bipinnata	Ferny cotula
Mesembryanthemum nodiflorum	Slender ice-plant
Solanum hoplopetalum	Afghan thistle

Other plant lists for the general area
Beard (1979)
Beard (1980)
Lefroy et al. (1991)

Vegetation condition

Condition	Description	% of site
Revegetation	An area of formerly cleared or otherwise degraded land that has been replanted	0
Pristine	No obvious signs of disturbance	0
Excellent	Vegetation structure intact, disturbance affecting individual species only and weeds non-aggressive species	0
Very good	Vegetation structure altered, obvious signs of disturbance	15
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate	10
Degraded	Basic vegetation structure severely impacted by disturbance. Regeneration to good condition requires intensive management	70
Completely degraded	Vegetation structure no longer intact and the area is without/almost without native species	5

Disturbance factors contributing to vegetation condition score							
Disturbance factor	**Level of threat**			**Disturbance factor**	**Level of threat**		
	H	**M**	**L**		**H**	**M**	**L**
Salinity	x			Rubbish			x
Waterlogging	x			Plant disease			
Ponding from road crossing				Erosion			x
Drainage				Service corridors			
Clearing		x		Feral animals		x	
Fire risk			x	Recreation			x
Weed invasion			x	Point source discharge			
Stock access	x			Other			
Vehicle access			x				

Comments

The main threats to the site are from increasing salinity and watertable rise. The site is not fenced but there is no evidence of damage caused by livestock grazing.

Links to protected areas of remnant vegetation

Name	**Area** (ha)	**Approximate distance and direction from site**
Cookinbin Nature Reserve	377	8 km NE
Lake Campion Nature Reserve	10 651	9 km E

Management

There are considerable areas that have been cleared in the past: these have regenerated into a shrubland but could benefit from revegetation with tree and taller shrub species. The site is unfenced on the south side and could benefit from fencing, however the regenerated areas may be useful as livestock feed. If these were not revegetated they could be kept as a grazing area, with a fence to the north protecting the main channel and vegetated areas, and perhaps additional saltland grazing species planted in this area. Rabbits are a problem and control is recommended. The major threats of increasing salinity and watertable rise must be addressed at a catchment scale.

Fauna

Scientific name	**Common name**
Birds	
Accipiter fasciatus	brown goshawk
Artamus cinereus	black-faced woodswallow
Coracina novaehollandiae	Black-faced cuckoo-shrike
Cracticus tibicen	Magpie

Fauna (continued)	
Scientific name	**Common name**
Birds	
Dromaius novaehollandiae	Emu
Ocyphaps lophotes	Crested pigeon
Platycercus zonarius	Australian ringneck parrot
Rhipidura leucophrys	Willy wagtail
Mammals	
Macropus fuliginosus	Western grey kangaroo
**Oryctolagus cuniculus*	Rabbit
* Introduced species	
Other fauna lists for the general area	
Lefroy et al. (1991)	

Notes:

From field observations:

- There was more leaf litter than other sites.
- Cryptogam crust was seen to be lifting, indicating soil structure decline, in the gimlet woodland in the east-central area.
- The cryptogam crust in the regenerated area was in good condition, covering up to 70% of the soil surface.
- There is excellent regeneration of shrub species along the edge of the lake at what appears to be at the ‘normal’ winter water level line: *Jacksonia* sp., *Grevillea* spp., *Darwinia halophila*, *Melaleuca hamata, Eucalyptus* spp. including *E. sargentii*, and good regeneration higher up on the lunette in the burnt area, largely of the same species.
- There has been a fire along the lunette of the large lake, probably due to a lightening strike.
- There is an abandoned BBQ and shelter area on the lake edge.
- There was a dam across the lake exit but this is now broken.
- There was very little *Mesembryanthemum nodiflorum* (ice-plant) on the site, which is unusual.
- There are some gypsum deposits in the lunettes, but if any has been extracted it has only been a small amount. Generally the soil surface was loose and powdery.

- There is a rabbit warren in the gypsum area of the lunette.
- Recent roadworks have widened the road to the east, and have used the site to dump piles of trees cleared for widening.

Discussions with Mrs Jolly:

- The site has only been owned by Greg Jolly for about one year so he was unable to provide a detailed site history
- The dam was a private ski lake.
- Formerly owned by Mark Williams, son of Fred.

Discussions with Fred Williams 13 Feb 2008:

- The lake was a ski lake, with the water up to 4–5 feet (1.5 m) deep in a good year. The ski lake was a local attraction that had up to 20 boats on it at a time.
- The dam holding the water broke in 1963.
- The lake has silted up in recent times (as has the whole river system).
- There hasn't been any gypsum extraction from this site: the gypsum deposits were too small to make it worthwhile (it was 'kopi' gypsum which requires twice as much applied to have the same effect as the usual commercial gypsum).
- He didn't know about the burnt areas.
- Fred's opinion is that the salinity isn't getting any worse in the lake country.
- The cleared area south of the lake was cleared by overenthusiastic contractors about 25 years ago and was eventually sown to bluebush (see notes for YR07).

Plate A1.47: YR08 very good *condition vegetation association 1:* Eucalyptus salmonophloia *and* E. myriadena *woodland*

Plate A1.48: YR08 very good *condition vegetation association 2:* Eucalyptus salubris *woodland*

Plate A1.49: YR08 very good *condition vegetation association 3:* Callitris canescens *and* Melaleuca hamata *shrubland*

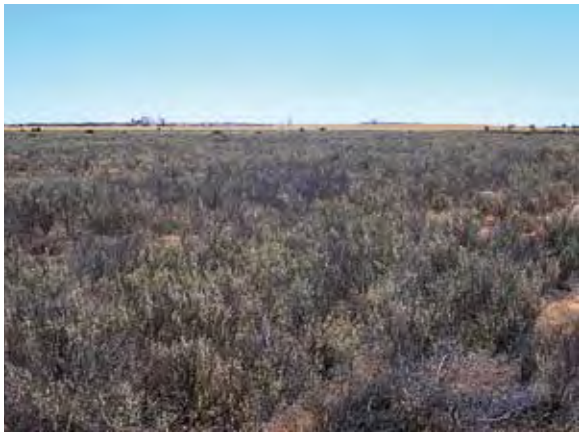


Plate A1.50: YR08 degraded *condition vegetation association 4:* Atriplex *spp. and* Maireana *spp. shrubland (regenerated area)*

Plate A1.51: YR08 degraded *condition vegetation association 5:* Halosarcia *spp. and* Frankenia *sp. shrubland*

Plate A1.52: YR08 lake edge showing regeneration. Note that there were other areas with more dense regeneration

Plate A1.53: YR08 broken dam on main lake

Plate A1.54: YR08 former BBQ area on edge of main lake

Plate A1.55: YR08 burnt area on lunette

Plate A1.56: YR08 rabbit warren on lunette

Plate A1.57: YR08 degraded *condition area near north-western corner*

Plate A1.58: YR08 degraded *condition area on 'island' between main and secondary channels*

Map A8
Vegetation condition for survey site YR08 Jolly's

LOCALITY MAP

LEGEND

Vegetation condition

- Revegetation
- Pristine
- Excellent
- Very good
- Good
- Degraded
- Completely degraded

Boundary

- Yilgarn survey site

Imagery

Merredin imagery 2004

N

0 100 200 300

Metres

Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum:GDA 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

Project Information
Client: Kate Gole
Map Author: Moses Gatenjwa
Task ID: 6979
Filepath: J:\gisprojects\Project\B_Series \B4148\0004_YilgarnRiver_wwa\mxd
Filename: YR09_vegetation_condition.mxd
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SOURCES

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

Yilgarn vegetation condition – DoW – 2008
Yilgarn survey sites – DoW – 2008
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Government of **Western Australia**
Department of **Water**

This map is a product of the Department of Water Spatial Analysis Division and was completed in August 2008.

This map was produced with the intent that it be used for display purposes at the scale of 1:14 000 when printing at A4.

Site YR9 — Lake Brown

General details	
Site name	Lake Brown
Landholder	DEC
Surveyed by	Lyn Atkins and Natalie Randall (Ecoscape)
Date	22.11.2007

Site description	
Landform	The site is almost entirely in the floodplain of the Yilgarn River, and largely consists of the vegetated fringe and lunettes of Lake Brown. Lake Brown Nature Reserve consists of a large bare salt lake on the Yilgarn River with fringing vegetation. There are several small tributaries entering the lake, and areas where the tributaries are trapped behind the tall gypsum dunes surrounding the lake, forming smaller lakes with no connection to the main lake. The lunettes, which are either sand or gypsum, are at times over 10 m high. An area of granite outcropping on the edge of the lake was also surveyed. There was a small area of lower valley slope vegetation included in the survey.
Site size	3660 ha

Beard vegetation description

Beard vegetation association 8: Medium woodland; salmon gum and gimlet (on fringe).

Beard vegetation association 125: Bare areas; salt lakes.

Beard vegetation association 413: Shrublands; *Acacia neurophylla* and *A.* sp. thicket (on fringe).

Beard vegetation association 1061: Mosaic; medium sparse woodland; salmon gum and yorrel/ succulent steppe; saltbush and samphire.

Overall vegetation structure and cover (for vegetated areas only)

Vegetation layer	Canopy cover class	Dominant species
Trees	2–10%	*Eucalyptus salicola, E. myriadena, E. salmonophloia*
mallees	0	
Shrubs	10–30%	*Halosarcia* spp.
Grasses	< 2%	*Spartochloa scirpoidea*
Herbs	< 2%	Mixed
Rushes and sedges	< 2%	*Lomandra effusa*
Litter	< 2%	
Bare ground	70–100%	
Rock outcrop	2–10%	

Summary

The fringes of the salt lakes and along the river edges and tributaries have *Halosarcia* spp. shrubland. Lake Brown is almost entirely surrounded by tall lunettes with *Eucalyptus salicola, E. myriadena* or *E. salmonophloia* woodland depending on substrate (sand or gypsum) and height above the lake, or *Melaleuca lateriflora* shrubland in flatter areas. Eaglestone Rock has *Acacia lasiocalyx* woodland in the rock fissures. The lower valley slopes have *Eucalyptus salmonophloia* woodland.

Individual vegetation association descriptions

Vegetation 1	*Eucalyptus salicola* sparse woodland over *Eremophila* sp. very sparse shrubs over *Olearia dampieri* subsp. *eremicola, Westringia cephalantha* and *Rhagodia preissii* sparse shrubs over *Lomandra effusa* very sparse herbs.
Vegetation 2	*Halosarcia* spp. sparse shrubland.
Vegetation 3	*Eucalyptus myriadena* sparse woodland over *Melaleuca hamata* very sparse shrubs over *Atriplex nana* very sparse shrubs.
Vegetation 4	*Eucalyptus salmonophloia* very sparse woodland over *Pittosporum angustifolium* and *Acacia* sp. very sparse shrubs over *Acacia hemiteles, Exocarpos aphyllus* and *Acacia* sp. very sparse shrubs over *Rhagodia preissii, Atriplex* sp. and *Olearia muelleri* very sparse shrubs.
Vegetation 5	*Acacia lasiocalyx* very sparse woodland over *Philotheca brucei* very sparse shrubs over *Spartochloa scirpoidea* very sparse grass over *Dianella revoluta* very sparse herbs.
Vegetation 6	*Melaleuca lateriflora* sparse shrubs over *Enchylaena tomentosa* and *Rhagodia preissii* very sparse shrubs over mixed introduced very sparse herbs.

Native species

Scientific name	Common name
+ *Acacia acuminata*	Jam
Acacia colletioides	Wait-a-while
Acacia hemiteles	Tan wattle
+ *Acacia lasiocalyx*	Silver wattle
Acacia sp.	Wattle
Acacia tetragonophylla	Kurara
Actinobole uliginosum	Flannel cudweed
Alyxia buxifolia	Dysentery bush
Aristida contorta	Bunched kerosene grass
Atriplex nana	Saltbush
Atriplex sp.	Saltbush
Austrostipa elegantissima	Feather speargrass
Austrostipa spp.	Speargrass
Borya sphaerocephala	Pin-grass
Callitris canescens	White cypress pine
Calycopeplus paucifolius	Broom spurge
Dianella revoluta	Blueberry lily
Dodonaea viscosa subsp. *angustissima*	Sticky hopbush
Eragrostis dielsii	Mallee lovegrass
Eremophila sp.	Poverty bush

Native species (continued)

Scientific name	Common name
Eucalyptus loxophleba subsp*. loxophleba*	York gum
Eucalyptus myriadena	Eucalypt
+ *Eucalyptus salicola*	Salt gum
Eucalyptus salubris	Gimlet
+ *Eucalyptus yilgarnensis*	Yorrel
Frankenia sp.	Frankenia
Grevillea paniculata	Grevillea
Gunniopsis quadrifida	Sturts pigface
Hakea recurva	Djarnokmurd
Halosarcia spp.	Samphire (5-6 species)
Jacksonia sp.	Jacksonia
Kunzea pulchella	Granite kunzea
Lepidosperma spp.	Sword sedge
Leptospermum erubescens	Roadside tea-tree
Leptospermum nitens	Tea-tree
Lomandra effusa	Scented matrush
Maireana spp.	Bluebush
Melaleuca atroviridis	Broombush
Melaleuca halmaturorum	Paperbark
Melaleuca hamata	Broombush
Melaleuca macronychia	
Olearia dampieri subsp*. eremicola*	Daisy-bush
Olearia muelleri	Dusky daisy-bush
Philotheca brucei	
+ *Pittosporum angustifolium*	Native apricot, native willow
Podolepis canescens	Bright podolepis
Podotheca gnaphalioides	Sticky longheads
Ptilotus obovatus	Cotton bush
Rhagodia preissii	Rhagodia
Roycea spinescens	
Spartochloa scirpoidea	
Templetonia sulcata	Centipede bush
Threlkeldia diffusa	Coast bonefruit
Thryptomene australis	Hook-leaf thryptomene
Westringia cephalantha	Westringia
Zygophyllum sp.	Twin-leaf

+ *Regeneration noted*

Weed species

Scientific name	Common name
Aira cupaniana	Hair-grass
Avena fatua	Wild oat
Brassica tournefortii	Wild turnip
Bromus rubens	Red brome
Carpobrotus edulis	Hottentot fig
Mesembryanthemum nodiflorum	Slender ice-plant
Pentaschistis airoides	False hair-grass

Other plant lists for the general area
Beard (1979)
Beard (1980)
Lefroy et al. (1991)

Vegetation condition

Condition	**Description**	**% of site**
Revegetation	An area of formerly cleared or otherwise degraded land that has been replanted	0
Pristine	No obvious signs of disturbance	0
Excellent	Vegetation structure intact, disturbance affecting individual species only and weeds non-aggressive species	10
Very good	Vegetation structure altered, obvious signs of disturbance	40
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate	20
Degraded	Basic vegetation structure severely impacted by disturbance. Regeneration to good condition requires intensive management	25
Completely degraded	Vegetation structure no longer intact and the area is without/almost without native species	5

Disturbance factors contributing to vegetation condition score

Disturbance factor	**Level of threat**			**Disturbance factor**	**Level of threat**		
	H	**M**	**L**		**H**	**M**	**L**
Salinity			x	Rubbish			x
Waterlogging			x	Plant disease			
Ponding from road crossing			x	Erosion		x	
Drainage				Service corridors			
Clearing	x			Feral animals			x
Fire risk	x			Recreation		x	
Weed invasion	x			Point source discharge			
Stock access		x		Other: mining	x		
Vehicle access		x					

Comments

Most of the vegetation within the site is on lunettes or granite outcrops and is therefore less likely to be affected by increasing salinity and waterlogging than other sites. The site is fenced (it is a nature reserve) and largely ungrazed, however much of the lake bed and lunettes on the eastern and south-eastern sides are excised from the reserve and mined for gypsum. Some leases are currently not active and, if they come into use, will result in vegetation destruction on the lunettes, thus clearing is a threat on this site. Although the site is fenced, some of the fences are in poor condition thus grazing may be a threat in some areas. The site mostly consists of a narrow strip of vegetation along the edges of the lakes and fringing lunettes, thus the potential for soil disturbance and erosion from grazing, by either livestock or feral animals (rabbits), or weed invasion from the surrounding farmland are high, thus maintaining the fences and firebreaks is a management priority. Rubbish dumping along the lake edge is common. The lake bed is also frequently used by vehicles, both cars and motorbikes, for recreation, which may lead to erosion on the lake edges and disturbance of fringing vegetation. Eaglestone Rock is a picnic area, thus threats from recreational use, including rubbish dumping, off-road vehicle use and fire, may also be perceived as a threat to the vegetation on this site. The major threats to the site (salinity and waterlogging) must be managed at a catchment scale.

Links to protected areas of remnant vegetation

Name	**Area** (ha)	**Approximate distance and direction from site**
Cookinbin Nature Reserve	377	9 km NW

Management

Although the site is largely fenced, some of the fences are in poor condition and should be improved to prevent livestock from accessing the nature reserve. A buffer of trees (agroforesty) may be beneficial.

Fauna

Scientific name	**Common name**
Birds	
Aquila audax	Wedge-tailed eagle
Cacatua roseicapilla	Galah
Coracina novaehollandiae	Black-faced cuckoo-shrike
Cracticus torquatus	Grey butcherbird
Dromaius novaehollandiae	Emu
Falco cenchroides	Australian kestrel, Nankeen kestrel
Grallina cyanoleuca	Peewee or magpie-lark
Lichenostomus virescens	Singing Honey-eater
Manorina flavigula	Yellow throated miner
Merops ornatus	Rainbow bee-eater
Ocyphaps lophotes	Crested pigeon
Platycercus zonarius	Australian ringneck parrot
Mammals	
Macropus fuliginosus	Western grey kangaroo
**Oryctolagus cuniculus*	Rabbit

** Introduced species*

Other fauna lists for the general area
Lefroy et al. (1991)

Notes:

From field observations:

- Fences were either missing or in poor condition in places, although there was not a lot of livestock in the area at the time of survey.
- The north side of the lake has high gypsum dunes 5-6 m high with soil crust stabilising the surface (in comparison with YR09, where there was no soil crust and the surface was powdery). Behind the gypsum dunes were sand lunettes, but these were mostly outside of the surveyed area.
- The south side of the lake had higher gypsum dunes than the north, over 10 m high. The highest dunes were near the south-east corner.
- There were lakes or low-lying samphire areas trapped behind the dunes, some with tributaries running into them. This was more common on the south side of the lake. Other tributaries ran parallel and behind the dunes until they entered the lake.
- Eaglestone Rock is a tall granite outcrop on the western edge. There were other small granite intrusions into the lake along the southern edge.
- The area adjacent to the gypsum mine was not surveyed as it was inaccessible (signs saying ‘no entry’, gate across road, active mining in progress). However, there appeared to be very little vegetation present.
- Emus were observed on the lake bed, a reasonable distance from the edge.
- A red and white survey marker peg was observed on the northern edge of the lake.
- There was some rubbish dumping within the nature reserve.

Plate A1.59: YR09 excellent *condition vegetation association 1:* Eucalyptus salicola *woodland*

Plate A1.60: YR09 good *condition vegetation association 2:* Halosarcia *spp. shrubland*

Plate A1.61: YR09 good *condition vegetation association 3:* Eucalyptus myriadena *woodland*

Plate A1.62: YR09 very good *condition vegetation association 4:* Eucalyptus salmonophloia *woodland*

Plate A1.63: YR09 excellent *condition vegetation association 5:* Acacia lasiocalyx *woodland*

Plate A1.64: YR09 very good *condition vegetation association 6:* Melaleuca lateriflora *shrubland*

Plate A1.65: YR09 Brady's gypsum mine on lake bed

Plate A1.66: YR09 soil disturbance on lunettes, possibly due to prospecting for gypsum deposits

Plate A1.67: YR09 high gypsum dunes on south side of Lake Brown

Plate A1.68: YR09 small lake trapped behind gypsum dunes, south of Lake Brown

Plate A1.69: YR09 Eaglestone Rock

Plate A1.70: YR09 view over rock area near south-west corner of site

Plate A1.71: YR09 rubbish dumped in nature reserve. This dump is mostly old farm machinery, but is used for shooting practice

Plate A1.72: YR09 degraded *condition area: low-lying area behind fringing lunette*

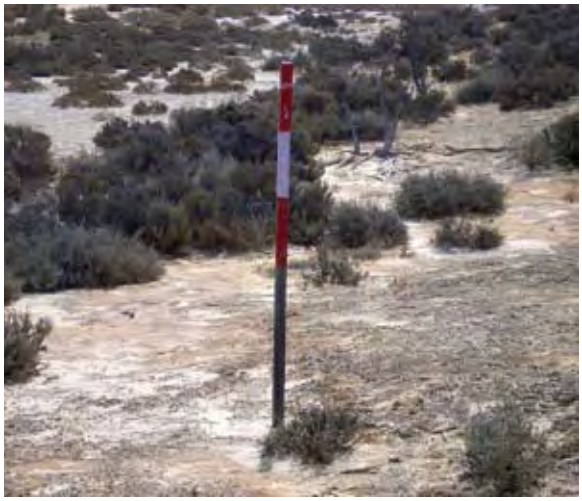

Plate A1.73: YR09 survey marker

Map A9
Vegetation condition for survey site YR09 Lake Brown

LOCALITY MAP

LEGEND

Vegetation condition

- Revegetation
- Pristine
- Excellent
- Very good
- Good
- Degraded
- Completely degraded

Boundary

- Yilgarn survey site

Imagery

Merredin imagery 2004

N

0 425 850

Metres

Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum:GDA 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

Project Information
Client: Kate Gole
Map Author: Moses Gatenjwa
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Filename: YR09_vegetation_condition_1.mxd
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Yilgarn vegetation condition – DoW – 2008
Yilgarn survey sites – DoW – 2008
Merredin 50cm Orthomosaic – Landgate – 2004

Government of **Western Australia**
Department of **Water**

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This map was produced with the intent that it be used for display purposes at the scale of 1:50 000 when printing at A4.

Site YR10 — Lake Campion Nature Reserve A

General details	
Site name	Lake Campion Nature Reserve A
Landholder	DEC
Surveyed by	Lyn Atkins and Natalie Randall (Ecoscape)
Date	23.11.2007

Site description	
Landform	The site occupies the western portion of Lake Campion Nature Reserve and is situated on the floodplain and lower valley slopes of the Yilgarn River. It includes Lake Campion, which is a large dry salt lake, several smaller playa lakes not connected to the river or Lake Campion, and backfill lakes and low-lying areas that fill in times of high flow. Between the lakes are raised areas of consolidated dunes. The sides of Lake Campion are steep, particularly on the north side, and the lunettes are 2–3 m high, sometimes higher. They are occasionally comprised of gypsum. There is a series of low parallel sand dunes with north-east / south-west orientation south of the eastern extremity of Lake Campion. There are several small tributaries flowing into the site. The main channel is wide and clear, and mostly straight.
Site size	1639 ha

Beard vegetation description

Beard vegetation association 125: Bare areas; salt lakes.

Beard vegetation association 1061: Mosaic; medium sparse woodland; salmon gum and yorrel/ succulent steppe; saltbush and samphire.

Overall vegetation structure and cover (for vegetated areas only)

Vegetation layer	Canopy cover class	Dominant species
Trees	2–10%	*Eucalyptus salubris*
mallees	0	
Shrubs	10–30%	*Eremophila* sp., *Olearia muelleri, Atriplex* sp.
Grasses	< 2%	*Eragrostis dielsii*
Herbs	< 2%	*Disphyma crassifolium*, *Maireana carnosa*
Rushes and sedges	< 2%	*Lomandra effusa*
Litter	2–10%	
Bare ground	70–100%	
Rock outcrop	0	

Summary

The edges of the salt lakes, stream channels and low-lying areas are *Halosarcia* spp. shrubland. In the most degraded areas dead sticks indicate that possibly a *Melaleuca* spp. shrubland formerly occupied this area. Upslope on the lunettes is *Callitris canescens* and *Eremophila oppositifolia* shrubland, while on the raised flatter areas and lower valley slopes the vegetation is mostly *Eucalyptus salubris* and *E. myriadena* woodland, with areas of *Acacia* sp. and *Templetonia sulcata* shrubland.

Individual vegetation association descriptions

Vegetation 1	*Eucalyptus salubris* and *E. myriadena* very sparse woodland over *Eremophila* sp very sparse shrubs over *Olearia muelleri* and *Atriplex* sp. very sparse shrubland.
Vegetation 2	*Callitris canescens* and *Eremophila oppositifolia* very sparse shrubland over *Hakea preissii* very sparse shrubs over *Scaevola spinescens*, *Rhagodia preissii* and *Atriplex* sp. very sparse shrubs.
Vegetation 3	*Halosarcia* spp. very sparse shrubland.
Vegetation 4	*Acacia* sp. and *Templetonia sulcata* very sparse shrubland over *Grevillea acuaria, Eremophila decipiens* and *Atriplex* sp. sparse shrubs over *Disphyma crassifolium* and *Maireana carnosa* very sparse herbs.

Native species

Scientific name	Common name
Acacia acuminata	Jam
Acacia assimilis	Wodjil
Acacia colletioides	Wait-a-while
Acacia erinacea	Spiny wattle
Acacia fragilis	Wodjil
Acacia merrallii	Merrall's wattle
Acacia sp.	Wattle
Acacia tetragonophylla	Kurara
Argyroglottis turbinata	Daisy
Atriplex nana	Saltbush
Atriplex sp.	Saltbush
Austrostipa spp.	Speargrass
+ *Callitris canescens*	White cypress pine
Darwinia halophila	Darwinia
Daviesia sp.	
Disphyma crassifolium	Round pig face
Eragrostis dielsii	Mallee lovegrass
Eremophila decipiens	Slender fuchsia
Eremophila ionantha	Violet-flowered eremophila
Eremophila oppositifolia	Weeooka
Eremophila scoparia	Broom bush
Erymophyllum tenellum	Everlasting
Eucalyptus loxophleba subsp. loxophleba	York gum
Eucalyptus myriadena	Eucalypt

Native species (continued)	
Scientific name	**Common name**
Eucalyptus salmonophloia	Salmon gum
+ *Eucalyptus salubris*	Gimlet
Exocarpos aphyllus	Leafless ballart
Frankenia sp.	Frankenia
Grevillea acuaria	Grevillea
Hakea preissii	Needle tree
Halosarcia spp.	Samphire
Jacksonia sp.	Jacksonia
Lomandra effusa	Scented matrush
Lycium australe	Australian boxthorn, water bush
Maireana carnosa	Cottony bluebush
Maireana georgei	Satiny bluebush
Maireana triptera	Threewinged bluebush
Melaleuca halmaturorum	Paperbark
+ *Melaleuca hamata*	Broombush
Melaleuca lateriflora	Gorada
Melaleuca scalena	Broombush
Olearia dampieri subsp. eremicola	Daisy-bush
Olearia muelleri	Dusky daisy bush
Olearia sp.	Daisy-bush
Pittosporum angustifolium	Native apricot, native willow
Santalum acuminatum	Quandong
Santalum spicatum	Sandalwood
Scaevola spinescens	Maroon bush
Sclerolaena diacantha	Grey copper-burr
+ *Senna pleurocarpa*	Native senna
Tecticornia lylei	Samphire
Templetonia sulcata	Centipede bush
Threlkeldia diffusa	Coast bonefruit
Westringia cephalantha	Westringia

+ *Regeneration noted*

Weed species	
Scientific name	**Common name**
Avena fatua	Wild oat
Bromus rubens	Red brome
Mesembryanthemum nodiflorum	Slender ice-plant

Other plant lists for the general area
Beard (1979)
Beard (1980)
Lefroy et al. (1991)

Vegetation condition		
Condition	**Description**	**% of site**
Revegetation	An area of formerly cleared or otherwise degraded land that has been replanted	0
Pristine	No obvious signs of disturbance	0
Excellent	Vegetation structure intact, disturbance affecting individual species only and weeds non-aggressive species	0
Very good	Vegetation structure altered, obvious signs of disturbance	60
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate	10
Degraded	Basic vegetation structure severely impacted by disturbance. Regeneration to good condition requires intensive management	10
Completely degraded	Vegetation structure no longer intact and the area is without/almost without native species	20

Disturbance factors contributing to vegetation condition score							
Disturbance factor	**Level of threat**			**Disturbance factor**	**Level of threat**		
	H	**M**	**L**		**H**	**M**	**L**
Salinity	x			Rubbish			x
Waterlogging	x			Plant disease			
Ponding from road crossing				Erosion		x	
Drainage				Service corridors			
Clearing				Feral animals			x
Fire risk	x			Recreation			
Weed invasion		x		Point source discharge			
Stock access		x		Other			
Vehicle access							

Comments
The major threats to the low-lying areas on this site are increasing salinity and waterlogging. The site is a nature reserve but some areas appear to be unfenced or have fencing in poor condition, so livestock grazing may be a threat. Some areas show signs of soil erosion, possibly due to livestock. Due to the extensive areas of woodland, uncontrolled fire may also be a major threat.

Links to protected areas of remnant vegetation		
Name	**Area** (ha)	**Approximate distance and direction from site**
None within a 10 km radius		

Management
Some sections of the perimeter fence on the northern side are missing or in poor condition and should be replaced or repaired to prevent livestock entering the reserve. A buffer of trees (agroforestry) may be beneficial to reduce wind erosion on the edges of the reserve. The major threats of salinity and watertable rise must be managed at a catchment scale.

Fauna	
Scientific name	**Common name**
Birds	
Anthochaera carunculata	Red wattlebird
Anthus australis	Australian pipit
Artamus cinereus	Black-faced woodswallow
Coracina novaehollandiae	Black-faced cuckoo-shrike
Cracticus nigrogularis	Pied butcher bird
Cracticus tibicen	Magpie
Dromaius novaehollandiae	Emu
Falco cenchroides	Australian kestrel, Nankeen kestrel
Grallina cyanoleuca	Peewee or magpie-lark
Hirundo neoxena	Welcome swallow
Manorina flavigula	Yellow throated miner
Ocyphaps lophotes	Crested pigeon
Oreoica gutturalis	Crested bellbird
Pardalotus striatus	Striated pardalote
Petroica goodenovii	Red-capped robin
Platycercus zonarius	Australian ringneck parrot
Pomatostomus superciliosus	White-browed babbler
Mammals	
Macropus fuliginosus	Western grey kangaroo
Macropus robustus	Euro, common wallaroo
Tachyglossus aculeatus	Echidna
**Oryctolagus cuniculus*	Rabbit

* *Introduced species*

Other fauna lists for the general area
Lefroy et al. (1991)

Notes:

From field observations:

- The main channel enters the lake in the south central area, and exits in the west central area. It is wide and clear.
- There are gypsum dunes along the northern edge of the main lake, and forming the smaller lakes in the north-east corner of the site.

- Pedestalling and soil erosion was observed along the northern edge of the reserve. There is little buffering vegetation between the edge of the reserve and the lake edge. Revegetation may help reduce water and wind erosion, but as the likely cause was probably livestock grazing, excluding stock by fencing will also help to manage this problem.
- Kangaroo and (probably) livestock trails were observed to cause soil erosion.
- Most of the vegetated area is gimlet woodland, with occasional salmon gum over mixed shrubs understorey. *Callitris* is present on and near dunes.
- Sandalwood is common – this is the only site it was observed on.
- Most of the vegetation is in *very good* condition, although it appears senescent and there is too much bare ground for the vegetation to be allocated a higher vegetation condition rating.
- Low-lying *Melaleuca* areas show the water line along the main stream, indicating prolonged submersion.
- There are parallel dunes along the south-eastern edge of lake. They are largely bare.
- *Callitris canescens* is burnt in places, but the fires don't appear to have spread.

Plate A1.74: YR10 very good *condition vegetation association 1:* Eucalyptus salubris *and* E. myriadena *woodland*

Plate A1.75: YR10 very good *condition vegetation association 2:* Callitris canescens *and* Eremophila oppositifolia *shrubland*

Plate A1.76: YR10 completely degraded *condition vegetation association 3:* Halosarcia *spp. shrubland*

Plate A1.77: YR10 very good *condition vegetation association 4:* Acacia *sp. and* Templetonia sulcata *shrubland*

Plate A1.78: YR10 parallel dunes

Plate A1.79: YR10 soil erosion and pedestalling at base of plants

Plate A1.80: YR10 Lake Campion edge

Plate A1.81: YR10 playa lake

Plate A1.82: YR10 gypsum dune on north edge of Lake Campion

Map A10
Vegetation condition for survey site YR10 Lake Campion Nature Reserve A

LOCALITY MAP

LEGEND

Vegetation condition

- Revegetation
- Pristine
- Excellent
- Very good
- Good
- Degraded
- Completely degraded

Boundary

- Yilgarn survey site

Imagery

Merredin imagery 2004

N

0 400 800

Metres

Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum:GDA 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

Project Information
Client: Kate Gole
Map Author: Moses Gatenjwa
Task ID: 6979
Filepath: J:\gisprojects\Project\B_Series \B4148\0004_YilgarnRiver_wwa\mxd
Filename: YR10_vegetation_condition.mxd
Compilation date: August 2008
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SOURCES

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Yilgarn vegetation condition – DoW – 2008
Yilgarn survey sites – DoW – 2008
Merredin 50cm Orthomosaic – Landgate – 2004

Government of **Western Australia**
Department of **Water**

This map is a product of the Department of Water Spatial Analysis Division and was completed in August 2008.

This map was produced with the intent that it be used for display purposes at the scale of 1:35 000 when printing at A4.

Site YR11 — Lake Campion Nature Reserve B

General details	
Site name	Lake Campion Nature Reserve B
Landholder	DEC
Surveyed by	Lyn Atkins and Natalie Randall (Ecoscape)
Date	22.11.2007

Site description	
Landform	The site is within part of the eastern end of Lake Campion Nature Reserve, and is within the floodplain and lower valley slopes of the Yilgarn River. The main channel is wide and clear, with gentle curves and no braiding or anabranching. There are banks of sediment apparent in the stream channel. There are low-lying areas adjacent to the main channel and a tributary entering from the north-east and a drain into the site along the main channel, entering from the eastern side. There is only one playa lake on the edge of the surveyed area. North of the river channel the ground is low-lying and flat, although it is likely to be inundated only in extreme floods. There are lunettes, over 1 m high, along the southern bank of the main channel, on the southern side of the playa lake and bordering the southern edge of some of the low-lying areas. The lower valley slopes are only slightly raised above the floodplain, and on the south consists of aeolian deposits
Site size	585 ha

Beard vegetation description

Beard vegetation association 511: Medium woodland; salmon gum and morrell.

Beard vegetation association 1061: Mosaic; medium sparse woodland; salmon gum and yorrel/ succulent steppe; saltbush and samphire.

Overall vegetation structure and cover (for vegetated areas only)

Vegetation layer	Canopy cover class	Dominant species
Trees	2–10%	*Eucalyptus salubris, E. longicornis*
Mallees	< 2%	*Eucalyptus sheathiana*
Shrubs	10–30%	*Halosarcia* spp., *Atriplex* spp.
Grasses	< 2%	*Eragrostis dielsii*
Herbs	2–10%	*Disphyma crassifolium*
Rushes and sedges	< 2%	*Lomandra effusa*
Litter	2–10%	
Bare ground	30–70%	
Rock outcrop	0	

Summary

Low-lying areas and along the drainage lines are *Halosarcia* spp. shrubland, sometimes with dead sticks indicating a former *Melaleuca* spp. overstorey. In places the *Halosarcia* spp. has recently died, and the only living plants are *Disphyma crassifolium* herbs. On slightly raised areas there is *Melaleuca* spp. shrubland. In some places the vegetation has recently dies and in others *Halosarcia* spp. are becoming more common as an understorey. The area north of the river is largely *Eucalyptus salubris* woodland, with patches of *Melaleuca* spp. shrubland on lower areas and *Acacia* sp. and *Exocarpos aphyllus* shrubland on higher areas. The vegetation south of the river is in places similar to the north, but more mosaic in nature, with the addition of small patches of *Melaleuca pauperiflora* shrubland or different tree species, especially on the lunettes. The lower valley slope on aeolian deposits is *Eucalyptus longicornis* woodland.

Individual vegetation association descriptions

Vegetation 1	Disphyma crassifolium very sparse herbland.
Vegetation 2	*Halosarcia* spp. sparse shrubland.
Vegetation 3	*Eucalyptus salubris* very sparse woodland over *Acacia* spp. and *Hakea preissii* very sparse shrubs over *Rhagodia preissii* and *Olearia dampieri subsp. eremicola* very sparse shrubs over *Disphyma crassifolium* very sparse herbs.
Vegetation 4	*Melaleuca hamata* and *M. lateriflora* sparse shrubland over *Frankenia* sp. sparse shrubs over *Disphyma crassifolium* very sparse herbs.
Vegetation 5	*Acacia* sp. and *Exocarpos aphyllus* sparse shrubland over *Grevillea acuaria, Scaevola spinescens* and *Hakea preissii* very sparse shrubs over *Maireana carnosa* very sparse herbs.
Vegetation 6	*Eucalyptus longicornis* very sparse woodland over *Eremophila* sp., *Templetonia sulcata* and *Exocarpos aphyllus* very sparse shrubs over *Atriplex bunburyana*. and *Lycium australe* sparse shrubs over *Austrostipa elegantissima* very spare grass.

Native species

Scientific name	Common name
Acacia merrallii	Merrall's wattle
Acacia sp.	Wattle
Alyxia buxifolia	Dysentery bush
Amyema miquelii	Stalked mistletoe
Atriplex bunburyana.	Silver saltbush
Atriplex nana	Saltbush
Atriplex vesicaria	Bladder saltbush
Austrostipa elegantissima	Feather speargrass
Disphyma crassifolium	Round pig face
Enchylaena tomentosa	Ruby saltbush
Eragrostis dielsii	Mallee lovegrass
Eremophila decipiens	Slender fuchsia
Eremophila oppositifolia	Weeooka
Eremophila scoparia	Broombush
Erymophyllum tenellum	Everlasting
Eucalyptus longicornis	Morrell
Eucalyptus salicola	Salt gum

Native species (continued)	
Scientific name	**Common name**
Eucalyptus salmonophloia	Salmon gum
+ *Eucalyptus salubris*	Gimlet
Eucalyptus sheathiana	Ribbon-barked gum
Eucalyptus yilgarnensis	Yorrel
Exocarpos aphyllus	Leafless ballart
Frankenia sp.	Frankenia
Grevillea acuaria	Grevillea
+ *Hakea preissii*	Needle tree
Hakea recurva	Djarnokmurd
Halosarcia spp.	Samphire
Lomandra effusa	Scented matrush
Lycium australe	Australian boxthorn, water bush
Maireana carnosa	Cottony bluebush
Maireana georgei	Satiny bluebush
Maireana sp.	Bluebush
Maireana triptera	Threewinged bluebush
Melaleuca brevifolia	Paperbark
Melaleuca hamata	Broombush
Melaleuca lateriflora	Gorada
Melaleuca pauperiflora	Boree
Melaleuca scalena	Broombush
Olearia dampieri subsp. *eremicola*	Daisy-bush
Olearia muelleri	Dusky daisy bush
Olearia sp.	Daisy-bush
Rhagodia preissii	Rhagodia
Santalum acuminatum	Quandong
Scaevola spinescens	Maroon bush
Sclerolaena? drummondii	
Sclerolaena diacantha	Grey copper-burr
Threlkeldia diffusa	Coast bonefruit
Westringia cephalantha	Westringia

+ *Regeneration noted*

Weed species	
Scientific name	**Common name**
Carpobrotus edulis	Hottentot fig
Mesembryanthemum nodiflorum	Slender ice-plant

Other plant lists for the general area
Beard (1979)
Beard (1980)
Lefroy et al. (1991)

Vegetation condition

Condition	Description	% of site
Revegetation	An area of formerly cleared or otherwise degraded land that has been replanted	0
Pristine	No obvious signs of disturbance	40
Excellent	Vegetation structure intact, disturbance affecting individual species only and weeds non-aggressive species	25
Very good	Vegetation structure altered, obvious signs of disturbance	5
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate	5
Degraded	Basic vegetation structure severely impacted by disturbance. Regeneration to good condition requires intensive management	10
Completely degraded	Vegetation structure no longer intact and the area is without/almost without native species	15

Disturbance factors contributing to vegetation condition score

Disturbance factor	Level of threat			Disturbance factor	Level of threat		
	H	M	L		H	M	L
Salinity	x			Rubbish			
Waterlogging	x			Plant disease			
Ponding from road crossing				Erosion			
Drainage	x			Service corridors			
Clearing				Feral animals		x	
Fire risk	x			Recreation			x
Weed invasion			x	Point source discharge	x		
Stock access			x	Other: sedimentation	x		
Vehicle access		x					

Comments

The main threats to Lake Campion Nature Reserve are increasing salinity and watertable rise, which are exacerbated by a drain that enters the site from the east. Sedimentation is also seen as an issue. Fire risk is also a threat to the large areas of woodland on the site: if a fire was to occur, feral animal (rabbit) control, and possibly kangaroo population control, may be required to enable regeneration of plant species. However, the lack of weeds and other disturbances indicate that good regeneration is possible if the climatic conditions are appropriate. Motor bike tracks were common on the reserve, and perhaps may lead to weed invasion or soil erosion in the future.

Links to protected areas of remnant vegetation		
Name	**Area** (ha)	**Approximate distance and direction from site**
None within a 10 km radius		

Management
The major threats to the site are salinity and watertable rise, which must be addressed at a catchment scale. The drain, which has highly acidic and highly saline water, enters the site from farmland east of the Rabbit Proof Fence Road, is a major threat.

Fauna	
Scientific name	**Common name**
Birds	
Platycercus zonarius	Australian ringneck parrot
Rhipidura leucophrys	Willy wagtail
Petroica goodenovii	Red-capped robin
Ocyphaps lophotes	Crested pigeon
Acanthiza sp.	Thornbills
Dromaius novaehollandiae	Emu
Artamus cinereus	Black-faced woodswallow
Pardalotus striatus	Striated pardalote
Malurus sp.	Fairy wren
Petroica cucullata	Hooded robin
Mammals	
Macropus fuliginosus	Western grey kangaroo
Tachyglossus aculeatus	Echidna

Other fauna lists for the general area
Lefroy et al. (1991)

Notes:

From field observations:

- Water sampling of the drain close to where it crosses the old closed road on the eastern side of Lake Campion Nature Reserve produced pH 3.08 and water temperature of 24.2°C. The conductivity was in excess of the maximum range of the meter. The drain was not traced to its western extent, therefore it is unknown how far into the reserve it extends. The drain appears to originate from farmland north-east of the edge of the reserve.

- The best possible condition vegetation (*pristine*) was found on this site: there was no sign of weeds, no rabbits, there didn't appear to be any missing species or strata, and plant species ranged in age from young (small) to

senescent, as would be expected in an undisturbed area. There was no reason to not rate this vegetation as *pristine*. No other sites had vegetation that could be rated this high.

- The worst example of *completely degraded* vegetation was also found at this site: the only living plants were *Carpobrotus* (pigface), the *Atriplex* and *Frankenia* spp. had recently died, and samphire had not yet invaded. The vegetation at and near our survey site 1 (vegetation association 1) is declining rapidly in condition.

- There were several areas where *Melaleuca* spp. had recently died (within the last few years).

- The north-west side is flat and low-lying. The vegetation is mostly *Acacia* shrublands and occasional gimlet, becoming more *Melaleuca* shrubland closer to drainage lines and areas where water has ponded.

- There is morrell woodland on the south side.

- *Templetonia sulcata* on lunettes around the playa lake is dead and dying. The probable cause is drought.

- There are more burnt *Callitris* near lunettes.

- There are few weeds.

From conversation with neighbour (Charlie Kittyea, north of site):

- He has been farming here since 1956. The conditions are the driest he has ever seen, with no water in the dams, and the river hasn't flowed for years.

- Trees along the tributary north of the site died in the last flood, which was highly saline: he couldn't remember exactly when it was but it was within the last 10 years.

- Since the drains went in the salinity has become worse. He calls them the 'drains to nowhere' because they just move the water into the reserve and into the watertable, not away from the area.

Plate A1.83: YR11 completely degraded *condition vegetation association 1: Disphyma crassifolium* herbland. Note: most plants are dead.

Plate A1.84: YR11 completely degraded *condition vegetation association 2:* Halosarcia *spp. shrubland*

Plate A1.85: YR11 pristine *vegetation association 3:* Eucalyptus salubris *woodland*

Plate A1.86: YR11 excellent *condition vegetation association 4:* Melaleuca hamata *and* M. lateriflora *shrubland*

Plate A1.87: YR11 excellent *condition vegetation association 5:* Acacia *sp. and* Exocarpos aphyllus *shrubland*

Plate A1.88: YR11 pristine *condition vegetation association 6:* Eucalyptus longicornis *woodland*

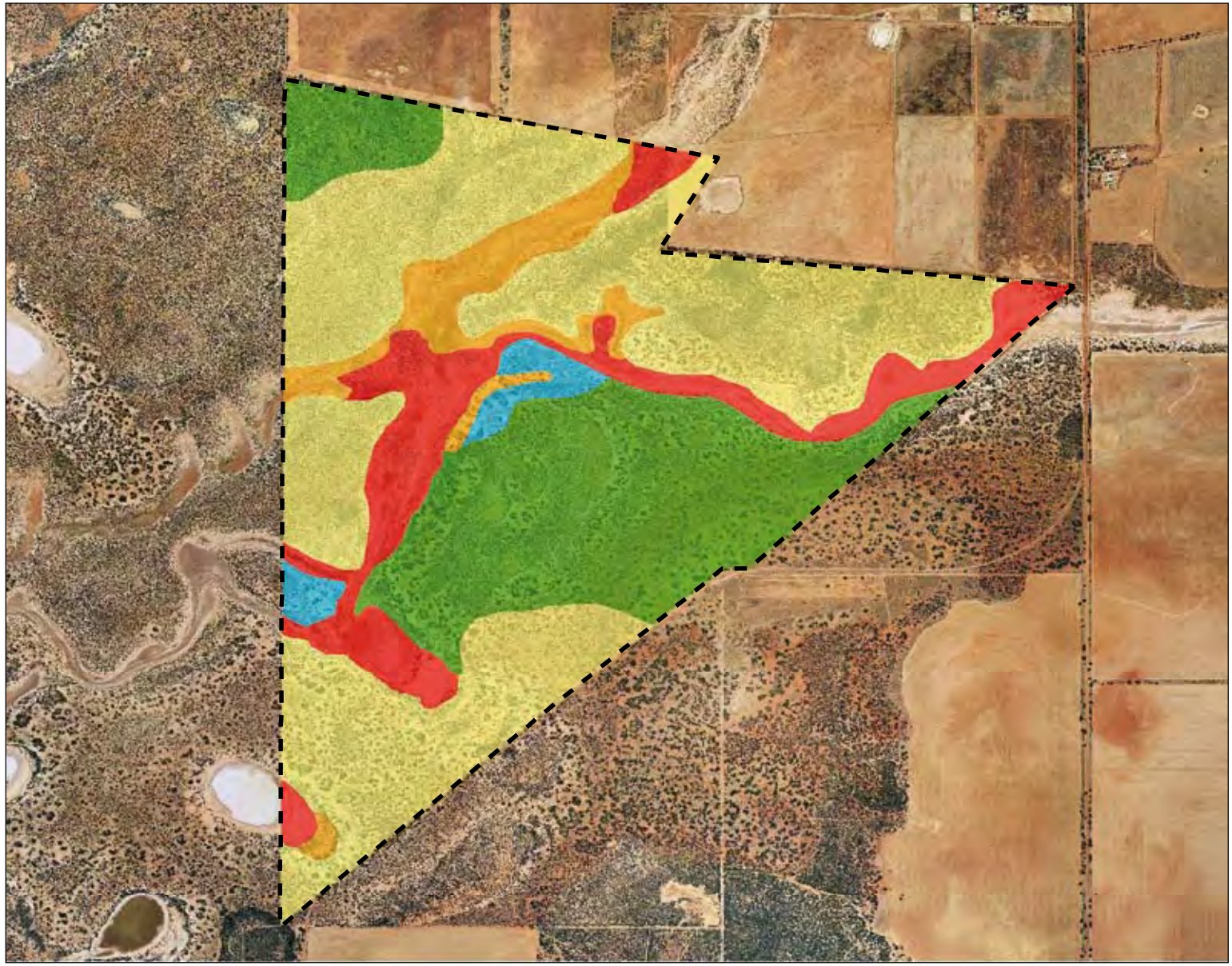
Plate A1.89: YR11 Eucalyptus salubris *woodland near the north-western corner of the site (*pristine *condition)*

Plate A1.90: YR11 completely degraded *condition vegetation. (Photo taken from same point as A1.83 but in reverse direction: the line of trees in the background (southwards) is the southern bank of the Yilgarn River).*

Plate A1.91: YR11 drain on eastern side of site

Plate A1.92: YR11 dead and dying shrubs on lunette near south-western corner of site

Map A11
Vegetation condition for survey site YR11 Lake Campion Nature Reserve B



LOCALITY MAP

LEGEND

Vegetation condition

- Revegetation
- Pristine
- Excellent
- Very good
- Good
- Degraded
- Completely degraded

Boundary

- Yilgarn survey site

Imagery

Merredin imagery 2004

N

0 200 400 600

Meters

Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum:GDA 94
Projection: MGA 94 Zone 50
Spheroid: Australian National Spheroid

Project Information
Client: Kate Gole
Map Author: Moses Gatenjwa
Task ID:
Filepath: J:\gisprojects\Project\B_Series \B414\B0004_YilgarnRiver_wwa\mxd
Filename: YR11_vegetation_condition.mxd
Compilation date: August 2008
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SOURCES

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Yilgarn vegetation condition – DoW – 2008
Yilgarn survey sites – DoW – 2008
Merredin 50cm Orthomosaic – Landgate – 2004

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Department of **Water**

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While the Department of Water has made all reasonable efforts to ensure the accuracy of this data, the department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.

Appendix 2 Comparison of survey results at all sites

This appendix contains tables which allow comparisons between observations at the survey sites to be made quickly.

Table A2.1 Native plant species

Scientific name	Common name	YR01	YR02	YR03	YR04	YR05	YR06	YR07	YR08	YR09	YR10	YR11
Acacia acuaria	Wattle			x								
Acacia acuminata	Jam									x	x	
Acacia assimilis	Wodjil							x			x	
Acacia colletioides	Wait-a-while	x	x	x				x		x	x	
Acacia erinacea	Spiny wattle			x					x		x	
Acacia fragilis	Wodjil										x	
Acacia hemiteles	Tan wattle	x		x		x				x		
Acacia lasiocalyx	Silver wattle									x		
Acacia merrallii	Merrall's wattle			x					x		x	x
Acacia sp.	Wattle	x	x	x	x			x	x	x	x	x
Acacia tetragonophylla	Kurara									x	x	
Actinobole uliginosum	Flannel cudweed									x		
Alyxia buxifolia	Dysentery bush									x		x
Amphipogon strictus	Greybeard grass								x			
Amyema miquelii	Stalked mistletoe	x										x
Angianthus tomentosus	Camel-grass		x									
Argyroglottis turbinata	Daisy							x			x	
Aristida contorta	Bunched kerosene grass		x						x	x		
Atriplex bunburyana.	Silver saltbush											x
Atriplex nana	Saltbush	x	x	x				x	x	x	x	x
Atriplex paludosa	Marsh saltbush	x	x		x		x	x	x			
Atriplex sp.	Saltbush									x	x	
Atriplex vesicaria	Bladder saltbush											x
Austrodanthonia spp.	Wallaby grass				x	x		x	x			
Austrostipa elegantissima	Feather speargrass			x				x	x	x		x
Austrostipa spp.	Speargrass		x				x	x		x	x	
Borya sphaerocephala	Pin-grass									x		

Scientific name	Common name	YR01	YR02	YR03	YR04	YR05	YR06	YR07	YR08	YR09	YR10	YR11
Callitris canescens	White cypress pine	x		x		x		x	x	x	x	
Calocephalus multiflorus	Yellow-top		x									
Calycopeplus paucifolius	Broom spurge									x		
Casuarina obesa	Swamp sheoak	x	x	x								
Chenopodiaceae sp.			x									
Chloris truncata	Windmill grass							x				
Darwinia halophila	Darwinia		x			x			x		x	
Daviesia sp.											x	
Dianella revoluta	Blueberry lily	x								x		
Disphyma crassifolium	Round pig face	x	x	x	x	x			x		x	x
Dodonaea viscosa subsp. angustissima	Sticky hopbush		x	x				x	x	x		
Elymus scaber	Common wheatgrass					x						
Enchylaena tomentosa	Ruby saltbush		x		x	x			x			x
Eragrostis dielsii	Mallee lovegrass	x	x	x	x	x	x	x		x	x	x
Eremophila decipiens	Slender fuschia			x				x			x	x
Eremophila ionantha	Violet-flowered eremophila										x	
Eremophila oppositifolia	Weeooka			x					x		x	x
Eremophila scoparia	Broom bush								x		x	x
Eremophila sp.	Eremophila					x						
Eremophila sp.	Poverty bush									x		
Erymophyllum tenellum	Everlasting				x	x					x	x
Eucalyptus capillosa subsp. *capillosa*	Wandoo					x						
Eucalyptus capillosa subsp. *polyclada*	Mallee wandoo					x						
Eucalyptus longicornis	Morrell											x
Eucalyptus loxophleba	York gum		x			x			x			
Eucalyptus loxophleba subsp. *lissophloia*	York gum mallee							x				
Eucalyptus loxophleba subsp. *loxophleba*	York gum									x	x	
Eucalyptus myriadena	Eucalypt	x	x	x	x	x	x	x	x	x	x	

Scientific name	Common name	YR01	YR02	YR03	YR04	YR05	YR06	YR07	YR08	YR09	YR10	YR11
Eucalyptus salicola	Salt gum	x	x	x				x		x		x
Eucalyptus salmonophloia	Salmon gum					x	x		x		x	x
Eucalyptus salubris	Gimlet	x		x	x	x		x	x	x	x	x
Eucalyptus sargentii	Salt River gum	x							x			
Eucalyptus sheathiana	Ribbon-barked gum											x
Eucalyptus sp.	Eucalypt		x									
Eucalyptus yilgarnensis	Yorrel									x		x
Exocarpos aphyllus	Leafless ballart		x	x	x	x	x		x		x	x
Frankenia setosa	Bristly frankenia							x				
Frankenia spp.	Frankenia	x	x	x					x	x	x	x
Gnephosis tenuissima	Gnephosis					x						
Grevillea acuaria	Grevillea								x		x	x
Grevillea huegelii	Grevillea								x			
Grevillea paniculata	Grevillea									x		
Gunniopsis intermedia	Yellow salt star		x					x				
Gunniopsis quadrifida	Sturts pigface								x	x		
Hakea preissii	Needle tree	x	x	x	x	x		x			x	x
Hakea recurva	Djarnokmurd									x		x
Halosarcia spp.	Samphire species	x	x	x	x	x	x	x	x	x	x	x
Jacksonia sp.	Jacksonia							x	x	x	x	
Kunzea pulchella	Granite kunzea									x		
Lepidosperma spp.	Sword sedge									x		
Leptospermum erubescens	Roadside tea-tree									x		
Leptospermum nitens	Tea-tree									x		
Lomandra collina	Matrush	x										
Lomandra effusa	Scented matrush		x	x		x			x	x	x	x
Lycium australe	Australian boxthorn, water bush		x	x	x			x			x	x
Maireana brevifolia	Small-leaf bluebush	x			x		x	x				
Maireana carnosa	Cottony bluebush	x	x		x	x	x	x	x		x	x
Maireana georgei	Satiny bluebush		x	x	x	x					x	x
Maireana spp.	Bluebush	x								x		x

Scientific name	Common name	YR01	YR02	YR03	YR04	YR05	YR06	YR07	YR08	YR09	YR10	YR11
Maireana triptera	Threewinged bluebush							x	x		x	x
Melaleuca acuminata	Paperbark						x					
Melaleuca atroviridis	Broombush									x		
Melaleuca brevifolia	Paperbark	x						x				x
Melaleuca halmaturorum	Paperbark									x	x	
Melaleuca hamata	Broombush	x	x		x	x	x	x	x	x	x	x
Melaleuca lateriflora	Gorada	x	x	x	x	x		x			x	x
Melaleuca macronychia										x		
Melaleuca pauperiflora	Boree								x			x
Melaleuca scalena	Broombush										x	x
Melaleuca thyoides	Paperbark	x	x									
Olearia dampieri subsp. eremicola	Daisy-bush	x		x						x	x	x
Olearia muelleri	Dusky daisy bush							x	x	x	x	x
Olearia sp.	Daisy-bush										x	x
Philotheca brucei										x		
Pittosporum angustifolium	Native apricot, native willow		x	x	x		x		x	x	x	
Podolepis canescens	Bright podolepis					x				x		
Podolepis capillaris	Wiry podolepis		x		x	x		x				
Podotheca gnaphalioides	Sticky longheads		x							x		
Ptilotus exaltatus	Tall mulla mulla								x			
Ptilotus gaudichaudii	Mulla mulla					x						
Ptilotus obovatus	Cotton bush									x		
Ptilotus sp.	Mulla mulla	x	x	x	x							
Rhagodia preissii	Rhagodia	x	x	x	x	x		x		x		x
Rhodanthe citrina	Everlasting			x								
Roycea spinescens			x					x		x		
Salsola australe	Prickly saltwort, roly-poly							x				
Santalum acuminatum	Quandong		x	x	x	x		x	x		x	x
Santalum spicatum	Sandalwood										x	
Scaevola spinescens	Maroon bush			x				x	x		x	x

Scientific name	Common name	YR01	YR02	YR03	YR04	YR05	YR06	YR07	YR08	YR09	YR10	YR11
Sclerolaena ?drummondii									x			x
Sclerolaena diacantha	Grey copper-burr	x	x	x	x	x		x	x		x	x
Senna pleurocarpa	Native senna										x	
Siloxerus pygmaeus			x									
Spartochloa scirpoidea										x		
Tecticornia lylei	Samphire	x		x		x			x		x	
Tecticornia sp.	Samphire				x							
Templetonia sulcata	Centipede bush	x		x	x	x	x	x		x	x	
Threlkeldia diffusa	Coast bonefruit							x		x	x	x
Thryptomene australis	Hook-leaf thryptomene									x		
Westringia cephalantha	Westringia	x				x				x	x	x
Zygophyllum sp.	Twin-leaf									x		

Table A2.2 Introduced plant species

Scientific name	Common name	YR01	YR02	YR03	YR04	YR05	YR06	YR07	YR08	YR09	YR10	YR11
Aira cupaniana	Hair-grass									x		
Avena fatua	Wild oat				x		x			x	x	
Brassica tournefortii	Wild turnip									x		
Bromus rubens	Red brome	x	x		x		x		x	x	x	
Carpobrotus edulis	Hottentot fig	x								x		x
Cotula bipinnata	Ferny cotula								x			
Hordeum leporinum	Barley grass						x					
Lolium rigidum	Annual ryegrass				x							
Mesembryanthemum crystallinum	Common ice-plant						x					
Mesembryanthemum nodiflorum	Slender ice-plant	x	x	x	x	x	x	x	x	x	x	x
Oncosiphon piluliferum	Matricaria						x	x				
Parapholis incurva	Coast barbgrass			x								
Pentaschistis airoides	False hair-grass	x	x			x		x		x		
Solanum hoplopetalum	Afghan thistle								x			
Vulpia myuros	Silver grass		x			x	x					

Table A2.3 Bird species

Scientific name	Common name	YR01	YR02	YR03	YR04	YR05	YR06	YR07	YR08	YR09	YR10	YR11
Acanthiza apicalis	Inland thornbill				x	x						
Acanthiza chrysorrhoa	Yellow-rumped thornbill							x				
Acanthiza sp.	Thornbills		x									x
Accipiter fasciatus	Brown goshawk								x			
Anthochaera carunculata	Red wattlebird										x	
Anthus australis	Australian pipit		x	x				x			x	
Aquila audax	Wedge-tailed eagle				x					x		
Artamus cinereus	Black-faced woodswallow		x	x		x	x		x		x	x
Cacatua roseicapilla	Galah	x			x	x	x			x		
Coracina novaehollandiae	Black-faced cuckoo-shrike								x	x	x	
Corvus coronoides	Australian raven					x						
Cracticus nigrogularis	Pied butcher bird	x				x					x	
Cracticus tibicen	Magpie		x			x			x		x	
Cracticus torquatus	Grey butcherbird									x		
Dromaius novaehollandiae	Emu	x			x			x	x	x	x	x
Elanus caeruleus	Black-shouldered kite	x										
Epthianura tricolor	Crimson chat		x					x				
Falco cenchroides	Australian kestrel, nankeen kestrel							x		x	x	
Grallina cyanoleuca	Peewee or magpie-lark									x	x	
Hirundo neoxena	Welcome swallow										x	
Lichenostomus virescens	Singing honey-eater							x		x		
Malurus sp.	Fairy wren		x					x				x
Manorina flavigula	Yellow throated miner		x							x	x	
Merops ornatus	Rainbow bee-eater									x		
Ocyphaps lophotes	Crested pigeon	x	x	x	x	x		x	x	x	x	x
Oreoica gutturalis	Crested bellbird		x								x	
Pardalotus striatus	Striated pardalote		x			x					x	x
Petroica cucullata	Hooded robin											x

Scientific name	Common name	YR01	YR02	YR03	YR04	YR05	YR06	YR07	YR08	YR09	YR10	YR11
Petroica goodenovii	Red-capped robin										x	x
Phaps chalcoptera	Common bronzewing					x						
Platycercus zonarius	Australian ringneck parrot	x	x	x	x	x	x		x	x	x	x
Pomatostomus superciliosus	White-browed babbler		x								x	
Rhipidura leucophrys	Willy wagtail		x						x			x

Table A2.4 Disturbance factors

	YR01	YR02	YR03	YR04	YR05	YR06	YR07	YR08	YR09	YR10	YR11
Salinity	H	H	H	H	H	H	H	H	L	H	H
Waterlogging	H	H	H	H	H	H	H	H	L	H	H
Ponding from road crossing							L		L		
Drainage	M										H
Clearing	M	L	L	L	L		H	M	H		
Fire risk	L			L	L		M	L	H	H	H
Weed invasion	L	L	L	M	L	H	M	L	H	M	L
Stock access	L	M	M	M	L	H	M	H	M	M	L
Vehicle access	L		L	L	L		L	L	L		
Rubbish	L			L	L	L	L	L		L	
Plant disease				L		M			M		
Erosion	L	M		M	L	M	M	L		L	
Service corridors				L	L				L		
Feral animals	L	L	L	L	L	M	L	M	M	L	M
Recreation				L	L			L			L
Point source discharge	M										H
Other: gypsum/sand extraction	L										
Other: sedimentation		M									H
Other: mining									H		

L = low threat level
M = moderate threat level
H = high threat level

Appendix 3 Waterway assessment survey form

General details

Recorder's name: …… Survey date: ……

Site number: …… Site name……..

Landholder: …….. Contact Number: ……

Property address: ……

Site position in landscape

❒ Valley floor
❒ Valley slope
❒ Uplands
❒ Rocky outcrop

Floodplain features

Natural features:

❒ Salt lakes (playas)
  ❒ Permanent water
  ❒ Seasonally wet
❒ Braided channel
  ❒ Discontinuous
  ❒ Continuous
❒ Lunettes (dunes)
❒ Tributary

Constructed features:

❒ Drain
❒ Dam
❒ Other……

Vegetation description (from Keighery, 1994)

Beard vegetation association

Number	Description
8	Medium woodland; salmon gum and gimlet
125	Bare areas; salt lakes
356	Succulent steppe with open woodland; eucalypts over saltbush
413	Shrublands; *Acacia neurophylla* and *A.* species thicket
511	Medium woodland; salmon gum and morel
631	Succulent steppe with woodland and thicket; York gum over *Melaleuca thyoides* and samphire
955	Mosaic; Shrublands; scrub-heath (SE Avon)/Shrublands; *Allocasuarina* campestris thicket
1049	Medium woodland; wandoo, York gum, salmon gum, morel and gimlet
1053	Shrublands; Melaleuca uncinata thicket with scattered York gum
1061	Mosaic; Medium sparse woodland; salmon gum and yorrell/succulent steppe; saltbush and samphire

Vegetation structure and cover (both native and weed species)

Vegetation layer	Canopy cover class*	Dominant species**
Trees		
Mallees		
Shrubs		
Grasses		
Herbs		
Rushes and sedges		
Litter		
Bare ground		
Rock outcrop		

*Canopy cover class Very open 2-10% Sparse 10-30% Open 30-70% Closed 70-100%

**More than 3 dominant species described as mixed

Native species list

Record number of species if all species cannot be identified by name

Regeneration ❒ Yes ❒ No Species: …….

Weed species list

Record number of species if all species cannot be identified by name

Vegetation condition (from Keighery, 1994)

Condition	Description	% of site
Revegetation	An area of formerly cleared, or otherwise degraded, land that has been replanted	
Pristine	No obvious signs of disturbance	
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species	
Very good	Vegetation structure altered, obvious signs of disturbance	
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate	
Degraded	Basic vegetation structure severely impacted by disturbance. Regeneration to good condition requires intensive management	
Completely degraded	Vegetation structure no longer intact and the area is without/almost without native species	

Disturbance factors affecting vegetation condition score

Disturbance factor	Threat level		
	High	Medium	Low
Salinity			
Waterlogging			
Ponding from road crossing			
Drainage			
Clearing			
Fire risk			
Weed invasion			
Stock access			
Vehicle access			
Rubbish			
Plant disease			
Service corridors			
Feral animals			
Recreation			
Point source discharge			
Other			

Linkages to protected remnant vegetation

Site name	Area (ha)	Approximate distance and direction from site

Water quality data (channels, wetlands, drains, tributaries)

Sample number	pH	Conductivity (mS/m)	Temperature (ºC)	Location

Evidence of management

Tick the appropriate boxes:

- ❒ Revegetation
- ❒ Fencing
- ❒ Drainage
- ❒ Fire break control
- ❒ Weed control
- ❒ Surface water management
- ❒ Groundwater management
- ❒ Other: ……

Ideas for management

Tick the appropriate boxes:

- ❒ Prescribed burning
- ❒ Firebreak control
- ❒ Fencing
- ❒ Erosion control
- ❒ Saltland grazing
- ❒ Agroforestry
- ❒ Weed control
- ❒ Drainage
- ❒ Sediment management
- ❒ Surface water management
- ❒ Groundwater management
- ❒ Road crossing
- ❒ Other……

Fauna list

Photographs

Number	Description

Appendix 4 Vegetation condition photographs

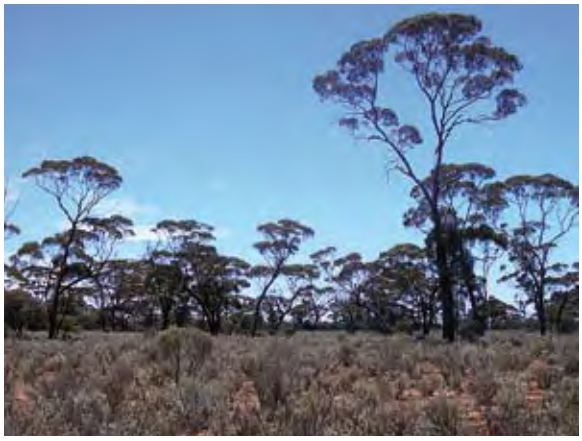


Plate A3.1: Pristine *condition vegetation, Lake Campion Nature Reserve B (YR11 vegetation association 6)*

Plate A3.2: Excellent *condition vegetation, Giles B (YR02, vegetation association 1)*

Plate A3.3: Very good *condition vegetation*

Plate A3.4 Good *condition vegetation, Herbert's (YR05 vegetation association 1)*

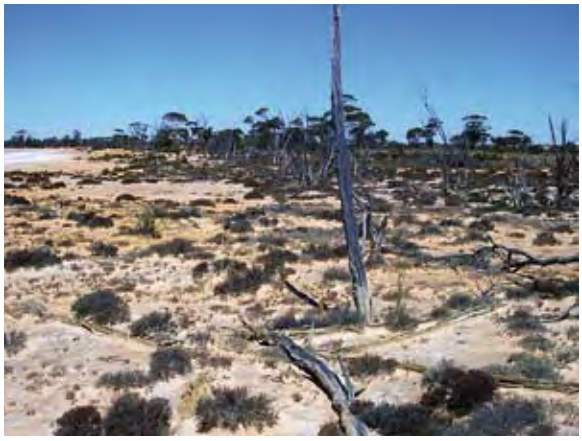


Plate A3.5: Degraded *condition vegetation, Thorpe's (YR04 vegetation association 2)*

Plate A3.6: Completely degraded *condition vegetation, Jordina (YR06)*

Appendix 5 Examples of local native species suitable for revegetation

Inclusion in this table does not guarantee availability of seed or tubestock for revegetation, nor success of establishment. Information is sourced from Oversby (2004), Mitchell & Wilcox (1994), Lefroy, Hobbs & Atkins (1991), and observations during the field survey.

Table A5 Examples of local species suitable for revegetation in valley floors in the Yilgarn catchment

Inclusion in this table does not guarantee availability of seed or tubestock for revegetation, nor success of establishment.
Information is sourced from Oversby (2004), Mitchell & Wilcox (1994), Lefroy, Hobbs & Atkins (1991), and observations during the field survey.

Species	Tolerance			Propagation				Seed harvested	Notes
	Salt	Water-logging	Drought	Direct seeding	Tubestock	Cuttings/ transplanting	Self-seeding		
Understorey									
Atriplex amnicola (river saltbush)	Very	Moderate (when mature)	Moderate	Yes	Yes	Yes		Dec-Feb	
Atriplex semibaccata (creeping saltbush)	Slightly	Not	Very	Yes	Yes			Jan-Mar	Grows naturally near salt lakes and in woodlands. Short-lived but regenerates well.
Cyperus gymnocaulos (spiny flat-sedge)	Moderate	Short periods		Yes		Yes		Jan-Feb	Grows in a wide variety of soils, including floodways, seeps and lake edges, especially in disturbed areas with high nutrient levels.
+ * *Eragrostis dielsii* (mallee lovegrass)	Moderate	Moderate	Moderate	Yes	Yes				Prefers lighter soils.
Gahnia trifida (coast saw-sedge)	Very	Moderate		Low success		Yes		Jan-Mar	Grows in a wide variety of soil types, including floodways, clay pans and lake edges.

Species	Tolerance			Propagation				Seed harvested	Notes
	Salt	Water-logging	Drought	Direct seeding	Tubestock	Cuttings/ transplanting	Self-seeding		
+ * *Halosarcia* species (samphire)	Various	Very	Very			Yes	Yes	Yes	Other samphire genera, including *Tecticornia* spp. may also be suitable.
+ *Maireana brevifolia* (small-leaf bluebush)	Yes	Slightly	Very	Yes	Yes		Yes	Dec-Mar	Grows naturally on drier parts of floodplain.
Rhagodia drummondii (lake fringe rhagodia)	Very	Slightly	Very	Yes	Yes				Grows in a wide variety of soils, especially sand.
Sporobolus virginicus (native marine couch)	Moderate	Very		Yes		Yes		Jan-Mar	Prefers lighter soils.
Midstorey									
+ *Acacia acuminata* (jam)	Slightly	Slightly	Very	Yes	Yes			Nov-Dec	Grows in a wide variety of soil types.
+ *Acacia colletioides* (wait-a-while)								Nov	Seed will need to be heat treated or scarified before sowing.
+ * *Acacia hemiteles* (tan wattle)								Nov	Suits loamy soils.
+ *Acacia merrallii* (Merrall's wattle)								Nov-Dec	Suits loamy soils.

Species	Tolerance			Propagation				Seed harvested	Notes
	Salt	Water-logging	Drought	Direct seeding	Tubestock	Cuttings/ transplanting	Self-seeding		
Acacia microbotrya (manna wattle)	Slightly	Slightly		Yes	Yes			Oct-Dec	Grows in a wide variety of soil types.
Callistemon phoeniceus (lesser bottlebrush)	High-Mod	High-Mod	High-Mod	Yes	Yes			All year	Grows in a wide variety of soil types.
Grevillea paniculata	Not	Not			Yes				Suitable for fresh flood fringes.
Hakea kippistiana									Found naturally in areas south of the Yilgarn, growing on the edge of salt lakes.
+ * *Hakea preissii* (needle tree)	Moderate	Moderate			Yes				Grows in many soil types.
+ * *Hakea recurva* djarnokmurd								Nov	Prefers lighter soils.
Melaleuca adnata									Grows in floodplains.
+ *Melaleuca acuminata*									Grows in floodplains.
+ *Melaleuca brevifolia*									Grows in floodplains.
Melaleuca cuticularis (saltwater paperbark)									Grows in saline floodplains and on the edge of lakes.

Species	Tolerance			Propagation				Seed harvested	Notes
	Salt	Water-logging	Drought	Direct seeding	Tubestock	Cuttings/ transplanting	Self-seeding		
+ * *Melaleuca hamata* (broombush)									One of the broombush melaleucas (formerly included with *M. uncinata*). Found near the edge of salt lakes.
+ * *Melaleuca lateriflora* gorada									Grows in floodplains.
+ *Melaleuca thyoides*									Grows on the edge of salt lakes.
Melaleuca uncinata (broombush)	Variable	Variable							Grows in a wide variety of soil types.
+ * *Pittosporum angustifolium* (native apricot, native willow)									Grows in lunettes and non-saline stream edges.
Overstorey									
+ *Casuarina obesa* (swamp sheoak)	Very	Very		Yes	Yes				Grows in many soil types.
Eucalyptus horistes (white flowered mallee)									Grows on dunes near salt lakes and waterways. Includes the mallee formerly called *Eucalyptus hypochlamydea.*
+ *Eucalyptus longicornis* morrell									Grows in saline fine-textured loams and clays on valley floors

Species	Tolerance			Propagation				Seed harvested	Notes
	Salt	Water-logging	Drought	Direct seeding	Tubestock	Cuttings/ transplanting	Self-seeding		
+ * *Eucalyptus loxophleba* (York gum)	Some moderate	Not		Yes	Yes			All year	Grows in many soil types. Both mallee (subsp. *gratiae*) and tree (subsp. *loxophleba*) suitable.
+ * *Eucalyptus myriadena*									Similar in appearance to yorrel. Prefers clay soils near salt lakes.
+ * *Eucalyptus salicola* (Salt gum)									Similar in appearance to salmon gum, grows in loams on valley floors and lunettes and dunes along lake and stream edges.
+ * *Eucalyptus salmonophloia* (salmon gum)	Moderate	Not							Grows in loams and duplex soils on lower slopes and valley floors.
+ * *Eucalyptus salubris* (gimlet)	Moderate								Grows in loams and duplex soils on lower slopes and valley floors.
+ * *Eucalyptus sargentii* (Salt River gum)	Mod-High	Some		Yes	Yes			All year	Grows in a wide variety of soils associated with salt lakes and saline waterways.
+ *Eucalyptus spathulata* (swamp mallet)									Grows close to salt lakes
+ * *Eucalyptus yilgarnensis* (yorrell)									Grows in saline fine-textured loams and clays on valley floors

+ Species found during field survey.

** Natural regeneration observed during field survey.*

Appendix 6 Examples of species suitable for saltland pasture

Table A6 Examples of species suitable for saltland pasture.

Sourced from Oversby (2004), Phelan (2004), Butler (2001), Barrett-Lennard & Malcolm (1995), Mitchell & Wilcox (1994) and Runciman & Malcolm (1991).

Species	Origin	Tolerance			Propagation				Seed harvested	Notes
		Salt	Water-logging	Drought	Direct seeding	Tubestock	Cuttings	Self-seeding		
saltbush										
Atriplex amnicola (river saltbush)	Local	Very	Moderate (when mature)	Moderate	Yes	Yes	Yes		Dec-Feb	Good forage with up to 10% protein. Recovers well from grazing.
Atriplex cinerea (grey saltbush)	WA	On saline seeps	Moderate		Yes		Yes			Palatability varies
Atriplex nummularia (old man saltbush)	Australia	Moderate	Sensitive		Yes	Yes			Sept-Oct	Not as palatable as other species, brittle and easily damaged by trampling.
Atriplex semibaccata (creeping saltbush)	Local	Slightly	Not	Very	Yes	Yes			Jan-Mar	Short-lived but regenerates well. Very palatable and prone to being eaten out.
Atriplex undulata (wavy-leaf saltbush)	Intro-duced	Yes	Moderate		Yes			Yes		Palatable. Recovers well from grazing.

Species		Tolerance			Propagation				Seed harvested	Notes
	Origin	Salt	Water-logging	Drought	Direct seeding	Tubestock	Cuttings	Self-seeding		
samphire										
Halosarcia species (samphire)	Various	Very	Very			Yes	Yes	Yes		Can survive moderate grazing. Highly saline, therefore sheep must have access to fresh water and graze in conjunction with stubble or other sources.
bluebush										
Maireana brevifolia (small-leaf bluebush)	Local	Yes	Slightly	Very	Yes	Yes		Yes	Dec-Mar	Good forage with up to 16% protein, very palatable. Recovers well from grazing.
Grasses										
Grass species	Various	Various	Various	Various						A number of summer active grasses are available: contact the Department of Agriculture and Food for details. Includes Tall Wheatgrass and Puccinellia.

Appendix 7 Flora and fauna lists

Table A7.1 Native plant species found during the survey.

Species	Common name
Acacia acuaria	Wattle
Acacia acuminata	Jam
Acacia assimilis	Wodjil
Acacia colletioides	Wait-a-while
Acacia erinacea	Spiny wattle
Acacia fragilis	Wodjil
Acacia hemiteles	Tan wattle
Acacia lasiocalyx	Silver wattle
Acacia merrallii	Merrall's wattle
Acacia sp.	Wattle
Acacia tetragonophylla	Kurara
Actinobole uliginosum	Flannel cudweed
Alyxia buxifolia	Dysentery bush
Amphipogon strictus	Greybeard grass
Amyema miquelii	Stalked mistletoe
Angianthus tomentosus	Camel-grass
Argyroglottis turbinata	Daisy
Aristida contorta	Bunched kerosene grass
Atriplex bunburyana	Silver saltbush
Atriplex nana	Saltbush
Atriplex paludosa	Marsh saltbush
Atriplex sp.	Saltbush
Atriplex vesicaria	Bladder saltbush
Austrodanthonia spp.	Wallaby grass
Austrostipa elegantissima	Feather speargrass
Austrostipa spp.	Speargrass
Beyeria lechenaultii var. *drummondii*	Pale turpentine bush
Borya sphaerocephala	Pin-grass
Callitris canescens	White cypress pine
Calocephalus multiflorus	Yellow-top
Calycopeplus paucifolius	Broom spurge
Casuarina obesa	Swamp sheoak
Chenopodiaceae sp.	
Chloris truncata	Windmill grass
Darwinia halophila	Darwinia
Daviesia sp.	
Dianella revoluta	Blueberry lily
Disphyma crassifolium	Round pig face
Dodonaea viscosa subsp. *angustissima*	Sticky hopbush
Elymus scaber	Common wheatgrass
Enchylaena tomentosa	Ruby saltbush
Eragrostis dielsii	Mallee lovegrass
Eremophila decipiens	Slender fuchsia
Eremophila ionantha	Violet-flowered eremophila
Eremophila oppositifolia	Weeooka
Eremophila scoparia	Broom bush

Species	Common name
Eremophila sp.	Poverty bush
Erymophyllum tenellum	Everlasting
Eucalyptus capillosa subsp. *capillosa*	Wandoo
Eucalyptus capillosa subsp. *polyclada*	Mallee wandoo
Eucalyptus longicornis	Morrell
Eucalyptus loxophleba subsp. *lissophloia*	York gum mallee
Eucalyptus loxophleba subsp. *loxophleba*	York gum
Eucalyptus myriadena	Eucalypt
Eucalyptus salicola	Salt gum
Eucalyptus salmonophloia	Salmon gum
Eucalyptus salubris	Gimlet
Eucalyptus sargentii	Salt river gum
Eucalyptus sheathiana	Ribbon-barked gum
Eucalyptus sp.	Eucalypt
Eucalyptus yilgarnensis	Yorrel
Exocarpos aphyllus	Leafless ballart
Frankenia sp.	Frankenia
Gnephosis tenuissima	Gnephosis
Grevillea acuaria	Grevillea
Grevillea huegelii	Grevillea
Grevillea sp.	Grevillea
Gunniopsis intermedia	Yellow salt star
Gunniopsis quadrifida	Sturts pigface
Hakea preissii	Needle tree
Hakea recurva	Djarnokmurd
Halosarcia spp.	Samphire (approx 6 species in total)
Jacksonia sp.	Jacksonia
Kunzea pulchella	Granite kunzea
Lepidosperma drummondii	Sword sedge
Lepidosperma spp.	Sword sedge
Leptospermum erubescens	Roadside tea-tree
Leptospermum nitens	Tea-tree
Lomandra collina	Matrush
Lomandra effusa	Scented matrush
Lycium australe	Australian boxthorn, water bush
Maireana brevifolia	Small-leaf bluebush
Maireana carnosa	Cottony bluebush
Maireana georgei	Satiny bluebush
Maireana sp.	Bluebush
Maireana triptera	Threewinged bluebush
Melaleuca acuminata	Paperbark
Melaleuca atroviridis	Broombush
Melaleuca brevifolia	Paperbark
Melaleuca halmaturorum	Paperbark
Melaleuca hamata	Broombush
Melaleuca lateriflora	Gorada
Melaleuca macronychia	
Melaleuca pauperiflora	Boree
Melaleuca scalena	Broombush
Melaleuca thyoides	Paperbark

Species	Common name
Olearia dampieri subsp. *eremicola*	Daisy-bush
Olearia muelleri	Dusky daisy bush
Olearia sp.	Daisy-bush
Philotheca brucei	
Pittosporum angustifolium	Native apricot, native willow
Podolepis canescens	Bright podolepis
Podolepis capillaris	Wiry podolepis
Podotheca gnaphalioides	Sticky longheads
Ptilotus exaltatus	Tall mulla mulla
Ptilotus gaudichaudii	Mulla mulla
Ptilotus obovatus	Cotton bush
Ptilotus sp.	Mulla mulla
Rhagodia preissii	Rhagodia
Rhodanthe citrina	Everlasting
Roycea spinescens	
Salsola australe	Prickly saltwort, roly-poly
Santalum acuminatum	Quandong
Santalum spicatum	Sandalwood
Scaevola spinescens	Maroon bush
Sclerolaena drummondii	
Sclerolaena diacantha	Grey copper-burr
Sclerolaena eurotioides	Fluffy bindi
Senna pleurocarpa	Native senna
Siloxerus pygmaeus	
Spartochloa scirpoidea	
Tecticornia lylei	Samphire
Templetonia sulcata	Centipede bush
Threlkeldia diffusa	Coast bonefruit
Thryptomene australis	Hook-leaf thryptomene
Westringia cephalantha	Westringia
Zygophyllum sp.	Twin-leaf

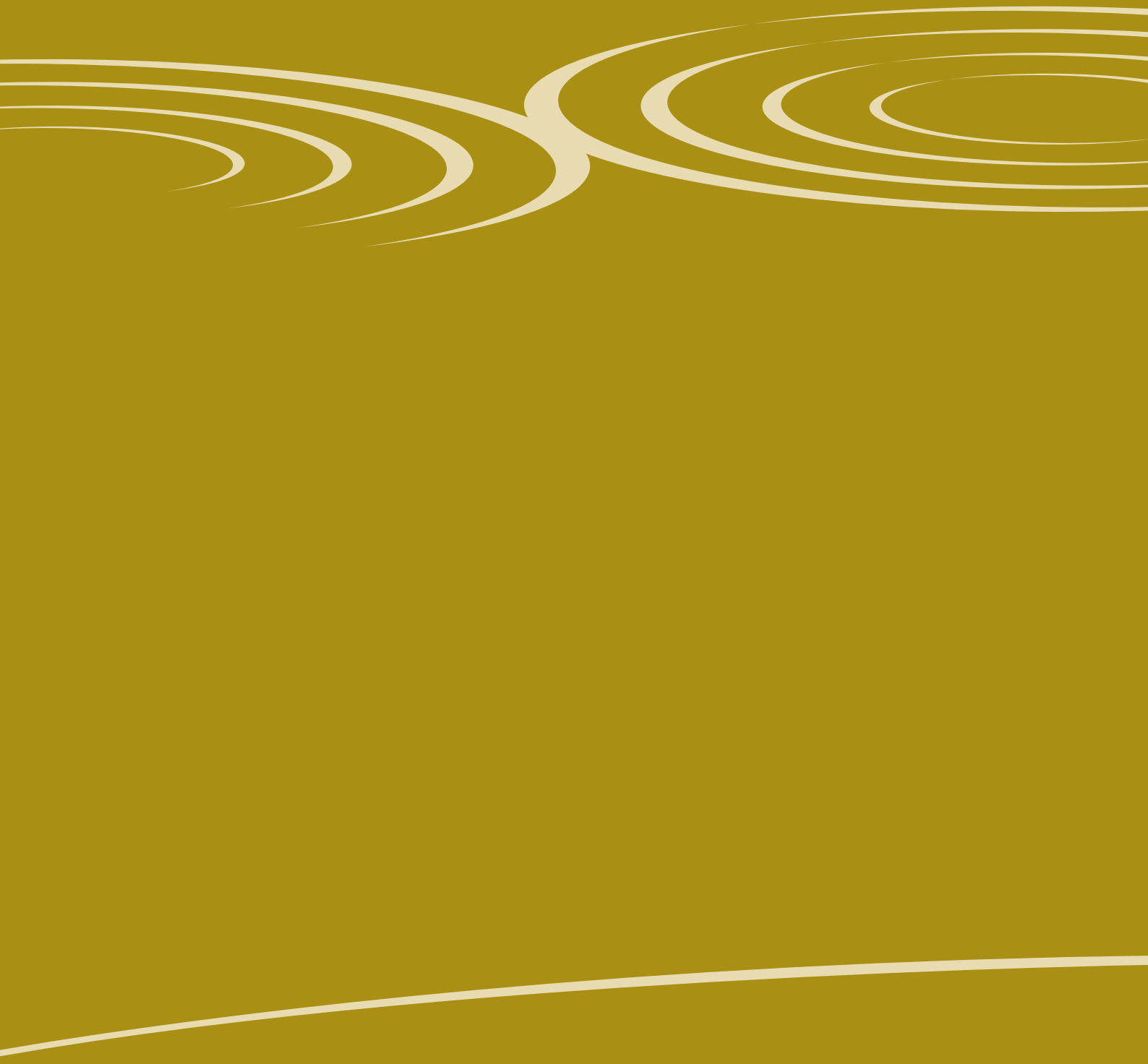
Table A7.2: Weed species found during the survey.

Species	Common name
Aira cupaniana	Hair-grass
Avena fatua	Wild oat
Brassica tournefortii	Wild turnip
Bromus rubens	Red brome
Carpobrotus edulis	Hottentot fig
Cotula bipinnata	Ferny cotula
Hordeum leporinum	Barley grass
Hypochaeris glabra	Flatweed
Lolium rigidum	Annual ryegrass
Mesembryanthemum crystallinum	Common ice-plant
Mesembryanthemum nodiflorum	Slender ice-plant
Oncosiphon piluliferum	Matricaria
Parapholis incurva	Coast barbgrass
Pentaschistis airoides	False hair-grass
Solanum hoplopetalum	Afghan thistle
Vulpia myuros	Silver grass

Note: Species used for revegetation are not included in this list.

Table A7.3 Birds found during the survey.

Species	Common name
Acanthiza apicalis	Inland thornbill
Acanthiza chrysorrhoa	Yellow-rumped thornbill
Acanthiza sp.	Thornbills
Accipiter fasciatus	Brown goshawk
Anthochaera carunculata	Red wattlebird
Anthus australis	Australian pipit
Aquila audax	Wedge-tailed eagle
Artamus cinereus	Black-faced woodswallow
Cacatua roseicapilla	Galah
Coracina novaehollandiae	Black-faced cuckoo-shrike
Corvus coronoides	Australian raven
Cracticus nigrogularis	Pied butcher bird
Cracticus tibicen	Magpie
Cracticus torquatus	Grey butcherbird
Dromaius novaehollandiae	Emu
Elanus caeruleus	Black-shouldered kite
Epthianura tricolor	Crimson chat
Falco cenchroides	Australian kestrel, nankeen kestrel
Grallina cyanoleuca	Peewee or magpie-lark
Hirundo neoxena	Welcome swallow
Lichenostomus virescens	Singing honey-eater
Malurus sp.	Fairy wren
Manorina flavigula	Yellow throated miner
Merops ornatus	Rainbow bee-eater
Ocyphaps lophotes	Crested pigeon
Oreoica gutturalis	Crested bellbird
Pardalotus striatus	Striated pardalote
Petroica cucullata	Hooded robin
Petroica goodenovii	Red-capped robin
Phaps chalcoptera	Common bronzewing
Platycercus zonarius	Australian ringneck parrot
Pomatostomus superciliosus	White-browed babbler
Rhipidura leucophrys	Willy wagtail
Taeniopygia guttata	Zebra finch



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