Murray Mallee Biodiversity Plan

Managing wildlife areas in the Murray Mallee

Government of South Australia

South Australian Murray-Darling Basin Natural Resources Management Board

MURRAY MALLEE

Local Action Planning Association Inc.

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Written on behalf of the Murray Mallee Local Action Planning (MMLAP) Association by Environmental & Biodiversity Services, 2005.

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ecocreative.

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ABBREVIATIONS USED IN THIS PLAN

APCB Animal and Plant Control Board
BGEA Biodiversity Group, Environment Australia
CP Conservation Park
CSIRO Commonwealth Scientific and Industrial Research Organisation
(DEH) NPWSA Department for Environment and Heritage National Parks and Wildlife South Australia
DEH SA Department for Environment and Heritage South Australia
EPA Environment Protection Authority
GIS Geographical Information System
IS Investment Strategy (specifically the NRM strategy for the SA Murray-Darling Basin)
MMLAP Murray Mallee Local Action Planning (Area or Association, depending on context)
NP National Park
NRM Natural Resources Management
RCD Rabbit Calicivirus Disease
SAMDB NRM Board South Australian Murray-Darling Basin Natural Resources Management Board (formerly the Animal and Plant Control Commission, Soil Board and River Murray Catchment Water Management Board)
sp. Species
ssp. Subspecies

STRATEGIC STATEMENT

VISION

To assist in identifying, protecting and enhancing the region's conservation assets, whilst raising community awareness.

PURPOSE

To provide practical information to the community and land managers to assist in achieving biodiversity conservation while enabling the strategic direction of resources to the highest priority actions.

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MAPS

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Nicole Zeoli.

Photograph: Ben Simon / MMLAP

Introduction

How to use this Plan

Introduction

The Murray Mallee Biodiversity Plan is designed to identify areas with significant flora and fauna within the Murray Mallee Local Action Planning area (see Figure 2). This Plan will assist active protection, management and extension, and provide strategic information for land managers to be used when making biodiversity conservation decisions. The Plan is further aimed at providing the community with information to assist with property-based projects, particularly regarding protection, restoration and enhancement of important natural habitat on their properties. A regional contact list for the Murray Mallee LAP area is also provided for more information and/or further assistance (see Regional Contacts, page 87).

In addition, the Plan aims to assist in achieving the following goals identified in the *Murray Mallee Local Action Plan* (2002), particularly with respect to Goals 1 and 7. The plan provides information and contacts to inform landholders and community members alike, regarding some of the main issues existing within the local area. Equipped with a greater level of local information, the community have the opportunity to direct on-ground action and resources that focus on local issues according to identified priorities and are in a better position to assist in protecting and enhancing the region's natural conservation assets.

Our Local Action Plan goals are to:

1. Raise awareness in the Murray Mallee community of the need for change.
2. Increase gross margins of Mallee farming systems within land capability.
3. Reduce the erosion of topsoil caused by wind.
4. Ensure sustainable use of the groundwater resources of the Murray Mallee.
5. Increase the water use efficiency on farms in the Murray Mallee.
6. Minimise the impacts of irrigation drainage in the Murray Mallee.
7. Protect and enhance native vegetation communities in the Murray Mallee and the species they support.

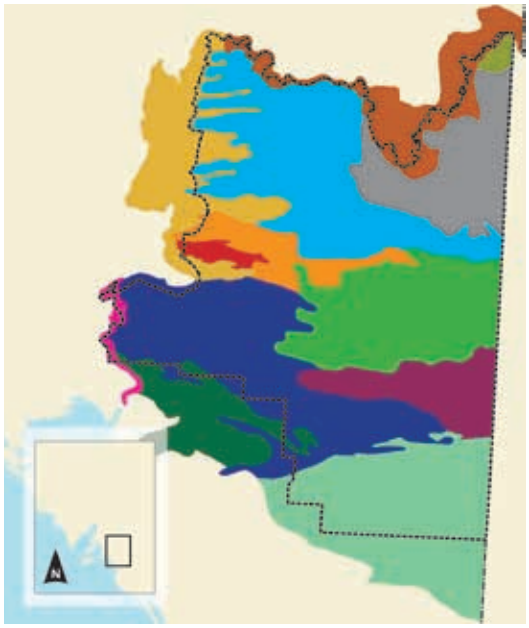

Figure 1. Land Units in the MMLAP area.
Map Illustration: Ecocreative
For a larger, more detailed version of this map, please refer to page 49.

HOW TO USE THIS PLAN

STEP 1

Go to Section 1 of the Plan to obtain regional information specific to the Murray Mallee Local Action Planning area. This section will allow you to find out:

- **WHERE** the MMLAP area is located and which major land uses are active in the region
- **WHAT** are the important conservation assets within the region
- **WHY** they need to be protected
- **HOW** to implement strategies to assist in their protection.

Section 1 primarily aims to equip land managers, project officers and interested community members with the information they require to prioritise on-ground works and enable appropriate targeting of resources across the region.

STEP 2

After reading about the regional issues, identify which Land Unit you are interested in and go to Section 2 where each Land Unit is colour-coded. Figures 1 and 29 will assist you in selecting the appropriate Land Unit. The Land Units are listed below with their corresponding colours:

- Bandon
- Billiatt
- Blanchetown
- Holder
- Karoonda
- Kunlara
- Lower Murray
- Moorlands
- Murtho
- Pata
- Pinnaroo
- Renmark
- The Big Desert

Section 2 delivers more specific information relating to the primary biodiversity issues within the individual Land Units across the region. Land Units represent the environmental associations, which have been identified based on factors such as land form, vegetation and soil types. For each Land Unit, the main conservation assets, active threatening processes and suggested mitigation measures are highlighted. It is the intention of Section 2 to identify priority areas which require greater levels of investment, while strategically improving biodiversity across the greater region. It also aims to provide landholders with the practical information and contacts they may need to assist in the planning and implementation of on-ground works.

STEP 3

Information provided under each Land Unit section may direct you to the Appendices where further information can be obtained to assist in planning and implementation. This information includes:

- Appendix 1: Weed species and associated management techniques within the MMLAP area
- Appendix 2: Methods of weed control (broad methodologies of weed removal)
- Appendix 3: Plant lists for typical vegetation communities within the MMLAP area
- Appendix 4: Methods of feral animal control and monitoring of effectiveness
- Appendix 5: Conservation ratings and priorities.

Both Sections of the Plan include broad objectives and management actions at both regional and Land Unit level to assist in prioritising investment for the protection, restoration and recovery of priority habitat areas for threatened species in the Murray Mallee LAP area.

Table 1: Summary of the key objectives, management actions and outcomes for the MMLAP area

Actions and links to Investment Strategy*		Murray Mallee Local Action Plan objectives		Primary responsibility (see Regional Contacts, page 87)
ACTIVITY	**TASK**	**OBJECTIVES**	**WHAT IT ACHIEVES**	
Habitat protection and recovery to improve biodiversity and protect areas of conservation significance (IS 9.1)	Protect existing resources though covenant , reserves and Heritage Agreements (IS 9.1.1)	Promote the protection of remnant vegetation using conservation programs, such as Heritage Agreements and Land for Wildlife (IS 13.1)	Widespread awareness of Heritage Agreements and other conservation options.	Department for Environment and Heritage South Australia (DEH SA) Bushcare Greening Australia Trees for Life Nature Conservation Society Murray Mallee Local Action Planning Association Inc. (MMLAP Association)
	Increasing knowledge on remnant vegetation management and habitat re-establishment (IS 9.1.2)		Increases total area of formal protection (Heritage Agreements) over remnant areas	
			Raise awareness with all landholders with remnant native vegetation on their properties of the benefits of the Heritage Agreement scheme	
	Implement on-ground actions to retain natural habitat, re-establish threatened habitat areas, revegetate buffer areas, link blocks of remnant vegetation and encourage natural regeneration of degraded areas (IS 9.1.3)	Promote the protection of remnant vegetation using incentive programs (IS 13.2)	Raises awareness of landholders of the incentive payment programs (Mallee Futures Program)	MMLAP Association Bushcare Greening Australia Trees for Life Nature Conservation Society DEH SA Local government SAMBD NRM Board Authorised Officers
			Increases total area of protected remnant areas	
			Ensure knowledge of benefits of native vegetation and wildlife	
	Identification and extension of climate change impacts on biodiversity (IS 9.1.4)	Increase the total area of remnant vegetation protected in the Murray Mallee (IS 13.3)	Increases size of core areas	MMLAP Association Bushcare Greening Australia Trees for Life DEH SA Nature Conservation Society State Government agencies
			Improves connectivity	
			Preserves adequate representation of vegetation associations	
			Increases in the total area of protected remnants	
Recovery of threatened ecological communities and species (IS 9.2)	Develop and implement recovery programs for priority threatened species (IS 9.2.1)	Identify areas with threatened flora and fauna as priorities for protection to prevent further decline in biodiversity (IS 12.3)	Identifies threatened flora and fauna and communities across the Murray Mallee LAP area	MMLAP Association Bushcare Greening Australia Trees for Life DEH SA Nature Conservation Society State Government Agencies
			Increases total area of formal protection (ha) over remnant areas containing significant biodiversity	
			Identifies key habitat areas	
			Ensures knowledge of benefits of native vegetation and wildlife	
Support community groups to increase capacity to improve biodiversity across the SAMDB (IS 9.3)	Provide technical support to community groups to re-establish habitat and/or protect threatened species (IS 9.3.1)	Provide a link for landholders with the SAMDB NRM Board (formerly Animal and Plant Control Board (APCB)) to assist with information exchange (IS 14.2)	Promotes activities of the Board	MMLAP Association SAMBD NRM Board Authorised Officers Local government Greening Australia Trees for Life DEH SA Nature Conservation Society
			Raises awareness of feral animals and exotic plants across the region	
			Greater availability of technical support and information	
			Provides links to landholders to info and SAMBD NRM Board Authorised Officers	
		Promote the eradication of feral animal and weed populations in remnant vegetation on farms using best practice control methods (IS 14.1)	Raises awareness of best practice methodology for management of feral animals and weeds	SAMBD NRM Board Authorised Officers MMLAP Association DEH SA Trees for Life Bush for Life Greening Australia Nature Conservation Society
			Provides links to landholders to info and SAMBD NRM Board Authorised Officers	

** SAMDB NRM Investment Strategy: Program 9—Biodiversity Protection and Enhancement*

Photograph: Keith Payne / MMLAP

Section One

Murray Mallee Local Action Planning Area

Where?

PHYSICAL DESCRIPTION

The Murray Mallee Local Action Planning area (MMLAP area) encompasses approximately 20 000 square kilometres of land within the agricultural zone of the Murray-Darling Basin (MMLAP, 2001) (see Figure 2).

The climate is defined by cool to cold winters and warm to hot summer seasons with mean annual rainfall varying from 400–450 mm in the south to 250 mm further north and inland (Laut et al., 1977), with the majority of rainfall occurring in the winter months. Land types across the region are described by Laut et al. as comprising undulating calcrete plains with shallow soils largely dominated by low woodlands or tall open shrublands, overlain in areas by low dunes or sand sheets supporting predominantly mallee vegetation.

Figure 2. The Murray Mallee Local Action Planning area Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

LAND USE

The dominant commercial land use for the region is agriculture or dryland farming, comprising domestic stock grazing and cereal cropping. The nature of this enterprise has largely shaped the landscape since European settlement, whereby much of the native vegetation has been cleared and most remaining examples have been degraded, fragmented and isolated. The total remaining vegetation cover for the region is approximately 6312.9 square kilometres, forming approximately 32.5% of the MMLAP area (DEH figures, 2005). Remaining vegetation varies considerably in condition across the region, a proportion of which is mapped as remnant vegetation despite a high level of modification due to grazing. Hence, the total area occupied by agriculture within the region overlaps the total area of native vegetation. This indicates that approximately 35% of the remaining vegetation across the region is utilised for grazing. Other land uses across the region include conservation, horticulture and mining ventures.

AGRICULTURE

Dryland agriculture and pastoralism are by far the dominant land use practices, occupying approximately 79% of the region (MMLAP, 2005). More specifically, the practices include rotational cropping (mainly wheat and barley) and grazing of improved introduced and native pastures by sheep and cattle (Laut et al., 1977). In recent years, there have been increases in irrigated horticulture (vegetables, olives, almonds, vines), particularly in the south-west, which has accompanied a greater understanding of land capability and water resources (Kahrimanis et al., 2001). Animal industries such as pig and poultry farming also operate within the region (MMLAP, 2005). As a region, the Murray produces $850 million from agricultural production per annum (Lewis, pers. comm., 2005).

CONSERVATION

Areas managed for conservation include reserves managed by the Department for Environment and Heritage National Parks and Wildlife South Australia ((DEH) NPWSA). These reserves represent the largest remnants of vegetation in the region. A large number of smaller blocks are protected under Heritage Agreements (see Figure 4 for more information on Heritage Agreements). Together the conservation areas protect approximately 50.7% of all remaining native vegetation across the region, which makes up 16.5% of the total area of the Murray Mallee LAP area. Currently there are six DEH (NPWSA) reserves within the region, the largest of them being Ngarkat and Billiatt Conservation Parks.

Parks

Bakara Conservation Park (CP)—2048 ha

The Park is located 32 km East of Swan Reach on the Swan Reach to Loxton Road (DEH, 2005) (see Figure 3). Bakara was compulsorily acquired and granted formal protection in 1983 in recognition of its high floristic diversity and significant Malleefowl population. The dominant Mallee vegetation association (*Eucalyptus socialis*) present within the block was also identified as being absent or poorly represented in the nation's reserve system (Foulkes et al., 2000). An area of 1021 hectares to the north of the Park (formally known as Marshal's Block) has recently been acquired and added to the park (Crawford, pers. comm., 2006). Combined with the existing park, this additional section makes up the total of 2048 hectares. The maps showing the reserve areas throughout this plan do not reflect this recent addition to Bakara CP.

Billiatt Conservation Park—59 273 ha

Billiatt is located approximately 37 km north of Lameroo. It was originally declared a Fauna and Flora park in 1940, but with the proclamation of the *National Parks and Wildlife Act 1972*, was renamed a Conservation Park, along with Peebinga Conservation Park (Kahrimanis et al., 2001). Since that time, adjacent remnant blocks have been added. (Foulkes et al., 2000). The large size of the park and the relatively undisturbed nature of the vegetation mean it is an important refuge for threatened and common wildlife in the area. Some of these include the Pygmy Possum, Southern Ningaui, Western Whipbird, Red-lored Whistler and Malleefowl (DEH, 2005).

Karte Conservation Park—3614 ha

Karte is 30 km north-east of Pinnaroo. It was considered to have little value for agricultural purposes and was therefore dedicated as a reserve in 1969 (Foulkes et al., 2000). Karte, Billiatt and Peebinga all fall within the 'Billiatt Complex' identified in the *Biodiversity Plan for the South Australian Murray-Darling Basin* (hereafter referred to as *Biodiversity Plan for the SAMDB*) as being an important habitat refuge for wildlife in the district (Kahrimanis et al., 2001). Several fauna species of conservation significance have been identified within the park, including Malleefowl and Chestnut Quail-thrush.

'THE MURRAY MALLEE LOCAL ACTION PLANNING AREA ENCOMPASSES APPROXIMATELY 20, 000 SQUARE KILOMETRES OF LAND.'

CONTINUED

LAND USE

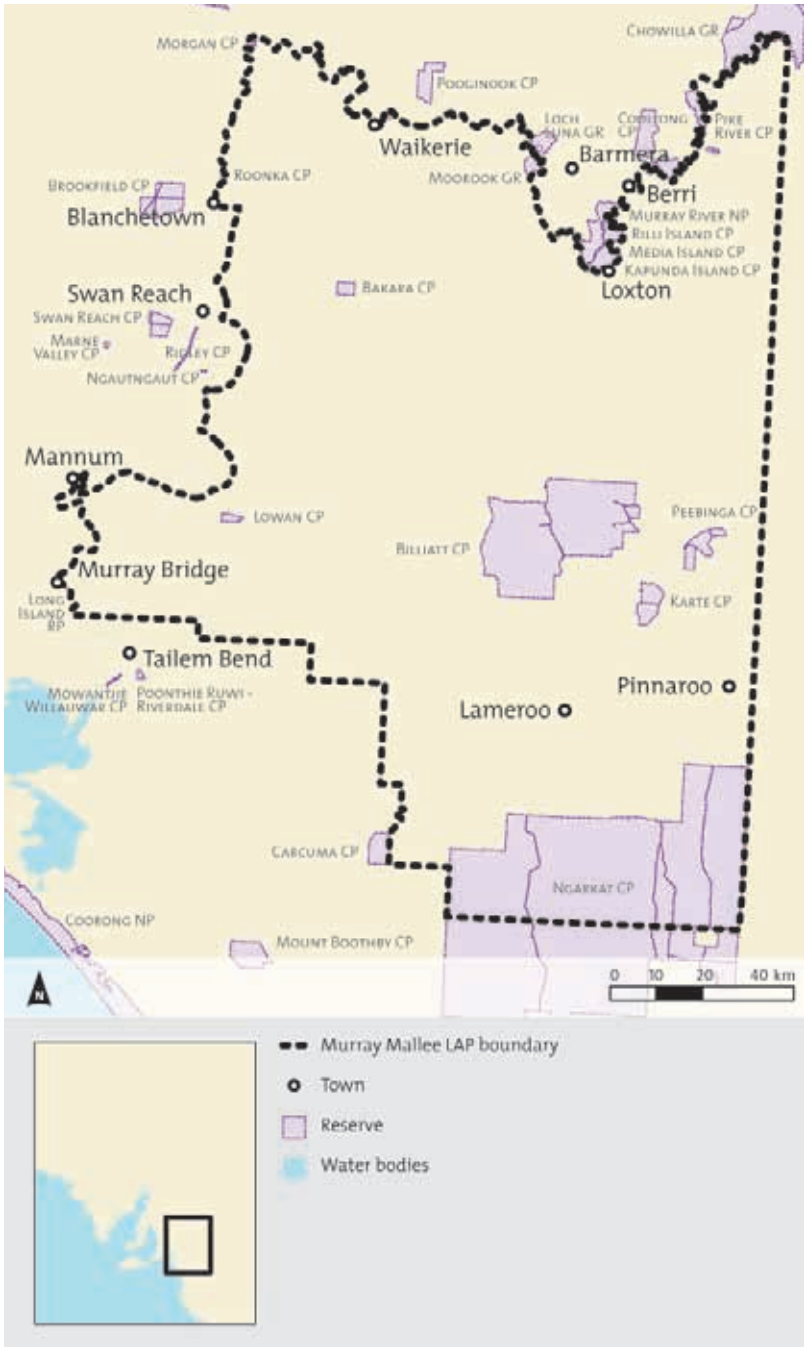

Figure 3. Reserve locations across the Murray Mallee Local Action Planning area
Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

Lowan Conservation Park—675 ha

Lowan is located approximately 30 km east of Mannum within the 'Ettrick Fragmented Habitat Area' identified in *Biodiversity Plan for the SAMDB* (Kahrimanis et al., 2001). The Park is known to provide habitat to a number of fauna and flora species of conservation significance including Malleefowl, Chestnut Quail-thrush and the Streaked Wattle (*Acacia lineata*), rare in South Australia.

Ngarkat Conservation Park (Scorpion Springs CP, Mt. Shaugh CP, Mt. Rescue CP)—267 393 ha

The majority of this Park lies within the south-eastern corner of the MMLAP area with the southern section falling into the Coorong LAP area. This group of parks comprises the largest native vegetation remnant in the agricultural regions of South Australia (Foulkes et al., 2000). There has been a history of light grazing and systematic burning, however the land was generally considered to be unsuitable for agricultural production and since 1962 has been gradually integrated into the reserve system. The parks are identified in *Biodiversity Plan for the SAMDB* as one of four 'large remnant areas' within the region (Kahrimanis et al., 2001) and is known to provide habitat to a large number of fauna species, including many threatened species of both fauna and flora. Some of these are the Malleefowl, Western Whipbird, Mallee Emu-wren and the Nationally Vulnerable Lowan Phebalium (*Phebalium lowanense*).

Peebinga Conservation Park—3381 ha

Peebinga is located approximately 35 km north of Pinnaroo and was set aside as a flora and fauna reserve in 1940. The area was considered to be unsuitable for agriculture and was often subject to sand drift. It was also recognised as habitat for the Western Whipbird and Malleefowl populations (Foulkes et al., 2000).

Heritage Agreements

Heritage Agreements allow for the formal and permanent protection of native vegetation across South Australia and account for approximately 4.7% of the region's total area. The Heritage Agreement Scheme was developed in 1980 and encourages conservation management by an agreement established between the landholder and the Minister for Environment. Currently there are 429 blocks protected under Heritage Agreement across the region, comprising 92 413 hectares of native vegetation. This figure represents 29% of the total vegetation protected within the reserve system across the MMLAP area (see Figure 4). For more information on Heritage Agreements, refer to the *Biodiversity Plan for the SAMDB* or contact the DEH Bush Management Advisor (see Regional Contacts, page 87).

Conservation managed areas

There are many other unprotected areas managed for conservation which include Council reserves, privately-owned remnants, unmade road reserves and Crown Land.

MINING

The *Biodiversity Plan for the SAMDB* identifies 13 mines and quarries in the region. These are primarily located in the MMLAP area and have been established to extract minerals such as lignite, gypsum, copper and heavy mineral sand, however many are not currently operational (Kahrimanis et al., 2001). In recent times, mineral sand mining claims have been placed over areas around Mindarie, within the Hundreds of Bandon, Chesson, McPherson, Allen and Mindarie. It is understood that there are substantial deposits of mineral sands within this region and some mining ventures are currently underway (How, pers. comm., 2005). Several of these mining operations have been proposed through Heritage Agreement areas. It is understood that this will require the removal of large tracts of native vegetation through Heritage Agreement areas and that they are likely to take a considerable time to recover. It is highly unlikely that they will resemble their original state and provide the same quality of habitat in the short term.

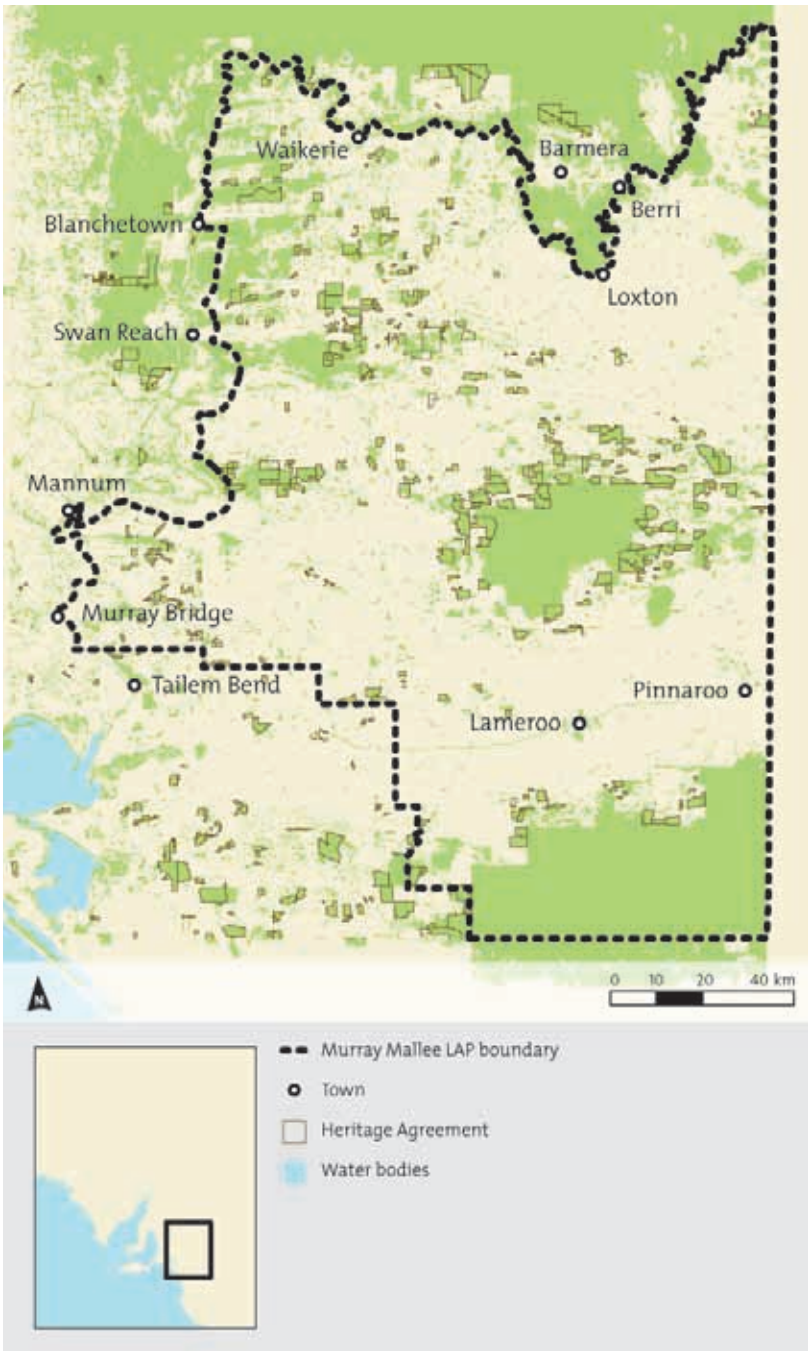

Figure 4. Heritage Agreements across the Murray Mallee Local Action Planning area
Map illustration: Ecocreative (based on GIS map supplied by Sarah Crossman, DEH)

What?

KEY CONSERVATION ASSETS

The vast majority of native vegetation across the Murray Mallee LAP area has been cleared or severely modified. Preferential clearance of vegetation on soils best suited to agriculture has led to the remaining examples being located on poorer soils and of relatively poorer habitat quality.

Apart from several large Conservation Parks, most remnant blocks (approximately 90%) are less than 100 ha in size (MMLAP Association, 2004) and are isolated from other blocks of native vegetation. As a direct result, many of the region's native vegetation communities and local fauna and flora species have significantly declined and some are now considered threatened. Tables 2, 3 and 4 list the area's threatened species and communities.

THREATENED FAUNA, FLORA AND VEGETATION COMMUNITIES

The following nationally and state threatened species have been recorded within the MMLAP area, including a selection of regionally significant species. A total of 23 bird species, seven mammals, four reptiles and 22 plant species. Four threatened vegetation communities have also been identified. Most of the nationally threatened species have Recovery Plans aimed at improving their conservation status, whereas management actions for State threatened species exist in the form of Taxon summaries with recommended actions. Nationally threatened species are required under the *Environment Protection and Biodiversity Conservation Act 1999* to have Recovery Plans outlining future conservation management plans.

Table 2: Threatened fauna of the MMLAP area

Common Name, *Scientific name*	Conservation Status	Current management actions
BIRDS		
Australian Bustard, *Ardeotis australis*	Vulnerable (SA, MM)	Taxon Summary with recommended actions†
Black-eared Miner, *Manorina melanotis*	Endangered (Aus, SA, MM)	National Recovery Plan 2002–2006*
Blue-winged Parrot, *Neophema chrysostoma*	Vulnerable (SA, MM)	None
Chestnut Quail-thrush, *Cinclocoma castanotus*	Rare (SA), Vulnerable (MM)	Taxon Summary with recommended actions†
Diamond Firetail, *Stagonopleura guttata*	Vulnerable (SA, MM)	Taxon Summary with recommended actions†
Elegant Parrot, *Neophema elegans*	Rare (SA), Uncertain (MM)	None
Gilbert's Whistler, *Pachycephala inornata*	Rare (SA, MM)	None
Major Mitchell's Cockatoo, *Cacatua leadbeateri*	Vulnerable (SA, MM)	Taxon Summary with recommended actions†
Mallee Emu-wren, *Stipiturus mallee*	Vulnerable (Aus, SA, MM)	National and Regional Recovery Plans (implementation in progress)*
Malleefowl, *Leipoa ocellata*	Vulnerable (Aus, SA, MM)	National Recovery Plan*
Painted Button-quail, *Turnix varia*	Vulnerable (SA, MM)	None
Peregrine Falcon, *Falco peregrinus*	Rare (SA, MM)	None

Table 2: Threatened fauna of the MMLAP area		
Common Name, *Scientific name*	Conservation Status	Current management actions
Plains Wanderer, *edionomus torquatus*	Vulnerable (Aus) Endangered (SA, MM)	National Recovery Plan 2002–2006 (in preparation)*
Red-lored Whistler, *Pachycephala rufogularis*	Vulnerable (Aus, SA, MM)	National and Regional Recovery Plans (implementation in progress)*
Redthroat, *Pyrrholaemus brunneus*	Rare (SA, MM)	Taxon Summary with recommended actions†
Regent Parrot, *Polytelis anthopeplus*	Vulnerable (Aus, SA, MM)	National and Regional Recovery Plans (implementation in progress)*
Scarlet-chested Parrot, *Neophema splendida*	Rare (SA), Vulnerable (MM)	Taxon Summary with recommended actions†
Slender-Billed Thornbill, *Acanthiza iredalei hedleyi* (eastern subspecies)	Vulnerable (SA, MM)	Taxon Summary with recommended actions†
Striated Grasswren, *Amytornis striatus striatus*	Rare (SA), Vulnerable (MM)	National and Regional Recovery Plans (implementation in progress)*
Striped Honeyeater, *Plectorhyncha lanceolata*	Rare (SA), Vulnerable (MM)	None
Western Whipbird (eastern), *Psophodes nigrogularis leucogaster*	Vulnerable (Aus, SA, MM)	National and Regional Recovery Plans (implementation in progress)*
White-browed Treecreeper, *Climacteris affinis*	Rare (SA), Vulnerable (MM)	Taxon Summary with recommended actions†
Yellow-tailed Black-Cockatoo, *Calyptorhynchus funereus*	Vulnerable (SA, MM)	None
MAMMALS		
Common Brushtail Possum, *Trichosurus vulpecula*	Soon to be listed Rare (SA), Rare (MM)	Recovery actions being implemented*
Common Dunnart, *Sminthopsis murina*	Rare (SA, MM)	None
Inland Forest Bat, *Vespadelus baverstocki*	Unknown (SA), Rare (MM)	None
Little Forest Bat, *Vespadelus vulturnus*	Unknown (SA), Rare (MM)	None
Mitchell's Hopping Mouse, *Notomys mitchellii*	Common (SA) Uncommon (MM)	None
Southern Ningaui, *Ningaui yvonneae*	Common (SA) Uncommon (MM)	None
Yellow-bellied Sheathtail Bat, *Saccolaimus flaviventris*	Rare (SA), Rare (MM)	None
REPTILES		
Bardick, *Echiopsis curta*	Rare (SA, MM)	None
Carpet Python (SAMDB subspecies), *Morelia spilota variagata*	Vulnerable (SA, MM)	None
Olive Snake Lizard, *Delma inornata*	Rare (SA)	None
Jacky Lizard, *mphibolurus muricatus*	Rare (SA)	

**(EPA, 2003) †(Neagle, 1995)*

Table 3: Threatened flora of the MMLAP area		
Common Name, *Scientific Name*	Conservation Status	Current management actions
(Previously Limestone Phebalium), *Leionema microphyllum*	Rare (SA), Vulnerable (MM)	
Australian Broomrape, *Orobanche cernua* ssp. *australiana*	Vulnerable (SA, MM)	
Cleland's Beard-heath, *Leucopogon clelandii*	Rare (SA), Endangered (MM)	
Club Spear-grass, *Stipa nullanulla*	Vulnerable (Aus, SA) Uncommon (MM)	Recovery Plan in preparation, recovery action being implemented*
Cushion Centrolepis, *Centrolepis cephaloformis* ssp. *cephaloformis*	Rare (SA), Uncertain (MM)	
Eichler's Raspwort, *Haloragis eichleri*	Rare (SA), Endangered (MM)	
Five-spine Bindyi, *Sclerolaena muricata* ssp. *villosa*	Rare (SA, MM)	
Fringed Heath-myrtle, *Micromyrtus ciliata*	Rare (SA, MM)	
Lowan Phebalium, *Phebalium lowanense*	Vulnerable (Aus, SA, MM)	Recovery action being implemented*
Mallee Bitter-pea, *Daviesia benthamii* ssp. *humilis*	Rare (SA, MM)	
Mallee Wattle, *Acacia montana*	Rare (SA), Vulnerable (MM)	
Narrow-leaf Wax-flower, *Philotheca angustifolia* ssp. *angustifolia*	Rare (SA, MM)	
Rasp Daisy-bush, *Olearia picridifolia*	Rare (SA, MM)	
Rohrlach's Bluebush, *Maireana rohrlachii*	Rare (MM)	
Sand Lily, *Corynotheca licrota*	Rare (SA, MM)	
Scaly Haeckeria, *Ozothamnus pholidotus*	Vulnerable (SA) Endangered (MM)	
Showy Copper-wire Daisy, *Podolepis jaceoides*	Rare (SA), Uncertain (MM)	
Spiny Daisy, *Acanthocladium dockeri*	Endangered (Aus, SA, MM)	National Recovery Plan (in preparation)*
Streaked Wattle, *Acacia lineata*	Rare (SA, MM)	
Sundew, *Drosera whittakeri* ssp. *aberrans*	Rare (SA), Uncertain (MM)	
Williamson's Riceflower, *Pimelea williamsonii*	Rare (SA, MM)	
Yellow Burr-daisy, *Calotis lappulacea*	Rare (SA), Uncertain (MM)	

**(EPA, 2003)*

Table 4: Threatened vegetation communities of the MMLAP area		
Community type	Conservation Status	Comments/current management actions
Eucalyptus cyanophylla Open Mallee	Priority 3†	
Eucalyptus porosa Woodland	Priority 5†	
Allocasuarina luehmannii (Buloke) Woodland	Priority 6† Endangered Ecological Community under EPBC Act	No Recovery Plan
Callitris gracilis (Southern Cypress Pine) Low Woodland (south-western population)	Regionally threatened	

**(EPA, 2003) †(Neagle, 1995)*

Appendix 5 (page 129) provides a general explanation of the conservation ratings for the above threatened species and the conservation priorities for threatened vegetation associations.

Eucalyptus arenacea (Sand Stringybark) Open Woodland is not particularly widespread in the MMLAP area, however is common in Ngarkat Conservation Park. The community is mainly located in the upper south-east and its low distribution within this region can be explained by the population being on the far northern end of its range.

Eucalyptus leucoxylon ssp. *stephaniae* (Scrubby Bluegum) Low Woodland is another vegetation association which is not well represented within the MMLAP area, however this is primarily due to being on the far northern end of its range. It is known to occur between broad sand ridges on heavy soils in the northern end of Ngarkat Conservation Park.

FLAGSHIP SPECIES AND COMMUNITIES

Some of the focal or 'flagship' vegetation communities and fauna and flora species located within the region are highlighted below. Public recognition combined with community support for conservation efforts has the potential to benefit the survival of focal species, in addition to other less high profile species, primarily through the conservation of similar habitats.

The general locations of these species have been recorded in Section 2 within particular Land Units.

Many of the general management techniques that can be employed to help maintain and improve the status of some of the described flagship species are similar for all species. They include:

- Buffer and/or improve remnant vegetation blocks—revegetation with site-specific local native species around perimeters of remnant blocks, increasing the size and reducing 'edge effects' of remnants.
- Fence off remnants—reduce grazing impacts from key habitat areas, aimed at encouraging natural regeneration and accumulation of leaf litter.
- Reduce the risk of fire—take precautions to avoid spread of fire into remnant habitat areas such as abiding by the Harvest Code of Practice or maintaining firebreaks in adjoining paddocks.
- Heritage Agreement status—formally protect and manage remnants through the Heritage Agreement Scheme.
- Connect remnants—revegetate with local native species between remnants with the aim of connecting and encouraging wildlife movement between patches of remnant vegetation.
- Weed control—manage the spread of weeds into remnant blocks to encourage recruitment of native understorey species and overstorey species, which may provide habitat to native species into the future.
- Fox and cat control—limit predation by controlling feral predators across the property.
- Reduce the risk of wildfire—take precautions to avoid spread of wildfire into remnant habitat areas, potentially causing local extinctions and/or destruction of hollow bearing limbs. Note: the use of controlled burns as an ecological management tool has been employed in some situations and may benefit some species.
- Control feral animals—limit grazing impacts of rabbits and goats. See pages 38–39.

Remnant vegetation with a dense understorey.
Photograph: Ben Simon / MMLAP

Malleefowl

(Leipoa ocellata)

The Malleefowl is now well-recognised as a threatened species throughout the region due to extensive efforts directed toward its conservation. The species, which is listed as nationally, State and regionally Vulnerable, now has a National Recovery Plan as required under the *Environment Protection and Biodiversity Conservation Act 1999* (Benshemesh, 1994).

The distribution of Malleefowl was once considerably more widespread than it is today. This is primarily due to habitat clearance and fragmentation that has resulted in small, isolated populations which are restricted to pockets of remaining habitat. Since the vegetation on the 'best' soils has been cleared to make way for agriculture and ongoing degradation of mallee remnants by grazing and weed invasion, many of the remaining patches of suitable habitat are of sub-optimal quality (Kahrimanis et al., 2001).

Predation by foxes and competition from grazing animals has also contributed to their decline. Malleefowl do not tend to travel long distances between patches of habitat (Garnett, 1992b, Silveria 1993, Cutten 1998 as cited in Kahrimanis et al., 2001), which increases the species' vulnerability in the event of a local catastrophe such as wildfire. Aside from the immediate threat posed by fire, it has also been shown that Malleefowl prefer suitable mallee habitat, which has not been burnt for 10–20 years (Kahrimanis et al., 2001).

What can be done?

The Murray Mallee LAP area contains numerous zones of suitably intact mallee habitat which currently provides adequate refuge for the area's remaining Malleefowl.

Figure 5: Malleefowl building nest mound. Photograph: Keith Payne / MMLAP

Predicted Malleefowl habitats are those that contain greater than 500 ha of unburnt mallee vegetation (Kahrimanis et al., 2001) and it is important that these areas are effectively managed to maintain suitable habitat. Aside from the region's reserves, there are many privately-owned Heritage Agreements and remnant blocks which are also likely to be suitable. Some of the techniques used at the property level, which can potentially improve and restore the habitat quality for the species include:

- buffering and/or improving remnant vegetation blocks.
- connecting remnants with revegetation
- fox baiting
- rabbit control
- fencing off remnants
- reducing risk of fire
- Heritage Agreements
- fire management
- weed control.

CONTINUED

FLAGSHIP SPECIES AND COMMUNITIES

Common Brushtail Possum

(Trichosurus vulpecula)

The Brushtail Possum has no national or state conservation status, however it is considered to be endangered in the Murray Mallee (Barratt et al., 1991 as cited in Kahrimanis et al., 2001).

Along the River Murray corridor, the species is normally associated with *Eucalyptus camaldulensis* (River Red Gum) and *Eucalyptus largiflorens* (River Box) communities whilst in the mallee areas it can be found feeding in *Callitris gracilis* (Native Pine) communities and nesting in old-growth mallee (Kahrimanis et al., 2001). The species feeds predominantly at night on leaves, flowers, fruits, *Callitris* cones and insects, and generally nests in tree hollows, fallen logs, building roof cavities and limestone sinkholes during the daylight hours (Foulkes, 2000). The Murray Mallee population is considered to be in steady decline due to habitat loss, degradation and predation. Decline of suitable habitat has been attributed to death and destruction of hollow-bearing trees due to drought or drowning, clearance of old-growth mallee vegetation, unauthorised removal of hollows for the aviary trade, firewood, campfires and grazing (Kahrimanis et al., 2001). The ongoing loss of suitable habitat throughout the region has lead to increased competition for nesting sites between species with similar habitat requirements, including galahs and feral bees. Increased competition and loss of habitat have forced the species to spend more time on the ground, foraging for food or moving between remnants and exposing them to additional threats (Kahrimanis et al., 2001) including predation by foxes, cats and dogs and traffic fatalities.

What can be done?

The species has been recorded from numerous locations within the Murray Mallee, particularly within blocks located in close proximity to the river corridor, containing River Box, River Red Gum or old-growth mallee communities. These areas can be managed to maintain and improve potential habitat for Brushtail Possums. Some of the techniques used at the property level, which can potentially improve and restore the habitat quality for the species include:

- buffering and/or enhancing remnant vegetation blocks containing old-growth mallee vegetation through revegetation with local native species around perimeters of remnant blocks, increasing the size and reducing edge effects of remnants
- connecting remnants with revegetation
- weed control
- feral bee control in trees containing hollows
- fox and cat control
- reducing the risk of fire
- fencing off remnants
- Heritage Agreements
- retention of large trees containing hollows (including dead trees)
- revegetation using species likely to form hollows in the future
- planting Native Pine (*Callitris gracilis*) in revegetation projects (in suitable areas) which are known to provide food for the Brushtail Possum.

Major Mitchell's Cockatoo

(Cacatua leadbeateri)

The Major Mitchell's Cockatoo is listed as Rare for the State and Vulnerable within the region. It has been recorded from numerous locations within the northern and western regions of the Murray Mallee LAP area, with the majority being recorded from the Bakara–Mantung–Maggea high value habitat area. This area is considered to be the stronghold for the species within the district (Kahrimanis et al., 2001).

The species mainly feeds on fruit, including native fig (*Ficus* sp.), the seed of Native Pine (*Callitris* sp.) and introduced pines and requires fresh surface water to drink (Blakers et al., 1984 as cited in Kahrimanis et al., 2001). Nesting requirements include large hollows contained within *Eucalyptus camaldulensis* (River Red Gums), *Eucalyptus largiflorens* (River Box), Native Pine (*Callitris* sp.) and old-growth mallee vegetation. Breeding pairs tend to return every year to the same nest, becoming extremely aggressive and territorial toward other individuals within the same species. It is considered that the Major Mitchell's Cockatoo requires blocks of suitable habitat in excess of 300 ha in order to ensure its long-term survival (Kahrimanis et al., 2001).
The main threats to the survival of the species are loss and fragmentation of habitat. This has particular significance in the north-western regions of the Murray Mallee LAP area where preferred habitat is located. Many of the vegetation communities containing suitable habitat have been extensively cleared and now exist as fragmented and isolated remnants and are regionally threatened themselves. Historic wood-cutting practices have lead to the removal of much of the old-growth mallee vegetation which provide nesting habitat. Additional threats include poaching of birds and eggs for the illegal aviary trade, competition for nest hollows with galahs and wildfire (Kahrimanis et al., 2001).

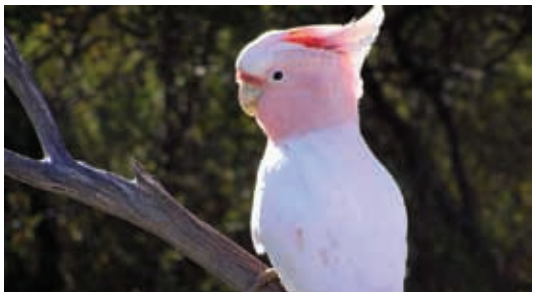

Figure 6: Major Mitchell's Cockatoo. Photograph: David Cook

What can be done?

Blocks containing suitable nesting and feeding habitat which are in excess of 300 ha and located within the north-western regions of the Murray Mallee LAP area can be managed to retain and improve existing habitat. This applies to smaller blocks of suitable habitat, which are in close proximity to larger remnants. Some of the techniques used at the property level, which can potentially improve and restore the habitat quality for the species include:

- buffering and/or improving remnant vegetation blocks
- connecting remnants
- feral bee control
- fox and cat control
- retention of large dead trees containing hollows
- revegetation with species likely to form hollows in the future
- fencing off remnants
- reducing the risk of fire
- Heritage Agreements
- reducing illegal poaching—report all suspicious behaviour in known Major Mitchell's Cockatoo habitat areas (contact the DEH Regional Ecologist listed under Regional Contacts)
- revegetate with species known to provide food for the Major Mitchell's Cockatoo. Plant Native Pine (*Callitris gracilis*), *Hakea* sp. in revegetation projects (in suitable areas).

CONTINUED

FLAGSHIP SPECIES AND COMMUNITIES

Figure 7: Streaked Wattle. Photo: Ben Simon / MMLAP

Streaked Wattle

(Acacia lineata)

Streaked Wattle is listed as Rare for the State and region. It is mainly located in mallee eucalypt communities in the central and western Murray Mallee with an isolated population in the north of the region near Waikerie (Berkinshaw, 2005). Many of the species' records are collected from Ettrick and surrounds, Bakara–Mantung–Maggea, Billiatt CP and Forster–Chesson high value habitat areas. The species is known to prefer sandy loam soils in interdune swales of dune systems (EAC, 2005). The species is a bushy spreading green to greenish yellow shrub to 1.5 m high, with sticky or hairy leaves 1–2 cm long and 2 mm wide. The flowers are globular on stalks as long as the leaves. The curled, twisted and usually hairy seed pods are normally 2–4 cm long and 2–3 mm broad (Jessop et al., 1986).

Streaked Wattle has declined as a result of land clearance and grazing of remnants. It has been documented that two large populations exist in the northern Murray Mallee region with several small populations occurring across private properties within the area. A population of approximately 100 individuals occurs next to the Karoonda Road and several others are located nearby along back roads near Wynarka (Simon, pers. comm.).

What can be done?

Some of the techniques used at the property level, which can potentially improve and restore the habitat quality for the species include:

- fencing off remnants
- weed management
- buffering and/or improving of remnant vegetation blocks
- revegetation with the local species including threatened species such as Streaked Wattle (if appropriate to landform, soils and geography)
- controlling feral animals
- reducing the risk of fire
- Heritage Agreements
- education programs to assist in highlighting the significance of the species
- community field days to assist with educating members about the species
- contacting the Bush Management Advisor (see Regional Contacts) to seek further advice on what information/management techniques and/or support is available
- development of Roadside Vegetation Management Plans.

Southern Cypress Pine

(*Callitris gracilis*) Low woodland

The Southern Cypress Pine or Native Pine Low Woodland (Figure 9) is a threatened vegetation community which was once considerably more widespread throughout the south-western areas of the Murray Mallee LAP area. Today only small pockets remain due to large-scale preferential clearance of the vegetation due to its suitability for house building and fence posts, and the higher fertility of the soils (Kahrimanis et al., 2001). It is estimated that only 1208 ha of the woodland remains to the east of the River Murray, with only 68 ha protected (DEH, 2005). The other example occurs in the north-east of region. The species mix differs from the population in the south-west and is therefore considered an entirely different association. It has also experienced widespread clearance and exists in small remnant pockets.

In addition to over-clearing of the woodland, it is also very susceptible to weed invasion in the understorey, which inhibits the recruitment of native species, including the Native Pine. The grazing of remnants by domestic and feral animals has also limited regeneration of pine within the woodlands.

The species can be easily confused with similar species of native pine. These are *Callitris verrucosa* (Mallee Cypress Pine) and *Callitris canescens* (Scrubby Cypress Pine). The easiest way to differentiate between species is through the appearance of the cones:

- *Callitris verrucosa* (Mallee Cypress Pine) cones are round and covered with small wart-like bumps (see Figure 8)
- *Callitris canescens* (Scrubby Cypress Pine) cones are small, round and very smooth.

The vegetation type is known to provide feeding habitat to many birds in the region, including Major Mitchell's Cockatoos which feed on the mature cones (Berkinshaw, 2005).

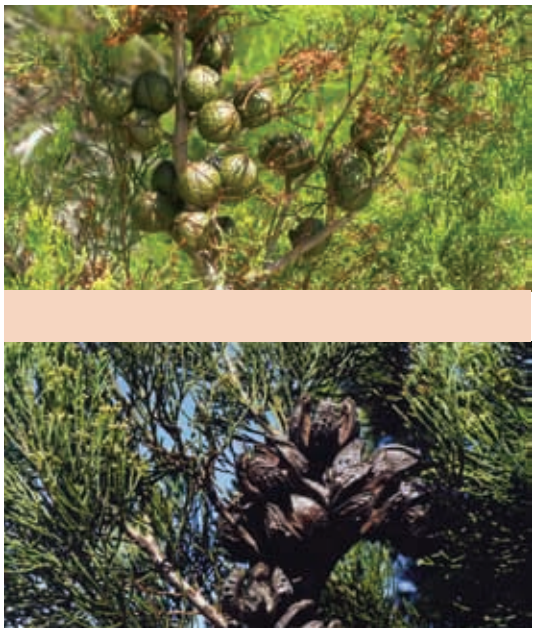

Figure 8: Top: Callitris verrucosa (Mallee Cypress Pine) cones
Bottom: Native Pine (Callitris gracilis).
Photographs: Keith Payne / MMLAP and Ben Simon / MMLAP

Figure 9: Southern Cypress Pine community.
Photograph: Chris Obst

What can be done?

Some of the techniques used at the property level, which can potentially improve and restore the habitat quality for the species include:

- fencing off remnants
- buffering and/or improving remnant vegetation blocks
- revegetation with the local species to increase the size of the declining vegetation community
- controlling feral animals
- reducing the risk of fire
- Heritage Agreements
- weed management
- contacting the Bush Management Advisor/ Revegetation Officer under Regional Contacts) to seek further advice.

CONTINUED

FLAGSHIP SPECIES AND COMMUNITIES

Figure 10: Blue-leaf Mallee community. Photograph: Keith Payne / MMLAP

Blue-leaf Mallee

(*Eucalyptus cyanophylla*) Open mallee

Blue-leaf Mallee is a small tree to eight metres tall with dense, silver-blue foliage and rusty-brown coloured branchlets and buds. It is endemic to far north-western Victoria and the upper Murray Mallee in South Australia (Walsh and Entwisle 1993, cited from Kahrimanis et al., 2001).

The vegetation community is known to be endemic to the Mallee Block (it encompasses the Murray Mallee in South Australia and parts of western Victoria). Of the remaining 6486 ha of Blue-leaf mallee, only 75 ha is protected in four Heritage Agreements (Kahrimanis et al., 2001). Blue-leaf Mallee as a vegetation community is threatened.

Much of the region was cleared in the past due to its suitability for agriculture (Berkinshaw, 2005). The vegetation community now occurs on sandy soils in fragmented and isolated remnants in the northern Murray Mallee LAP area, where many of the remaining examples are degraded by weed invasion and grazing (Kahrimanis et al., 2001). The majority of examples now exist only within the roadside verges, as those on the paddock side of fences generally cleared. The association is known to provide important habitat to species such as the Mallee Emu-wren as well as many other wildlife species.

What can be done?

Some of the techniques used at the property level, which can potentially improve and restore the habitat quality for the species include:

- fencing off remnants
- buffering and/or improving remnant vegetation blocks
- revegetation with the local species to increase the size of this declining vegetation community
- controlling feral animals
- reducing the risk of fire
- Heritage Agreements
- weed management
- contact Bush Management Advisor/ Revegetation Officer under Regional Contacts) to seek further advice on what management techniques and/or support is available.

Further information of the conservation management of many of the threatened species and ecosystems listed in Tables 2–4 are documented in the *Biodiversity Plan for the SAMDB* (Kahrimanis et al., 2001). Information includes:

- status
- distribution
- biology and habitat
- threats
- management
- photo and distribution map.

More information regarding threatened species can be sourced from the Department for Environment and Heritage (Berri), who have produced a series of Fact Sheets for threatened species within the Murray Mallee region. Further information regarding threatened bird species can also be obtained from *The Field Guide to the Birds of Australia* (Pizzey & Knight, 1997).

HIGH VALUE HABITAT AREAS

NGARKAT AND BILLIATT

The two most significant remnant areas within the region are represented by Ngarkat and Billiatt Conservation Parks and surrounding remnant vegetation. The *Biodiversity Plan for the SAMDB* recognises both areas as large remnant areas possessing 'significant potential for the long term retention of biodiversity' (Kahrimanis et al., 2001). Both Parks, combined with the large number of Heritage Agreements surrounding them, are extremely important for maintaining biodiversity within the region for numerous reasons:

- large continuous blocks of native vegetation are more suitable for maintaining long term viable fauna and flora populations (Kahrimanis et al., 2001)
- they provide valuable refuge for many common and threatened plants and animals within the region
- they are permanently protected within the reserve system.

The majority of the larger remnant blocks adjacent the two Parks have been placed under Heritage Agreements, however many of the smaller blocks (<100 ha) are afforded no protection at present. These are in close proximity to other blocks and are likely to provide effective 'stepping stones' for wildlife movement throughout the area. An important future step in managing both areas is to protect and manage as many blocks within the area as possible. Revegetation projects may also be advantageous in connecting currently isolated blocks and promoting a greater movement of wildlife between remnants through the creation of corridors (see explanation of wildlife corridors and stepping stones under 'Wildlife corridors: Why should we connect remnants?', page 31). Threatened fauna species recorded from both areas are displayed in Table 5. Threatened plant species are listed nearby.

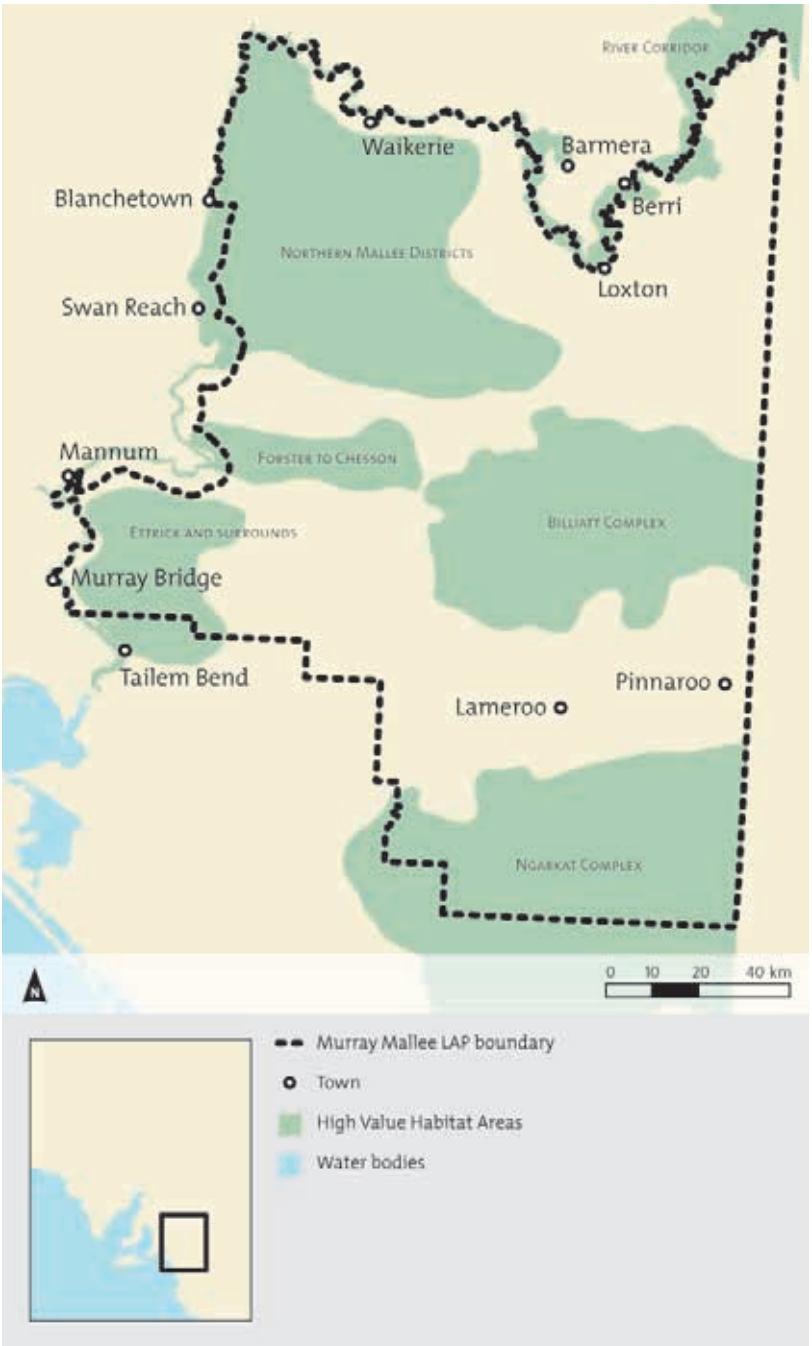

Figure 11: High Value Habitat areas across the Murray Mallee Local Action Planning area
Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

CONTINUED

HIGH VALUE HABITAT AREAS

NGARKAT AND BILLIATT / CONTINUED

Ngarkat

- Cleland's Beard-heath (*Leucopogon clelandii*)
- Fringed Heath-myrtle (*Micromyrtus ciliata*)
- Lowan Phebalium (*Phebalium lowanense*)
- Narrow-leaf Wax-flower (*Philotheca angustifolia* ssp. *angustifolia*).

Billiatt

- Cleland's Beard-heath (*Leucopogon clelandii*)
- Cushion Centrolepis (*Centrolepis , cephaloformis* ssp. *cephaloformis*)
- Williamson's Riceflower (*Pimelea williamsonii*).

BAKARA–MANTUNG–MAGGEA

This area is located within the Northern Mallee Districts (see Figure 11). The area extends from near Bakara township to Caliph in the south, to the Swan Reach–Maggea Road in the north and has previously been recognised as a high value habitat area in the recently updated resource *How to Manage Native Vegetation in the Murray Mallee—A Conservation Handbook* (EAC, 2005). The report primarily focuses on the conservation management of remnant native vegetation on private properties throughout this region. The development of a whole-region management system is entirely community driven. A large number of Heritage Agreements concentrated around Bakara Conservation Park account for the high proportion of intact native vegetation suitable for habitat. It is considered to have a high conservation value owing to the amount of remnant vegetation compared with some other districts and the presence of threatened fauna and flora (EAC, 2005). Threatened fauna species recorded from the area are displayed in Table 5. Threatened plant species are listed below:

- Rasp Daisy-bush (*Olearia picridifolia*)
- Rohrlach's Bluebush (*Maireana rohrlachii*)
- Streaked Wattle (*Acacia lineata*).

The *Biodiversity Plan for the SAMDB* recognises this area as part of the larger Northern Mallee Districts Fragmented Habitat Area, where the criteria are that an area contains 10–50% vegetation cover and 20–70% of that native vegetation is formally protected (Kahrimanis et al., 2001). It is accepted that there is a greater diversity of vegetation communities within the area compared with that of the larger remnant areas within the district, which often tend to contain continuous stands of similar vegetation (Kahrimanis et al., 2001).

The *Murray Mallee Revegetation Plan* (MMLAP, 2001) has also highlighted the whole of the Northern Mallee Districts Fragmented Habitat Area as a target area for revegetation projects.

FORSTER–CHESSON

The *Biodiversity Plan for the SAMDB* recognises this area as a Fragmented Habitat Area containing between 10–50% vegetation cover and of which 20–70% of that native vegetation is formally protected (Kahrimanis et al., 2001). It is located approximately 10 km north of Lowan Conservation Park and directly east of Purnong within the Hundreds of Forster, Bandon and Chesson. It encompasses a large, almost continuous block of remnant vegetation (Cox Plain) with numerous fragmented blocks to the east, much of which is protected under Heritage Agreements. The Cox Plain remnant is largely isolated from all other large remnant areas, however a few small isolated blocks may serve as stepping stones which can be a useful wildlife corridor for the movement of birds between the larger remnant areas.

Table 5: Threatened fauna species and other species of significance recorded within the High Value Habitat areas					
Threatened/significant wildlife species	**High Value Habitat area**				
	Ngarkat	**Billiatt**	**Bakara–Mantung–Maggea**	**Forster–Chesson**	**Ettrick and surrounds**
MAMMALS					
Common Brushtail Possum			•		
Common Dunnart	•	•			
Fat-tailed Dunnart	•				
Inland Eptesicus				•	
Lesser Long-eared Bat	•			•	•
Little Pygmy Possum	•				
Mitchell's Hopping-mouse	•	•			•
Plains Mouse	•				
Silky Mouse	•				
Southern Hairy Nose Wombat			•		
Southern Ningaui	•	•			
Western Pygmy-possum	•			•	
White-striped Mastiff-bat					•
White-striped Freetail-bat	•				
BIRDS					
Blue-winged Parrot	•	•			•
Chestnut Quail-thrush	•	•	•	•	
Elegant Parrot	•				
Gilbert's Whistler	•	•	•		
Major Mitchell's Cockatoo			•	•	
Mallee Emu-wren	•	•			
Malleefowl	•	•	•	•	•
Red-lored Whistler	•	•	•		
Regent Parrot		•	•	•	•
Shy Heathwren				•	
Slender-billed Thornbill	•				
Striated Grasswren	•	•			
Striped Honeyeater	•		•	•	•
Western Whipbird	•	•			
Yellow-tailed Black-Cockatoo	•				
REPTILES					
Bardick	•				
Bearded Gecko		•			
Carpet Python					•
Jacky Lizard		•			
Mallee Dragon		•		•	
Olive Snake Lizard					•
Nobbi Dragon				•	

CONTINUED

HIGH VALUE HABITAT AREAS

FORSTER–CHESSON / CONTINUED

The area has been identified as containing the SAMDB's only remaining examples of *Eucalyptus gracilis* (Yorrell), *E. oleosa* (Red Mallee), *E. leptophylla* (Narrow-leaf Mallee) and *E. socialis* (Red Mallee) Very open mallee, and *Acacia nyssophylla* (Spine Bush) Tall very open shrubland (Kahrimanis et al., 2001). It also provides an important refuge for many wildlife species, some of which are of conservation significance. Threatened fauna species recorded from the area are displayed in Table 5. Threatened plant species are listed below:

- Streaked Wattle (*Acacia lineata*)
- Rohrlach's Bluebush (*Maireana rohrlachii*).

Both the *Murray Mallee Revegetation Plan* (MMLAP, 2001) and the *Biodiversity Plan for the SAMDB* (Kahrimanis et al., 2001) have identified this area as a priority site for the restoration, re-establishment and management of native vegetation.

ETTRICK AND SURROUNDS

The Hundreds of Ettrick, Burdett and Younghusband contain numerous blocks of important remnant native vegetation, many of which are formally protected under Heritage Agreements, as well as Lowan CP. It is recognised in the *Biodiversity Plan for the SAMDB* as a Fragmented Habitat Area (Kahrimanis et al., 2001), providing valuable habitat to many fauna species including numerous of conservation significance (see Table 5).

Ettrick is known for its large areas of old-growth and long-unburnt mallee. In addition, it contains a diversity of mallee communities and examples of threatened plant communities including:

- Southern Cypress Pine (*Callitris gracilis*) Woodland
- Scented Mat-Rush (*Lomandra effusa*) Open tussock grassland
- Mallee Box (*Eucalyptus porosa*) Woodland (Kahrimanis et al., 2001).

Much of the vegetation throughout the area exists in small, highly fragmented blocks, which apart from being geographically isolated from other remnants, are at a greater risk of suffering from weed invasion or catastrophic events (such as fire). In recognition of its current vulnerability, both the *Murray Mallee Revegetation Plan* (MMLAP, 2001) and the *Biodiversity Plan for the SAMDB* (Kahrimanis et al., 2001) have identified this area as a priority site for the restoration, re-establishment and management of native vegetation.

ABORIGINAL CULTURAL AREAS

Figure 12: Native well in the Mantung area. Photograph: Keith Payne / MMLAP

Aboriginal people who occupied parts of the Murray Mallee region for thousands of years were known from two main tribes at the time of European settlement; Ngarkat and Ngintait (Foulkes et al., 2000). It is believed that their populations were largely limited by surface water availability, however they were able to rely on freshwater soaks located in interdune swales and capture rainfall and local runoff in rock holes (Kloeden, 1998).

Some evidence of their reliance on these areas is apparent by the open areas surrounding the water supply, presumably due to firewood removal (Foulkes et al., 2000). Stone flakes, weapons and implements were discovered around various soaks south of Pinnaroo and north of Ngarkat CP (Kloeden, 1998).

Why?

WHAT IS BIODIVERSITY AND WHY IS IT IMPORTANT?

Biodiversity is commonly known as the variety of all forms of life. It relates to plants, animals, micro-organisms, their genetic composition and the ecosystems they form (Department of the Environment, Sport and Territories, 1993), however most people typically think only of plants and animals. The richness of the biodiversity across the Murray Mallee region is expressed in the complex and unique ecological communities it contains.

There are a vast number of species recorded within the region and each one is uniquely connected in some form of relationship with others. Direct impacts upon one species may have a detrimental effect on another. This is why biodiversity conservation needs to be focussed upon conservation of ecosystems, as well as single species and ecological studies can now target 'few' species to assist in understanding how to manage the processes that operate at an ecosystem level.

Healthy ecosystems can perform a number of functions aside from the provision of habitat to plants and animals. These can range from the purification of water, pollination of plants, construction and stability of fertile soils, flood mitigation and breakdown of pollutants in our environment (Australian and New Zealand Environment and Conservation Council (ANZECC), 2001). Different ecosystems range in diversity and complexity, but all assist in performing these functions, which can have a direct impact on the lives of the Murray Mallee community. Evidence of the breakdown of these functions can be seen throughout the region in the form of erosion, salinity, flooding, weed infestations, disease and population fluctuations of native and feral animals. Maintenance and improvement of biodiversity and ecosystems can assist in alleviating some of these management problems.

Malleefowl nest. Photograph: Ben Simon / MMLAP

REMNANT NATIVE VEGETATION: WHY IS IT SIGNIFICANT?

With the onset of agriculture throughout the region, the Murray Mallee LAP area has experienced close to 70% clearance of its native vegetation. This degree of land clearance has resulted in a massive decline of native fauna and flora populations across the region. The remaining 30% of vegetation is now considered to be highly significant in providing habitat and refuge to those populations. Of this remaining habitat, the majority is contained within two large reserves and several smaller Conservation Parks, 429 blocks protected under Heritage Agreements, privately-owned, fragmented remnant blocks (90% are less than 100 hectares) (Good, 1994), and roadside verges. The ongoing maintenance of the remaining vegetation across the region is extremely important to the survival of the region's wildlife populations.

Remnant vegetation also provides a number of services for farm management. Blocks of remnant vegetation can provide shelter to domestic stock, whilst linear strips of vegetation along paddock boundaries can offer wind breaks for commercial crops or stock shelter. In addition to shelter, remnant vegetation also alleviates soil erosion and reduces the likelihood of drift. Furthermore, blocks of remnant native vegetation on properties and roadsides allow for the collection of seed for revegetation projects within local areas.

Olearia. Photograph: Ben Simon / MMLAP

Remnant vegetation can often provide suitable habitat to a number of bats, bird and native insect species which are known to feed upon common agricultural pests. It is suggested in a recent study into the role native vegetation plays in horticulture pest management, that remnant vegetation not only provides habitat to insectivorous birds and bats, but also homes for many insects that predate and parasitise pests (Rozario, 2005).

The MMLAP Association has produced an informative illustrated brochure that provides more detail on 'ecosystem services' provided by some of the plants and animals inhabiting remnant mallee scrub. Contact the MMLAP Association for a copy.

Native vegetation across South Australia is protected under the *Native Vegetation Act 1991*. Depending on the circumstances or the level of clearance proposed, it may be considered exempt under the Native Vegetation Regulations 2003, or alternatively, subject to an approval process by the Native Vegetation Council. For more information, contact the Native Vegetation Council (see Regional Contacts, page 87).

'HEALTHY ECOSYSTEMS CAN PERFORM A NUMBER OF FUNCTIONS ASIDE FROM THE PROVISION OF HABITAT FOR PLANTS AND ANIMALS. ALL CAN HAVE A DIRECT IMPACT ON THE LIVES OF THE MURRAY MALLEE COMMUNITY'

WILDLIFE HABITAT: WHY SHOULD WE PROTECT AND MANAGE IT?

To survive in an environment, plants and animals rely upon food, water and shelter against adverse climatic conditions and predators. If these basic requirements are not met within their environment, then it is likely a population will decline and become locally extinct. Although uncommon, some larger, more mobile species (such as larger birds and kangaroos) may relocate to an alternative habitat area.

Larger, more intact patches of vegetation form the main habitat strongholds for the region's plant and animal populations. These areas tend to be more robust and capable of self-sustaining despite changes or local disturbance events such as fire. They are therefore more effective at sustaining viable plant and animal populations into the future. Conversely, smaller blocks are more likely to be susceptible to weed invasion, grazing disturbance, and feral animal and insect damage, which can degrade the quality of the habitat and lead to local population extinctions.

Another feature of larger blocks is that they tend to support a more diverse number of species including 'specialist' species, which are species that have very specific habitat requirements. An example of a specialist species is the Western Whipbird, which is known to require habitat patches in excess of 1000 hectares, not recently burnt (Kahrimanis et al., 2001). In contrast, smaller blocks are normally dominated by common or 'increaser' species such as Galahs, Corellas, Magpies, Willie Wagtails and Ravens.

Figure 13: Hollow formed in a mallee eucalypt. Photograph: Tonia Brown

Figure 14: Poaching damage to tree branch. Photograph: Tonia Brown

If not effectively managed, the condition of small remnant blocks of vegetation can gradually deteriorate making them more unsuitable as habitat for many of the original species that utilised them.

Alterations to the quality of habitat, whether that is through degradation or restoration, can alter the level of suitability for a particular species. For example, a large variety of birds, bats and Brush-tailed Possums rely on hollows for nesting and den habitat. Hollows in mallee vegetation may take up to 200 years to form and therefore regrowth mallee or revegetation is not likely to provide suitable habitat for that period of time. Conversely, if nesting boxes or relocated hollow logs are introduced to an area of regrowth or revegetated mallee to improve the habitat quality, the above species may recolonise.

Hollows provide extremely valuable habitat to many wildlife species within the region. Destruction of habitat can create added pressure on particular wildlife species to find suitable nesting sites. In addition to high competition for sites, many hollows become occupied by feral bee colonies, which render the hollow useless to native wildlife species. Practical management actions, such as identifying, reporting or destroying bee hives can be undertaken by landholders and project officers to help limit the number of hollows occupied by feral bees.

Table 6: Bird species that inhabit hollows		
NATIVE BIRDS		
Common Name, *Scientific name*	Murray Mallee Conservation Rating	Hollow type
Adelaide Rosella, *Platycercus elegans* x *flaveolus*	Uncommon	Hollow
Australian Owlet-nightjar, *Aegotheles cristatus*	Common	Hollow
Australian Shelduck, *Tadorna tadornoides*	Common	Hollow
Australian Wood Duck, *Chenonetta jubata*	Common	Hollow
Barking Owl, *Ninox connivens*	Endangered	Hollow
Barn Owl, *Tyto alba*	Common	Hollow
Black-faced Woodswallow, *Artamus cinereus melanops*	Common	Spout
Blue Bonnet, *Northiella haematogaster*	Uncommon	Hollow
Blue-winged Parrot, *Eophema chrysostoma*	Vulnerable	Hollow
Brown Treecreeper, *Climacteris picumnus picumnus*	Common	Hollow
Budgerigar, *Melopsittacus undulatus*	Common	Hollow
Chestnut-rumped Thornbill, *Acanthiza uropygialis*	Common	Hollow
Cockatiel, *Nymphicus hollandicus*	Common	Hollow
Dusky Woodswallow, *Artamus cyanopterus cyanopterus*	Common	Spout
Eastern Rosella, *Platycercus eximus*	Common	Hollow
Elegant Parrot, *Neophema elegans*	Uncertain	Hollow
Fairy Martin, *Hirundo aeriel*	Common	Spout
Galah, *Cacatua roseicapilla*	Common	Hollow
Grey Shrike-thrush, *Colluricincla harmonica harmonica*	Common	Spout
Grey Teal, *Anas gracilis*	Common	Hollow
Laughing Kookaburra, *Dacelo novaeguineae*	Common	Hollow
Little Corella, *Cacatua sanguinea*	Common	Hollow
Major Mitchell's Cockatoo, *Cacatua leadbeateri*	Vulnerable	Hollow
Mallee Ringneck, *Barnardius zonarius barnardi*	Uncommon	Hollow
Masked Owl, *Tyto novaehollandiae*	Uncertain	Hollow
Masked Woodswallow, *Artamus personatus*	Common	Spout
Mulga Parrot, *Psephotus varius*	Common	Hollow
Musk Lorikeet, *Glossopsitta concinna*	Rare	Hollow
Pacific Black Duck, *Anas superciliosa*	Common	Hollow
Peregrine Falcon, *Falco peregrinus*	Rare	Spout
Pink-eared Duck, *Malacorhynchus membranaceus*	Common	Hollow
Purple-crowned Lorikeet, *Glossopsitta porphyrocephala*	Common	Hollow
Rainbow Lorikeet, *Trichoglossus haematodus*	Rare	Hollow
Red-rumped Parrot, *Psephotus haematonotus*	Common	Hollow
Regent Parrot, *Polytelis anthopeplus*	Vulnerable	Hollow

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CONTINUED

WILDLIFE HABITAT: WHY SHOULD WE PROTECT AND MANAGE IT?

<< table continued from previous page <<

Table 6: Bird species that inhabit hollows		
Common Name, *Scientific name*	Murray Mallee Conservation Rating	Hollow Type
Sacred Kingfisher, *Todiramphus sancta*	Common	Hollow
Scarlet-chested Parrot, *Neophema splendida*	Vulnerable	Hollow
Southern Boobook, *Ninox novaeseelandiae*	Common	Hollow
Southern Whiteface, *Aphelocephala leucopsis*	Uncommon	Hollow
Striated Pardalote, *Pardalotus striatus substriatus*	Common	Hollow
Sulphur-crested Cockatoo, *Cacatua galerita*	Common	Hollow
Tree Martin, *Hirundo nigricans neglecta*	Common	Hollow
White-browed Treecreeper, *Climacteris affinis superciliosa*	Vulnerable	Hollow
White-browed Woodswallow, *Artamus superciliosus*	Common	Spout
Yellow Rosella, *Platycercus flaveolus*	Uncommon	Hollow
Yellow-tailed Black-Cockatoo, *Calyptorhynchus funereus*	Vulnerable	Does not nest in MM
INTRODUCED BIRDS		
Rock Dove (Feral Pigeon), *Columba livia*		Hollow
House Sparrow, *Passer domesticus*		Hollow
Common Starling, *Sturnus vulgaris*		Hollow

WILDLIFE CORRIDORS: WHY SHOULD WE CONNECT REMNANTS?

Another important challenge facing small isolated remnant blocks is the limited ability for fauna to move freely between them. This can have severe impacts on the species' ability to mix genetically with the individuals from other separated populations, or for plant species to cross-pollinate. Isolation also provides a barrier to plant and animal colonisation into new habitat areas. Wildlife species with greater mobility (such as kangaroos, birds, bats and flying insects), may be better able to move between core habitat areas, whereas reptiles, small mammals and other smaller, less mobile species are more likely to be confined to a remnant block. With no avenue for escape, this can be disastrous for a population in the event of a local catastrophe such as fire. Connecting remnants with a revegetated corridor may provide greater opportunities for movement between habitat areas.

An area of vegetation connecting remnant habitats is called a 'wildlife corridor'. Wildlife corridors can vary from linear strips of vegetation to a disjointed series of smaller blocks providing 'stepping stones'. Examples of linear wildlife corridors can be seen in the form of road and rail reserves, whilst stepping stones can be observed as the fragmented remnant blocks situated between core habitat areas (e.g. remnant blocks between Billiatt CP and the Forster–Chesson High Value Habitat areas).

Figure 15: Three-year-old revegetation of a wildlife corridor linking two blocks in the Pata region. Photograph: Ben Simon / MMLAP

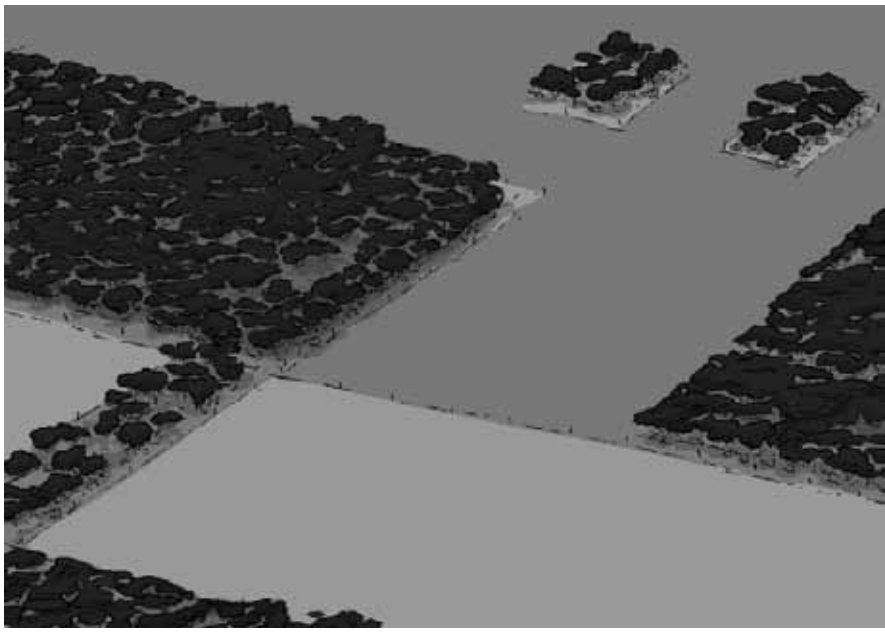

Figure 16: Continuous wildlife corridors (left) and stepping stones (top right). Illustration: Ecocreative

It is important to recognise that different fauna species will have particular requirements when utilising corridors for movement. Smaller species, such as lizards, Pygmy-possums and Hopping Mice are more likely to require a corridor of continuous vegetation with which to move from one area to another, whilst birds, bats and kangaroos can possibly rely on stepping stones.

It is important to recognise that there is still very little knowledge regarding the specific corridor requirements of species crossing landscapes between patches (Gates, pers. comm., 2006). Despite the overall lack of knowledge surrounding the best design of wildlife corridors, it is preferable for them to be as wide as possible. See Figure 16 for illustrations of a continuous wildlife corridor and stepping stones.

ROADSIDE VEGETATION: WHY IS IT IMPORTANT?

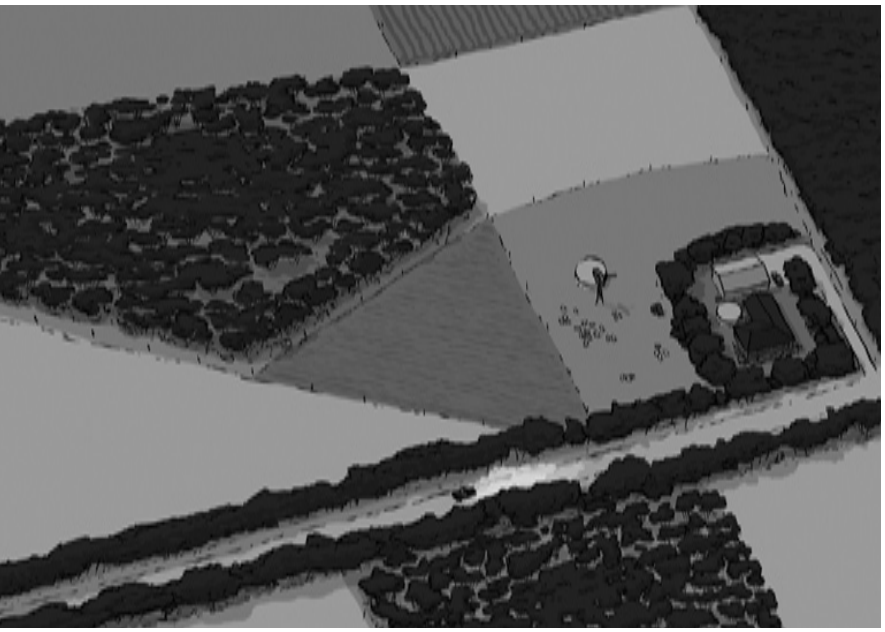

Figure 17: Roadside vegetation providing a wildlife corridor between remnant blocks. Illustration: Ecocreative

Due to the broad-scale clearance of native vegetation across the region, road verges often contain the only significant remnants of native vegetation. The vegetation within roadside verges and railway corridors is significant to biodiversity conservation. Roadside vegetation may:

- contain the last remaining examples of native vegetation in the area
- provide wildlife corridors for the movement of fauna species (see Figures 16 and 17)
- contain threatened flora species
- provide habitat to both threatened and common fauna species
- provide a local seed source for revegetation projects within the area
- provide shelterbelts for the protection of domestic stock in adjacent paddocks (Kahrimanis et al., 2001).

The responsibility of roadside vegetation management is under the care and control of local government (District Councils) and protection of the native vegetation is afforded by the *Native Vegetation Act 1991*. Councils are required to develop Roadside Vegetation Management Plans (RVMPs) to provide a framework for addressing the variety of issues associated with management of road reserves with a focus on protecting native vegetation. In the absence of a RVMP, any activity which has the potential to disturb roadside vegetation is subject to the Native Vegetation Council's *Guidelines for the Management of Roadside Vegetation* (1997).

Activities such as firewood collection and seed collection on roadsides is subject to a council's RVMP. Fallen timber is a source of habitat to many small wildlife species and removal can therefore impact on the habitat value of the roadside verge.

Stock grazing along roadsides is also subject to local council permission, however in many council areas it is not permitted. In some instances the practice is necessary for the movement of stock between paddocks, however it should be avoided to limit the associated impacts to roadside vegetation which is in many cases the last remaining native vegetation within the area.

The following councils have developed a RVMP or are in the process of doing so:

- Rural City of Murray Bridge
- District Council Karoonda East Murray
- District Council Loxton Waikerie
- Mid Murray Council
- Southern Mallee District Council (previously Lameroo's RVMP).

WHAT ARE THE MAJOR THREATS TO BIODIVERSITY IN THE MURRAY MALLEE?

The main threats to biodiversity in the Murray Mallee have been sufficiently documented and further information can be sourced from Part 5 of the *Biodiversity Plan for the SAMDB*. A brief outline of the major threats active in the Murray Mallee Local Action Planning area is discussed below.

GRAZING

Grazing has the potential to severely impact on the biodiversity of an area. Many areas throughout the region containing native vegetation are used as pasture for domestic livestock (mainly sheep and cattle). However, additional grazing animals such as goats, rabbits, and kangaroos can add to the total grazing pressure of a particular area and need to be taken into account when estimating the carrying capacity of a particular property. Inappropriate overstocking of the land combined with the added pressure of feral herbivores and kangaroos can lead to overgrazing. Overgrazing can have a number of negative impacts on pastures and vegetation communities including:

- loss of the understorey shrub layer
- reduction of native plant regeneration
- decline and loss of species diversity
- removal of palatable species
- change in species composition
- degradation and loss of habitat
- ringbarking of mature trees
- compaction of soils
- destruction of soil surface crust and lichens (cryptogams) and the leaf litter layer
- changes in nutrient status through faecal deposits
- changes to water surface flow
- depletion of the seed bank
- destabilisation of soils leading to erosion

(Kahrimanis et al., 2001).

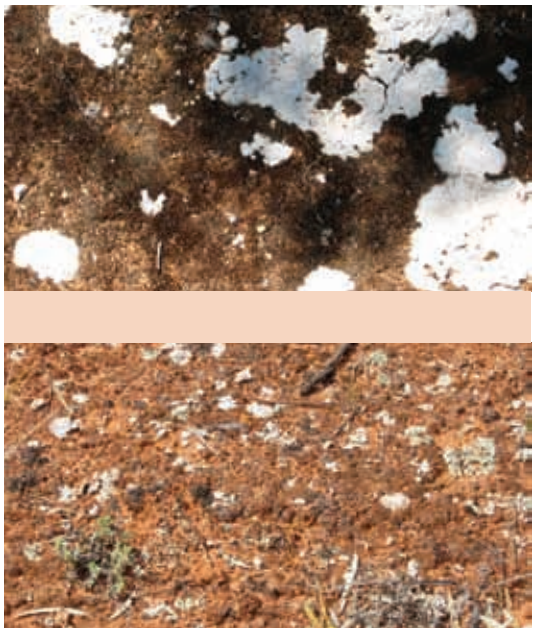

Figure 18: Cryptogams. Photograph: Ben Simon / MMLAP

Cryptogams

Cryptogams, which include lichens, fungi, mosses, liverworts and algae, serve an extremely important purpose in ecosystem function, but are often severely undervalued in remnant vegetation blocks. They are now recognised as playing a significant role in stabilising the soil surface, preventing erosion, improving water retention and quality and helping to build up humus to form more fertile soil. Unfortunately cryptogams (see Figure 18) are highly susceptible to overstocking and trampling and can take long periods of time to recover, leaving the soils further exposed to erosive forces. Hard-hoofed animals are particularly damaging, mainly through cutting through surface crusts and trampling lichens and protective leaf litter. The most effective method of encouraging their recovery or maintaining the growth of cryptogams on the soil surface is to exclude hard hoofed animals from the site.

CONTINUED

WHAT ARE THE MAJOR THREATS TO BIODIVERSITY IN THE MURRAY MALLEE?

ENVIRONMENTAL WEEDS

Environmental weeds are considered plants which invade and threaten the conservation of native habitats (Kahrimanis et al., 2001). Weeds are also an enormous problem to an agricultural community, invading cultivated and pasture areas. They can include both exotic species (non-Australian) and Australian native species not local to the area (EAC, 2005). Many weed species have the potential to out-compete, dominate and displace populations of native plants and can eventually modify habitats to a degree where they become unsuitable to native fauna species. Weeds tend to be more of a management problem along the edges of scrub blocks where the invasion occurs from adjacent cleared areas. This is particularly noticeable along narrow linear strips of vegetation such as roads. Varieties of pasture species can invade from the paddock side whilst weeds spread from vehicles and earth moving equipment invade from the roadside. The impact that weeds can make to the edges of native vegetation blocks is therefore more significant within smaller blocks as there is a greater area of edge as a proportion of the total size of the block. Conversely, weeds take longer to invade the interiors of large, more compact blocks. This allows for the opportunity to manage weed invasion at the edges before the interior of the block becomes degraded.

Appendix 1 lists the weed species found within the Murray Mallee LAP area. Section 2 of this Plan details weed species of significance within each Land Unit. Appendix 2 provides information relating to weed removal techniques. For technical advice and assistance, contact the SAMDB NRM Board Authorised Officers (former Animal and Plant Control Officers) listed in the Regional Contacts.

Figure 19: Boneseed Bush at Halidon (top) and large infestation on a dune near Mindarie. Photographs: Nicole Zeoli / MMLAP

Weeds of particular significance to native vegetation in the Murray Mallee

Boneseed

Boneseed is a 1–2 m shrub with bright green leaves and yellow daisy-like flowers (see Figure 19). This species often invades native bushland and has the ability to out-compete native understorey species and limit recruitment of dominant overstorey species. It has been noted in the Loxton, Waikerie and Halidon areas that boneseed is becoming more of a problem in certain areas. The seeds are eaten by birds and foxes and so the ongoing dispersal of seed can be widespread from the original infestation. There are several control techniques available (see Appendix 1), however whatever method is employed it is essential that follow-up control is undertaken as the species is a prolific seeder and seedlings will germinate given favourable conditions.

Perennial Veldt Grass

This tussocky grass is a perennial species which has been promoted and used as an effective stabiliser of soils and a pasture on many properties. Unfortunately, the grass is an invasive species which rapidly colonises roadsides, bushland and pastures alike, particularly on sandy soils. It reproduces mainly from seed, however it can also sometimes perpetuate itself from rhizomes (Blood, 2001).

Perennial Veldt Grass has the capacity to out-compete native species in the understorey, transforming the structure and composition of vegetation. There may be a need to revegetate with a native alternative following control treatments to stabilise the soil.

In many instances the extent of infestation, particularly in roadside vegetation, is so extreme that very few understorey species now remain. This species has the potential to inhibit the establishment of seedlings of threatened plant species through competition (Jusaitis, 1991).

Figure 20: Infestations on roadsides. Photographs: Tonia Brown

Figure 21: Red Eyed Wattle seeds. Photograph: Tonia Brown

Red-Eyed Wattle

This species is a Western Australian variety of acacia which is a highly invasive weed threatening native bushland mainly in the south-western areas of the Murray Mallee LAP area, around Peake and Tailem Bend. It is a large bright green bush from 1–6 m high with yellow globular flowers and linear pods to 15 centimetres long. It is a drought- and salt-tolerant species which effectively colonises areas of loam or sand, often over limestone (ABRS & CALM, 2001).

Boxthorn

Boxthorn is a well-recognised thorny, dense-branched shrub common in the Murray Mallee LAP area. Colonising and sometimes forming dense impenetrable thickets in pastures, roadsides and bushland, it is often difficult to stop the spread, as the berries are readily eaten and dispersed by birds and foxes. Therefore it is often seen colonising under trees and other bushes due to the drop of seeds. Follow-up treatments are essential with any Boxthorn control program making sure all seedlings are pulled up and any regrowth sprayed from previously removed bushes. Care should be taken to ensure this weed is not Native Boxthorn.

CONTINUED

WHAT ARE THE MAJOR THREATS TO BIODIVERSITY IN THE MURRAY MALLEE?

Bridal Creeper

Another well-recognised and noxious weed of the region, Bridal Creeper, has the ability to smother and block out all growth of understorey species within an infestation. Its seeds are readily dispersed by foxes, birds and other animals, which then germinate in autumn prior to the plant dying off in the summer. Manual control involves removal of the entire root system as plants can reshoot from rhizomes. The best long-term method of control is an integrated approach involving herbicide and biological control. In bushland, careful use of herbicide in combination with biological control is recommended to allow for large areas of Bridal Creeper to be managed (Allanson, pers. comm.).

Figure 22: Typical Bridal Creeper infestation in native vegetation. Photograph: Ben Simon / MMLAP

Fountain Grass

Introduced as an ornamental garden plant and still sold in many plant nurseries, Fountain Grass is highly invasive and actively competes with native species (Transport SA, 2004). The species is becoming a problem in the south-west of the region, particularly along roadsides. As the infestations are small and localised, action must be taken to restrict further spread. Controlling large infestations is difficult. Animals, wind and machinery are the main vehicle for the spread of seed, much of which is persistent on the plant all year.

Figure 23: Fountain Grass on roadside near Murray Bridge. Photograph: Ben Simon / MMLAP

There are significant populations of Fountain Grass at the Karoonda road entrance near Murray Bridge and around the Swan Reach Township that will need continued treatments and monitoring before they spread any further in the Mallee areas. Due to this plant's (and others in genus) ease of spread through wind dispersal of seeds, Fountain Grass should not be overlooked as a serious threat to native vegetation, particularly grassy habitats and less accessible areas such as the nearby cliffs along the River Murray Corridor. (Simon, pers. comm.).

Weed control notes

Weed control in areas containing native vegetation often requires a different approach to control techniques in paddocks. It is generally considered best practice to begin controlling weeds in the areas least affected by weeds and work out to the areas most infested. This technique is undertaken to limit the opportunity for weeds to become established in good quality vegetation.

The following principles have been adopted within other areas of South Australia:

- work from the small infestations to large infestations (least infested to most infested)
- minimise disturbance to soils
- do not over-clear weeds too rapidly (this may change the habitat too rapidly or create an opportunity for other exotics to colonise immediately).

FRAGMENTATION AND ISOLATION OF NATIVE VEGETATION COMMUNITIES

Aside from several large tracts of native vegetation within the region, much of the remaining vegetation is contained in small isolated remnants. The process of fragmentation occurs when surrounding vegetation is cleared, leaving smaller blocks of vegetation more exposed to degradation from such influences as weed invasion, feral animals, grazing, increased wind and light, or chemical spray drift. The diversity of species able to be sustained within small blocks invariably declines if such influences are not effectively managed. Isolation can inhibit many plant species' ability to cross-pollinate and cross-fertilisation of fauna species, through a decline in the movement between remnants. See 'Revegetation' (page 44) to obtain information for management of fragmented and isolated vegetation communities.

Figure 24: Examples of wind erosion in mallee dune areas. Photographs: Ben Simon / MMLAP

Severe erosion. Photograph: MMLAP

EROSION

In addition to the Murray Mallee community identifying soil erosion as one of the most important resource issues facing the region (MMLAP, 2002), the former Murray Mallee District Soil Conservation Board has also recognised that the potential for wind erosion is the greatest limitation to sustainable land use in the Murray Mallee (Murray Mallee District Soil Conservation Board, 1992).

The causes of erosion begin with destabilisation of the predominantly sandy soils, primarily caused by the removal of vegetation through mechanical clearance, grazing or drought. The problem can be exacerbated with the onset of adverse weather conditions such as strong winds or heavy rains. Impacts within the region range from blowouts, razorbacks, and exposure of subsoil upon removal of topsoil, to crop losses, and damage to infrastructure, such as fences, roads and railways (SAMDB INRM Group, 2004). One of the main side effects of wind erosion is sand drift, which has proved to be a serious issue facing many areas within the region. Sand drift has the potential to cover fencelines, roads and other farming infrastructure as well as smothering native vegetation.

Problem erosion areas are identified in Section 2, associated with the individual Land Units.

CONTINUED

WHAT ARE THE MAJOR THREATS TO 'BIODIVERSITY' IN THE MURRAY MALLEE?

FERAL ANIMALS

Feral animals which tend to have the most significant impact on native plants and animal species in the Murray Mallee LAP area include foxes, cats, rabbits, goats and hares. See Appendix 4 for suggested control methods.

Foxes and cats

Foxes (*Vulpes vulpes*) and cats (*Felis catus*) are introduced predators which are known to prey on native animals and have had a particularly devastating effect on the smaller native species of mammals, birds and reptiles. In conjunction with widespread habitat destruction across the region, foxes and cats have placed further pressure on remaining populations of threatened species, such as Malleefowl and the Brushtail Possum. Sheep graziers are also well aware of the impacts foxes can have on lambing mortality.

Integrated and coordinated fox baiting programs initiated by landholder groups within the region have shown to be successful in reducing numbers in the local area. In order to maintain low levels of fox numbers within a target area, annual baiting programs need to be ongoing. Local SAMDB NRM Board Authorised Officers (former Animal and Plant Control Officers) should be consulted to assist with helpful advice and establishing programs.

Rabbits

Rabbits (*Oryctolagus cuniculus*) have caused considerable damage to native vegetation and pastures throughout the region. In large numbers they have the ability to compete with native and domestic animals for food, degrade native vegetation and restrict recruitment of palatable native species, while also causing significant mechanical damage to soils though warren construction.

Figure 25: Rabbit warren. Photograph: Ben Simon / MMLAP

Rabbits have been largely responsible for the entire lack of regeneration of palatable species such as Drooping Sheoak (*Allocasuarina verticillata*) in many areas. They are considered to be Australia's most serious pest due to the damage they cause to the environment, pastoral and agricultural activities (Kahrimanis et al., 2001). Their success in the Murray Mallee LAP area has largely been due to the suitability of sandy soils, where extensive warren complexes can destabilise dunes, exposing them to erosion. The Rabbit Calicivirus Disease (RCD) combined with Myxomatosis has had some success in reducing numbers, however it appears to have been patchy and sporadic. An integrated approach needs to be adopted by landholders, local councils and NRM Boards in order to ensure rabbit populations are effectively controlled. A combined system of poison baiting, fumigation and warren destruction has proved to be the most effective method to date. Follow-up control is also an essential component of any eradication program to monitor and discourage recolonisation or 'reopening' of treated warrens.

Goats

Feral goats (*Capra hircus*) are problematic in a range of different environments across the region. Direct competition with domestic and native grazing animals, can escalate the total grazing pressure on properties, parks and remnant blocks of native vegetation. Grazing impacts on native vegetation have shown to be considerably greater compared with that of other grazing animals due to their overall agility, mobility and more generalist grazing habits. It has been suggested that even at low densities, goats can have considerable impacts on the regeneration of palatable native species and also reduce the effectiveness of revegetation programs (Parkes et al., (1996) as cited in Kahrimanis et al., 2001). The Department for Environment and Heritage conducts annual regional aerial kangaroo surveys which also monitor goat numbers (Strachan, pers. comm., 2005). Together with general site information collected from Parks, it is intended that a list of 'hotspots' will be compiled. It is also proposed that a trapping program be undertaken once water availability is more limited to help determine numbers. A program can then be designed with the sporting shooters association and/or local mustering crews to control goats in parks such as Ngarkat and Billiatt (Crawford, pers. comm., 2005). Future programs such as these need to be bolstered by additional methods on properties such as mustering, trapping, ground-shoots and closing of unused watering points on properties.

Hares

The Brown Hare occurs in small numbers but is capable of causing damage to native vegetation, particularly with respect to recruitment and revegetation projects. They have proved difficult to control as they do not live in burrows, do not take poison bait (Kahrimanis et al., 2001) and are not affected by the biological controls released to affect rabbits. Shooting and trapping are likely to be the most effective methods of control (seek advice from local SAMDB NRM Board Authorised Officer).

PROBLEM NATIVE ANIMALS

Unlike the majority of native wildlife species across the region, several native animals have proliferated in response to changes to their environment. The most prominent of these are the Western Grey Kangaroo, Galahs and Little Corellas, and Emus.

Western Grey Kangaroos

The population of the Western Grey Kangaroo (*Macropus fuliginosus*) has thrived in the current climate of reduced predation, increased watering points and the expansion of suitable grazing lands. The species was once kept in check by predation by dingoes prior to the installation of the South Australian dog fence (Kahrimanis et al., 2001) and hunting. Their numbers now fluctuate considerably in response to climatic conditions which directly effects food availability.

Western Grey Kangaroos.
Photograph: SA Tourism Commission

CONTINUED

WHAT ARE THE MAJOR THREATS TO 'BIODIVERSITY' IN THE MURRAY MALLEE?

Western Grey Kangaroos mainly inhabit native vegetation communities across the region and often venture onto cropping and domestic pastures to feed. Increases in population numbers in favourable years can create added pressures on agricultural lands and native vegetation, contributing to further degradation. In response to managing their population across the region and the state of South Australia, a monitoring and commercial harvesting program has been established which meets the aims set out in the Department for Environment and Heritage (NPWSA) Macropod Conservation Program in South Australia. Commercial destruction permits can be applied for from the DEH to manage the species on properties, parks and within the greater region. It is important to consider that this control technique should be used in conjunction with other techniques such as:

- closure of disused water points
- installation of specialised 'kangaroo gates' at sites where damage is occurring
- management of other pest species, such as rabbits and goats to reduce total grazing pressure, particularly in drought (Kahrimanis et al., 2001).

Corellas. Photograph: SA Tourism Commission

Galahs and Little Corellas

Galahs (*Cacatua roseicapilla*) and Little Corellas (*Cacatua sanguinea*) have both benefited from human alterations to their environments. The expansion of cultivated cropping lands and orchards have provided ideal feeding grounds combined with the increase of artificial water points. Impacts caused by unregulated populations of both species include damage to cereal crops, fruit orchards and native vegetation, and displacement of less aggressive species which also require hollow trees for nesting. Individuals can apply for destruction permits, however caution must be taken to ensure that other non-target species are not impacted upon. Closing disused water points is also likely to assist in reducing numbers (Kahrimanis et al., 2001).

Emus

Other problem native animals include Emus whose numbers fluctuate in response to favourable environmental conditions, which include the availability of artificial water points and food. In high numbers, the damage they cause to fences and crops can be considerable. As with kangaroos, destruction permits can be obtained from DEH to assist in controlling numbers (see Regional Contacts, page 87).

OTHER THREATS

Additional threatening processes active in the Murray Mallee LAP area include dieback of native vegetation, mining operations, dryland salinity and inappropriate fire regimes. These are further explained in the *Biodiversity Plan for the SAMDB*.

Remnant vegetation in the Murray Mallee. Photograph: Ben Simon / MMLAP

How?

WHAT CAN BE DONE TO CONSERVE NATIVE VEGETATION AND PROTECT LOCAL BIODIVERSITY?

The *Murray Mallee Revegetation Plan* (2001) previously set a target of 1200 hectares for the protection and enhancement of remnants. Since then, 7295 hectares have been fenced and managed. Conserving remnants should remain the highest priority objective in addressing the decline of biodiversity across the Murray Mallee LAP area. Existing remnants, regardless of their current condition, generally possess greater levels of habitat quality compared with that of revegetated blocks.

PROTECTION AND ENHANCEMENT OF REMNANTS

The protection of remnants involves control measures such as management of weed infestations and feral animals *and* reduction in the incidence of destructive processes such as fire and grazing.

The size and the shape of a block are of particularly importance in the conservation management of remnants. The shape of a vegetation block determines the ratio of perimeter to area, or edge to interior. Compared with the interiors, the edges of remnant blocks are more susceptible to destructive influences such as wind damage (exposure, sand blasting), spray drift, feral animals, weed invasion and erosion. These are commonly referred to as 'edge effects'. When blocks become highly fragmented, they develop a high edge to interior ratio leading to a greater percentage of the block being exposed to threatening processes (Bennett et al., 2000). This is most noticeable in small blocks, and depending on the width, narrow linear blocks (such as shelterbelts, dune crests, roadside verges) which are particularly susceptible to edge effects. Larger, more compact-shaped blocks contain a lower edge to interior ratio and are less susceptible. See Figure 26.

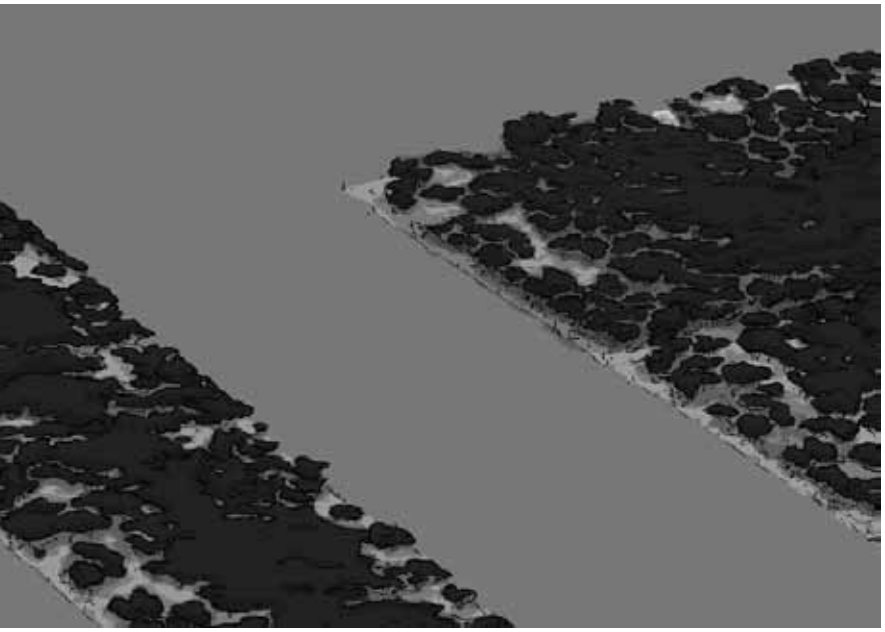

Figure 26: Edge effects on different-shaped remnant blocks (block and linear). Illustration: Ecocreative

Management of remnant blocks of vegetation needs to be tailored to the individual needs of each block. Factors such as current condition, size, shape, location (proximity to other blocks of vegetation) and isolation are all extremely important when considering what specific measures need to be undertaken to restore or maintain remnant blocks. When planning to manage for conservation, it is important to find out certain information about the block to help understand what kind of management is necessary. Some of the important features of your block that need to be identified are presented on the following page.

YOUR BLOCK OF REMNANT VEGETATION: QUESTIONS TO ANSWER

What shape and size is it?
Revegetation around small or linear remnants may help reduce the 'edge effects' (see page 42 for an explanation of edge effects). Contact The MMLAP Association or Rural Solutions.

Does it have weeds?
Different levels of weed infestation will determine the level of control required. Consult the local SAMDB NRM Board Authorised Officer to obtain technical advice and practical assistance.

Are there feral animals?
Implement feral animal control to reduce predation on native wildlife and domestic stock. Contact the SAMDB NRM Board Authorised Officer to obtain technical advice and practical assistance.

Is it grazed?
Fencing remnants is an effective way to limit the destructive impacts of grazing and promote natural regeneration (weed management may need to be employed following removal of stock). Contact the MMLAP Association for more information.

Do you have any threatened species or vegetation communities on your property?
Vegetation may have regional significance—seek advice from DEH Bush Management Advisor or Threatened species officer.

Is there other native vegetation in the vicinity?
Connection of close remnants may be possible through revegetated wildlife corridors. Contact the MMLAP Association or Rural Solutions SA for technical advice and practical assistance.

Natural regeneration: are there juvenile plants growing (recruiting)?
Heavy grazing can impact on native seedling recruitment. You may need to fence remnant if no natural regeneration is occurring. Contact MMLAP Association or regional DEH Bush Management Advisor.

Soil stability: is there leaf litter cover, lichens and soil surface crust (cryptogams)?
Grazing and vegetation disturbance can remove this protective cover, exposing soil surfaces to erosive forces. Contact the MMLAP Association for technical advice and practical assistance.

Plant species diversity: how many different species of plants are present?
Species diversity helps determine the significance of a remnant and the value of wildlife habitat it possesses. Seek advice from your regional DEH Bush Management Advisor.

Do the mature trees have hollows?
Mature remnants containing hollows can provide excellent native wildlife habitat.

Structure: does it have an understorey?
Understorey helps determine the significance of a remnant. Exclusion of stock may be required to encourage the recovery of understorey if it is degraded.

'CONSERVING REMNANTS SHOULD REMAIN THE HIGHEST PRIORITY OBJECTIVE IN ADDRESSING THE DECLINE OF BIODIVERSITY ACROSS THE MURRAY MALLEE LAP AREA.'

FOR FURTHER TECHNICAL AND PRACTICAL ASSISTANCE AND ADVICE, REFER TO REGIONAL CONTACTS, PAGE 87.

CONTINUED

WHAT CAN BE DONE TO CONSERVE NATIVE VEGETATION AND PROTECT LOCAL BIODIVERSITY?

Heritage Agreements

Heritage Agreements are an excellent way to formally protect areas of native vegetation and manage for wildlife conservation. A Heritage Agreement will remain the property of the landholder. As with many remnants, weed invasion, feral animals and grazing have degraded the environment and will most likely need ongoing management in order to maintain or enhance the habitat value of the block. Some landholder assistance is available through the Heritage Agreement scheme to manage the following projects:

- stock-proof fencing
- weed control
- feral animal control
- erosion remediation works
- vegetation mapping
- management plans
- revegetation (EAC, 2005).

For more information, contact the DEH Bush Management Advisor (see Regional Contacts).

Fencing

Fencing remnants to exclude stock is another effective measure to enhance and protect the habitat from the impacts of grazing. In the absence of heavy stock grazing, native species are able to regenerate. It is much easier and far more efficient to encourage natural regeneration than to revegetate degraded areas. In some cases weed species may proliferate in the understorey following stock removal and weed control treatments may be necessary. Revegetation of degraded remnants may also be a necessary step in restoring the quality of the habitat.

REVEGETATION

The *Murray Mallee Revegetation Plan* has identified and implemented a number of revegetation options ranging from protection and enhancement of remnants, development of wildlife corridors to shelter and fodder blocks.

There are several revegetation options available to landholders and community groups with respect to managing biodiversity on properties, which have been identified in the Mallee Futures Program, but these should only be done following expert advice.

Buffer zones

There are a number of options available to enhance and protect remnants through revegetation including buffering and restoration. Buffering involves planting around the edges of existing blocks of vegetation in order to protect the edges from weed invasion, spray drift, soil movement or exposure to adverse weather conditions, or simply to increase the size or alter the shape of a remnant.

Figure 27: Buffering remnants can significantly reduce edge effects such as weed invasion. Photograph: Ben Simon / MMLAP

To improve biodiversity and habitat quality around existing remnants and along roadsides, it is best to plant with local provenance species. If possible, it is most ideal to have the seed collected from within approximately five kilometres of the revegetation area to ensure the plants will be suited to the local conditions. When revegetating to enhance remnants, it is often necessary to use hand direct seeding or seedling planting. For larger areas it may be practical to use machinery. Successful revegetation sites will require follow-up work involving further planting of local species and weed control to help ensure that weeds have not proliferated and are inhibiting natural regeneration and that dead plantings are being replaced.

Figure 28: Newly-planted wildlife corridor. Photograph: Ben Simon / MMLAP

Wildlife corridors

Planting vegetation corridors between patches of remnant native vegetation is aimed at enhancing the conservation value of remnant patches by encouraging the movement of native animals between the patches. They are normally linear in design but can vary in width. However, in order for corridors to be successful they need to be wider than most windbreaks and shelterbelts (MMLAP, 2003). The width of the corridor may need to vary from one area to another depending on what kind of wildlife is being encouraged, but in general it is considered that 'wider is better'.

The selection of plant species should be as diverse as possible and of local provenance. Contact the Murray Mallee Local Action Planning Association who can provide revegetation fact sheets focusing on local native species wildlife corridors and buffer zones (see Regional Contacts, page 87).

Native species revegetation blocks

Establishing a block of native vegetation over an area which is highly modified or devoid of remnant vegetation is a long-term project. The aim is to establish self-regenerating, perennial vegetation that can assist in reducing groundwater recharge and soil erosion, providing habitat to wildlife species and has the potential to provide shelter for crops and stock (MMLAP, 2003). The type of vegetation chosen should resemble that which previously grew on the site prior to clearance. This would enable the species to be more adapted to the site conditions (slope, aspect, soil type etc). Using local provenance will also ensure that species are better suited to the local conditions.

It is highly recommended that technical advice and assistance is sought from the regional DEH Bush Management Advisor or the Murray Mallee Local Action Planning Association (see Regional Contacts, page 87) prior to beginning any revegetation project.

WHAT CAN BE DONE TO CONSERVE NATIVE VEGETATION AND PROTECT LOCAL BIODIVERSITY?

The costs associated with replanting areas can vary significantly depending on a number of variables:

- the total area of revegetation
- the level of weed control and site preparation required prior to planting. Some areas may have heavy weed infestations which will require control treatments prior to and following revegetation programs
- the level of grazing impacts. Some areas, even areas fenced from domestic stock, may be subject to grazing impacts from goats, kangaroos and/or rabbits. This may affect the amount of replacement planting required, or the number of tree guards needed to protect seedlings
- the type of native vegetation community being revegetated—some communities have an enormous diversity and selecting and purchasing a cross-section of that vegetation type may be more costly that another vegetation type with a lower diversity
- overall success and long term maintenance—the level of follow-up management will impact on total costs

There is the provision of incentive funds for fencing and revegetation projects in the Murray Mallee and this has proven to be a successful method of encouraging landholders to protect and enhance their remnant vegetation (MMLAP, 2003), however limited landholder assistance is available. Contact the Murray Mallee Local Action Planning Association for:

- information about the availability of financial incentives and technical support to assist with the costs of protecting remnants
- a copy of the Mallee Futures Program Resource Book, which contains additional contact details for further advice about protecting remnants (see Regional Contacts, page 87)
- revegetation fact sheets focusing on enhancing remnants.

Areas of revegetation can be protected in South Australia under the Native Vegetation Act

Changes to the Act introduced with recent amendments (2003) provide a mechanism for landholders involved in revegetation activities to have those planted sites considered for registration on the property titles and formally protected by the Act.

To qualify, landholders need to ensure only local indigenous (naturally occurring) native plants are used in the revegetation area. Landholders can apply to the Native Vegetation Council to have these areas protected under the Native Vegetation Act (see Regional Contacts, page 87).

Photograph: MMLAP

Section Two
Land Units

Land Units

The Murray Mallee LAP area comprises thirteen mapped and described Land Units, more commonly referred to as environmental associations. A general classification of environmental associations across South Australia was recognised and published by Laut et al., (1977), whereby they are distinguished according to a number of environmental attributes.

This section includes general descriptions, attributes and any other relevant issues relating to land management which have been identified for each of the Land Units. Figure 29 shows the locations of each Land Unit across the Murray Mallee LAP area.

Many of the key threatening processes, management strategies and regional contacts identified for the region are consistent across multiple Land Units. A greater level of definition for those issues and strategies is provided in Table 7, prior to the Land Unit sections. Within the individual Land Unit sections, only the issues and management strategies unique to that Land Unit are described in greater detail.

Land within the Pata Land Unit. Photograph: Ben SImon / MMLAP

For information or assistance with Land Unit management issues, refer to the summary table of recommended management strategies and Regional Contacts (see page 87).

MMLAP AREA LAND UNITS

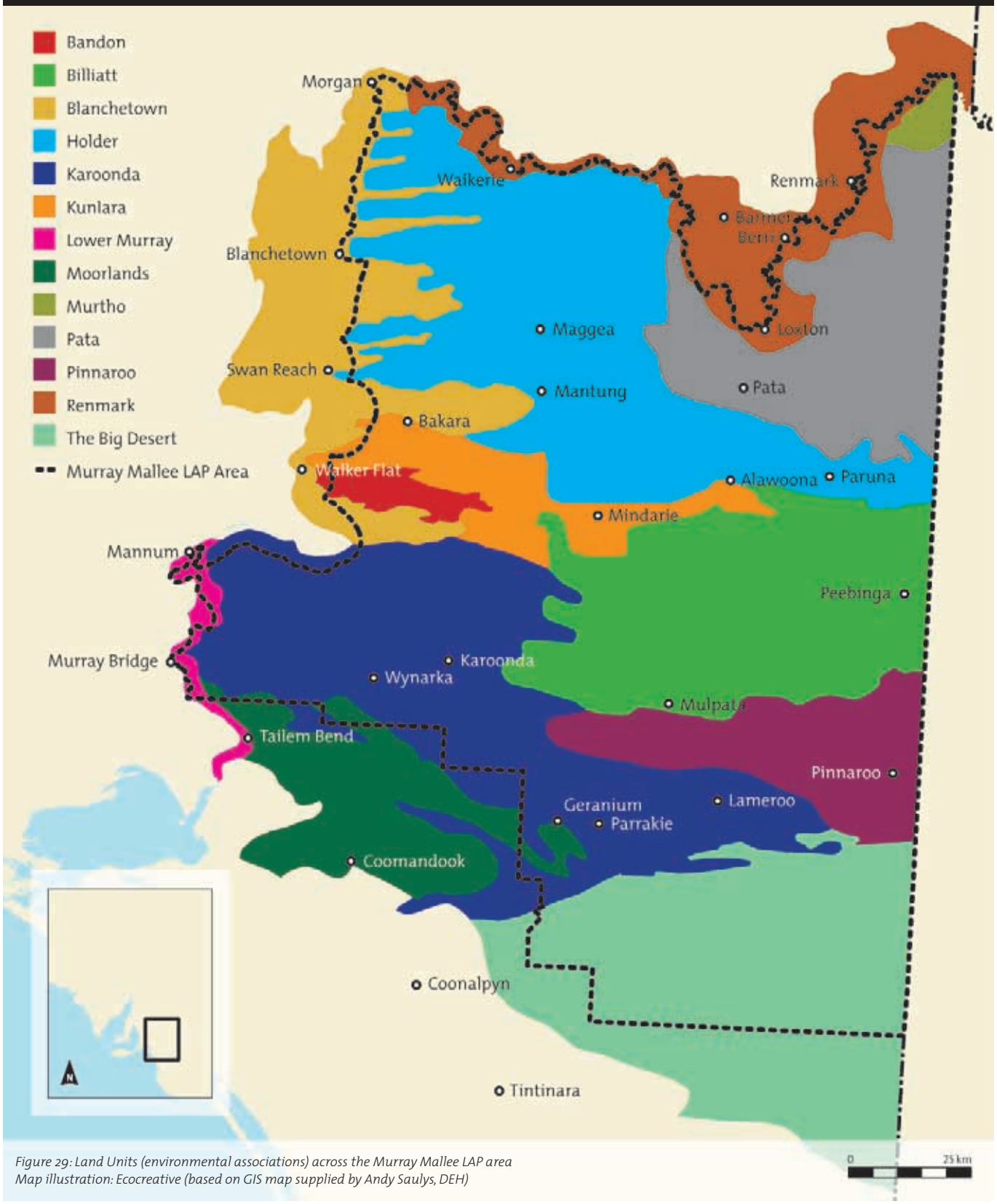

Figure 29: Land Units (environmental associations) across the Murray Mallee LAP area
Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

CONTINUED

LAND UNITS

KEY THREATENING PROCESSES

Fragmentation of remnants

Some of the blocks of native vegetation are isolated from neighbouring blocks, which may generate a significant barrier to the movement of wildlife, particularly small mammals and reptiles. Isolation can inhibit genetic mixing between animals which are unable to move freely between patches and cross-fertilisation between plants.

Feral animals

Foxes and cats need to be actively controlled. They prey on native mammal, reptile and bird species. Foxes can also be responsible for predation on lambs. Biological controls aimed at eradicating rabbits (Rabbit Calicivirus Disease and Myxomatosis) periodically sweep though localised populations, however when they are not active, numbers can rapidly rebuild. Rabbit-related impacts contribute to destabilisation of soils through overgrazing and warren construction.

Grazing of remnants

Unfenced remnants can be subjected to grazing by domestic stock, feral herbivores (goats and rabbits) and kangaroos. Over-grazing of native vegetation has the potential to severely modify species composition, structure and plant recruitment and contribute to soil instability and erosion.

Weed invasion

Weed invasion is an ongoing problem that threatens areas of remnant bushland and pastures alike. Small and linear-shaped remnants are particularly susceptible to weed invasion due to edge effects. The major exotic species recorded for the area are listed for each Land Unit. See Appendix 1 for recommended control techniques for each species and Appendix 2 for control methodologies.

Small remnants

Many of the blocks within the Land Unit are less than five hectares in size, which is considered too small to support viable populations of plants and animals into the future. Small remnants are at further risk of weed invasion and catastrophic events, such as fire. However, many small blocks may still warrant protection and extension depending on their individual merits.

Soil erosion

A number of areas have been identified and mapped under the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003). Erosion appears to have been more severe in the past due to overgrazing and land clearance.

Inappropriate fire regimes

Frequent fire outbreaks threaten to alter species composition in vegetation communities and destroy habitat for wildlife (Kahrimanis et al., 2001).

Table 7: Summary of the recommended management strategies for the Murray Mallee Local Action Planning area		
RECOMMENDED MANAGEMENT STRATEGIES		
Broad objectives	Management actions	Responsible organisation
Buffer existing remnants	Target revegetation around existing remnants and stepping stones for buffering effect	Landholders, MMLAP
Protection of existing remnants	Fencing off significant remnants, regardless of size	Landholders
Maintain and improve the condition of remnants	Encourage weed and feral animal control on properties	Landholders
Maintain and improve the condition of roadside vegetation	Control weeds on roadsides to improve the overall condition of roadside vegetation	Local council, landholders
Control erosion	Conduct remediation works on properties and roadsides identified as eroding	Landholders
Create wildlife corridors	Connect remnant patches using revegetated wildlife corridors	Landholders, MMLAP
Manage feral animals	Encourage coordinated fox baiting, rabbit and goat control on properties, parks and roadsides	NRM officer, MMLAP, landholders
Protect Heritage Agreements and other reserves and remnants	Manage for feral animals and weeds in Heritage Agreements, reserves and other fenced remnants	NPWSA, Bush Management Advisor, landholders
Rehabilitate degraded areas	Revegetate and fence-off areas of vehicle damage on public lands to discourage ongoing damage and encourage natural regeneration	MMLAP
Retain wildlife habitat	Retain mature hollow-bearing eucalypts along the River Murray corridor to minimise disturbance to wildlife habitat and also leave fallen timber	Landholders

BANDON

Area—208 km²
Mean annual rainfall—300 mm
Primary land uses—Cropping and stock grazing
Remnancy—4.5%

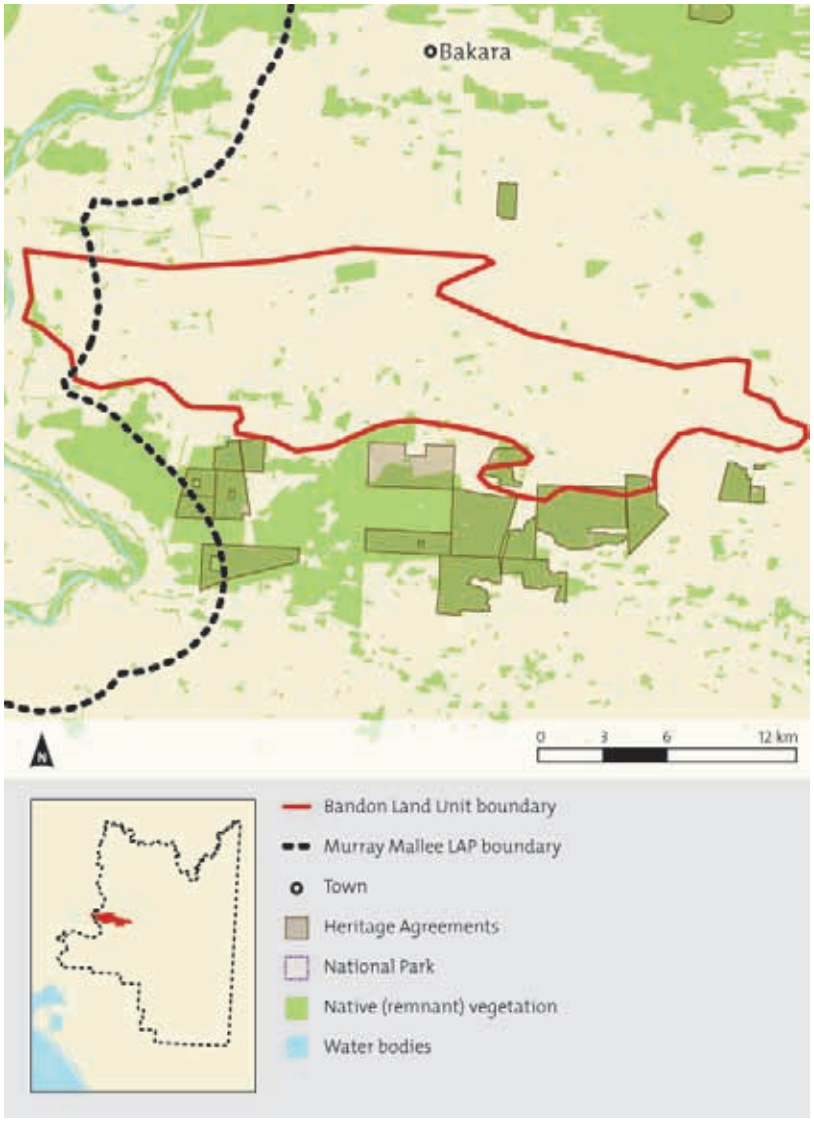

Figure 30: Bandon locality map. Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

DESCRIPTION

The Bandon Land Unit has been described as 'an undulating plain on extensive sheets of calcrete overlain by a series of easterly trending sand dunes which have been partly cleared to a mallee parkland. Elsewhere the vegetative cover is a cultural grassland. Cereal cultivation and livestock grazing occur throughout the area' (Laut et al., 1977).

The vast majority (94%) of this land type is located on the western boundary of the Murray Mallee LAP area adjacent the River Murray, encompassing approximately 208.4 km². Much of the Land Unit has been cleared of vegetation to make way for agriculture. Approximately 4.5% of the original vegetation remains, 31% of which is protected by three Heritage Agreements. The area lies between the Forster–Chesson and Mantung–Maggea High Value Habitat areas, and currently provides little scope for movement of wildlife between the areas due to the extremely low remnancy. Many of the remaining blocks are very small and isolated and due to a lack of formal protection, are most likely degraded from grazing and weed invasion.

NATIVE VEGETATION

The broadly defined dominant vegetation types occurring within the Bandon Land Unit include:

- White Mallee (*Eucalyptus dumosa*) +/- Narrow-leaf Mallee (*Eucalyptus leptophylla*) Mallee
- Yorrell (*Eucalyptus gracilis*), Red Mallee (*Eucalyptus oleosa*) Very Open Mallee.

CONSERVATION ASSETS

No threatened species are recorded from within the Bandon Land Unit, however it is likely that most of the small remnants have not been surveyed.

KEY THREATENING PROCESSES

- Fragmentation of remnants.
- Feral animals.
- Grazing of remnants.
- Soil erosion—Erosion potential due to low remnancy levels across the area coupled with a high density of linear dunes. Laut et al., (1977) notes that the undulating plains of this Land Unit are considered to have a slight drift potential, whilst the dunes face a moderate erosion risk.
- Weed invasion—The major weeds identified for the Land Unit are: African Boxthorn, African Lovegrass, Bathurst Burr, Bladder Campion, Boneseed, Bridal Creeper, Caltrop, Dandelion, False Caper, Field Garlic, Horehound, Innocent Weed, Noogoora Burr, Onion Weed, Prickly Pear, Salvation Jane, Silver Nightshade, Skeleton Weed, Soursob and Yellow Burr Weed.

CURRENT MANAGEMENT STRATEGIES

The Murray Mallee Long Term Eroding Land Project which was completed in 2001, identified and classified areas within the Bandon Land Unit which are subject to erosion. The report also identifies which areas have been mapped and revegetated. Several small areas south-east of Copeville have been mapped and classified as actively eroding or partly stabilised and mostly devoid of vegetative cover or only isolated trees and/or shrubs (Derby et al., 2003). Additional areas have been highlighted to the east of Walker Flat.

A landholders group in the Bandon area have been regularly fox baiting over an area of 38 000 hectares. Together with the Lower Murray Group and other groups within the region, a total of 118 000 hectares is regularly baited, assisted by funding through the Threatened Species Network (aimed at the protection of Malleefowl). It has been generally noted that after three years of baiting that the landholders within the Lower Murray Group, have noticed a drop in fox numbers (MMLAP, 2005).

RECOMMENDED MANAGEMENT STRATEGIES*

- Protect existing remnants
- buffer existing remnants
- maintain and improve the condition of remnants
- maintain and improve the condition of roadside vegetation
- control erosion.

*See Table 7 (page 51).

BILLIATT

Area—3026 km²
Mean annual rainfall—300–350 mm
Primary land uses—Conservation, cropping and stock grazing
Remnancy—44.8%

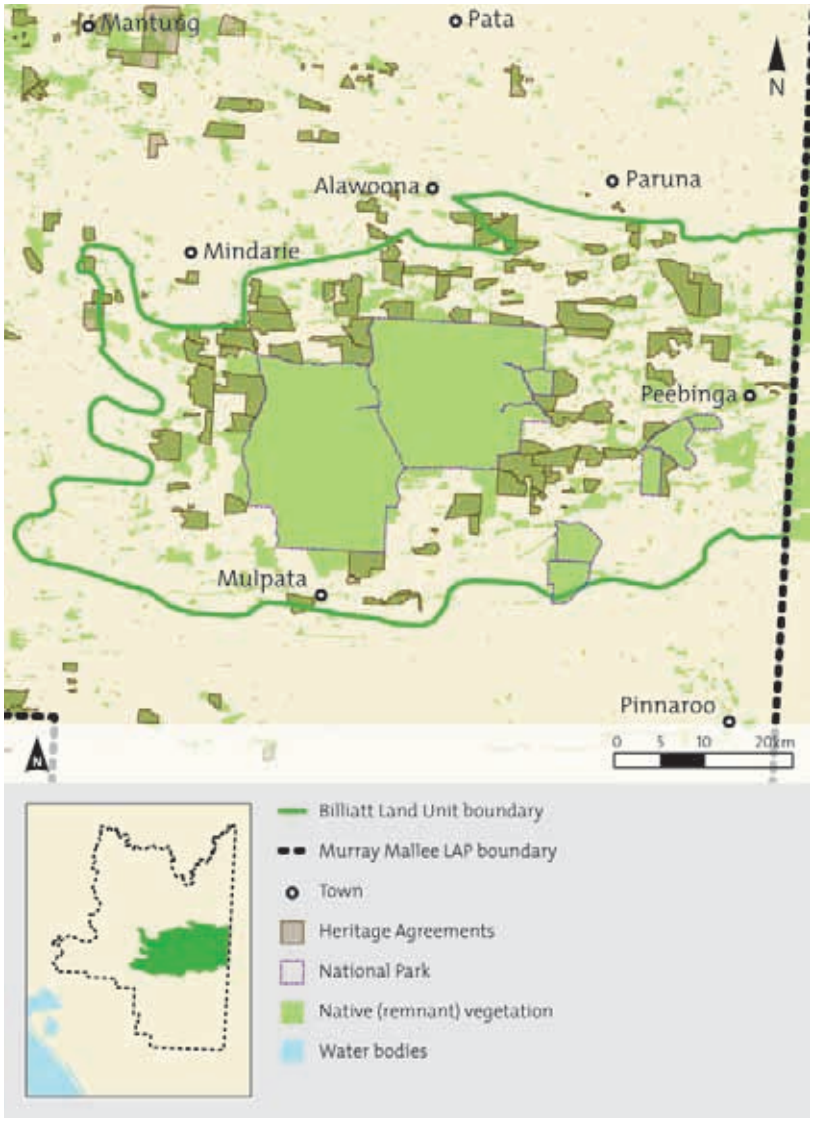

Figure 31: Billiatt locality map. Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

DESCRIPTION

The Billiatt Land Unit has been described as 'a gently undulating calcrete plain with extensive areas of easterly trending sand dunes. Large areas of undisturbed mallee are in conservation parks. The remainder of the association is grazed by livestock, with local areas of cereal growing. Middleground views enclosed by mallee are found in the cleared areas, whilst detailed views are provided in the undisturbed mallee' (Laut et al., 1977).

The entire Billiatt Land Unit in South Australia is contained within the Murray Mallee LAP area and is located centrally, sharing an eastern boundary with the Victorian border. Almost half of the land area contains native vegetation, of which 76.4% is protected under Billiatt, Karte and Peebinga Conservation Parks (see Section 1 for description of individual Conservation Parks) and 104 Heritage Agreements, totalling approximately 103 627 hectares (1036.3 km²).

The Billiatt complex has been identified as a High Value Habitat area within the region and forms a stronghold for many populations of native plants and animals, some of which are of conservation significance. This Land Unit is considered to contain enormous potential for maintenance of existing native plant and animal populations, along with protection and restoration of additional remnants not currently within the reserve system. There is also scope for connection of remnant blocks with revegetated wildlife corridors, and buffering of existing native vegetation.

Restoration of remnants through weed and feral animal control is also recommended in the Billiatt Land Unit where wildlife concentration is higher than many other areas and frequent movement between remnants is likely to be considerable.

NATIVE VEGETATION

The broadly defined dominant vegetation types occurring within the Billiatt Land Unit include:

- *Eucalyptus incrassata* Open Low Mallee
- *Callitris verrucosa* Tall Open Shrubland
- *Eucalyptus calycogona*/ *Eucalyptus dumosa* Very Open Mallee
- *Eucalyptus leptophylla*/ *Melaleuca lanceolata* Open Mallee
- *Melaleuca acuminatum*, *Melaleuca lanceolata* +/- *Eucalyptus socialis* +/- *Eucalyptus leptophylla* Tall Open Shrubland
- *Eucalyptus gracilis*, *Eucalyptus oleosa* Very Open Mallee
- *Eucalyptus dumosa* +/- *Eucalyptus leptophylla* Mallee
- *Eucalyptus cyanophylla* +/- *Eucalyptus socialis* Open Mallee.

CONSERVATION ASSETS

The Billiatt Land Unit possesses a number of important features which contribute to its overall conservation significance. The levels of native vegetation retained within the area are high compared with that of many other Land Units across the Murray Mallee LAP area and is largely due to the protection provided by three Conservation Parks and 104 Heritage Agreements. Collectively, these areas are known to provide excellent habitat for many native species populations including a high number of those listed as nationally, state and regionally threatened. Ratings are abbreviated to Rare (R), Vulnerable (V) and Known (K).

Species of conservation significance:

Flora

- Cleland's Beard-heath (*Leucopogon clelandii*), SA: R, MM: E
- Cushion Centrolepis (*Centrolepis cephaloformis* ssp. *cephaloformis*), SA: R, MM: K
- Narrow-leaf Ray-flower (*Philotheca angustifolia* ssp. *angustifolia*), SA: R, MM: R
- Showy Copper-wire Daisy (*Podolepis jaceoides*), SA: R, MM: K
- Williamson's Riceflower (*Pimelea williamsonii*), SA: R, MM: R

Fauna

- Bardick (*Echiopsis curta*), SA: R, MM: R
- Blue-winged Parrot (*Neophema chrysostoma*), SA: V, MM: V
- Chestnut Quail-thrush (*Cinclosoma castanotus*), SA: R, MM: V
- Gilbert's Whistler (*Pachycephala inornata*), SA: R, MM: R
- Jacky Lizard (*Amphibolurus muricatus*), SA: R
- Major Mitchell's Cockatoo (*Cacatua leadbeateri*), SA: V, MM: V
- Malleefowl (*Leipoa ocellata*), Aust: V, SA: V, MM: V
- Mallee Emu-wren (*Stipiturus mallee*), Aust: V, SA: V, MM: V
- Peregrine Falcon (*Falco peregrinus*), SA: R, MM: R
- Red-lored Whistler (*Pachycephala rufogularis*), Aust: V, SA: V, MM: V
- Regent Parrot (*Polytelis anthopeplus*), Aust: V, SA: V, MM: V
- Striated Grasswren (*Amytornis striatus*), SA: R, MM: V
- Striped Honeyeater (*Plectorhyncha lanceolata*), SA: R, MM: V
- Western Whipbird (*Psophodes nigrogularis leucogaster*), Aust: V, SA: V, MM: V
- White-browed Treecreeper (*Climacteris affinis*), SA: R, MM: V
- Yellow-tailed Black-Cockatoo (*Calyptorhynchus funereus*), SA: V, MM: V.

CONTINUED

BILLIATT

KEY THREATENING PROCESSES

- Fragmentation and isolation of remnants.
- Grazing of remnants.
- Feral animals.
- Brush cutting which threatens to modify the vegetation communities containing Broom Bush in the understorey. Harvesting of brush for the brush fencing industry currently operates in the Billiatt Land Unit under a permit system, however there is evidence to suggest that unauthorised harvesting is also occurring. Removal and damage to understorey in Broom Bush communities, threatens to alter the habitat suitability for certain species, in particular the Chestnut Quail-thrush, Malleefowl, Red-lored Whistler, Western Whipbird and the Gilbert's Whistler (Kahrimanis et al., 2001).
- Inappropriate fire regimes—*The Biodiversity Plan for the SAMDB* identifies inappropriate fire regimes as one of the greatest threats to the biodiversity of the Billiatt area (Kahrimanis et al., 2001).
- Soil erosion—There appears to be a moderate erosion potential of the predominantly sandy soils which are mainly defined by dune complexes and open sandy plains. A number of areas have been identified and mapped under the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003).
- Weed invasion—The major weeds identified for the Land Unit are: African Boxthorn, African Lovegrass, Artichoke Thistle, Athel Pine, Bathurst Burr, Bladder Campion, Boneseed, Bridal Creeper, Calomba Daisy, Caltrop, Two-leaf Cape Tulip, Cut-Leaf Mignonette, False Caper, Horehound, Innocent Weed, Lincoln Weed, Onion Weed, Perennial Ragweed, Prickly Pear, Salvation Jane, Silver Nightshade, Skeleton Weed, Soldier Thistle, Soursob and Yellow Burr Weed.

CURRENT MANAGEMENT STRATEGIES

Erosion control

There are areas identified for erosion management within the Billiatt Land Unit by the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003).

The report also identifies which areas have been revegetated between 1998 and 2001. Areas directly to the east of Karte CP, north and west of Mulpata, have been classified as severe, where they are defined by razorbacks, mobile drift, encroachment of erosion site onto neighbouring land, untrafficable by farm machinery, and/or mostly devoid of vegetative cover (MMLAP, 2003). Other areas are less severe with a greater cover of vegetation including locations north and west of Karte, north-west of Halidon and north-east of Sandalwood. Revegetation has been targeted at the following areas:

- north and west of Mulpata
- north, south and west of Kulkami
- east of Mindarie
- south of Alawoona
- south of Paruna.

RECOMMENDED MANAGEMENT STRATEGIES*

- Protect existing remnants
- buffer existing remnants
- create wildlife corridors
- maintain and improve the condition of remnants
- maintain and improve the condition of roadside vegetation
- control erosion
- manage feral animals
- protect Heritage Agreements and other reserves and remnants.

*See Table 7 (page 51).

BLANCHETOWN

Area—852 km²
Mean annual rainfall—250–300 mm
Primary land uses—Cropping and stock grazing
Remnancy—65.2%

DESCRIPTION

The Blanchetown Land Unit has been described as 'a gently undulating calcrete plain mainly veneered with sand and with occasional low dunes. It is traversed from north to south by the old entrenched floodplain of the Murray River. Low terraces occur along the river. Degraded low open woodland and mallee are interspersed with areas cleared to an open parkland. The land is mostly used for grazing wool sheep' (Laut et al., 1977).

Approximately 36% of the Blanchetown Land Unit occurs within the Murray Mallee LAP area and is located along the north-western boundary bordering the River Murray. More than half of the area within the Land Unit contains native vegetation (65.5%), and 15.8%, or 8806 hectares, is protected under 38 Heritage Agreements. Much of the remaining vegetation within the Land Unit is dominated by undulating calcrete plains with low chenopod shrublands (Bluebush/Blackbush) and Speargrass grasslands, with a small area dominated by mallee in the southern portion. The chenopod shrublands and grassland areas generally possess a greater productive capacity for pastoral activities compared with some mallee-dominated systems and may explain why only a small proportion is protected under Heritage Agreements. The Bluebush/Blackbush vegetation types are estimated to cover 10 115 hectares across the Murray Mallee LAP area, with none represented within the reserves system. *Stipa* grasslands, however, are known to cover approximately 49 892 hectares of which 2%, or 1078 hectares, is protected.

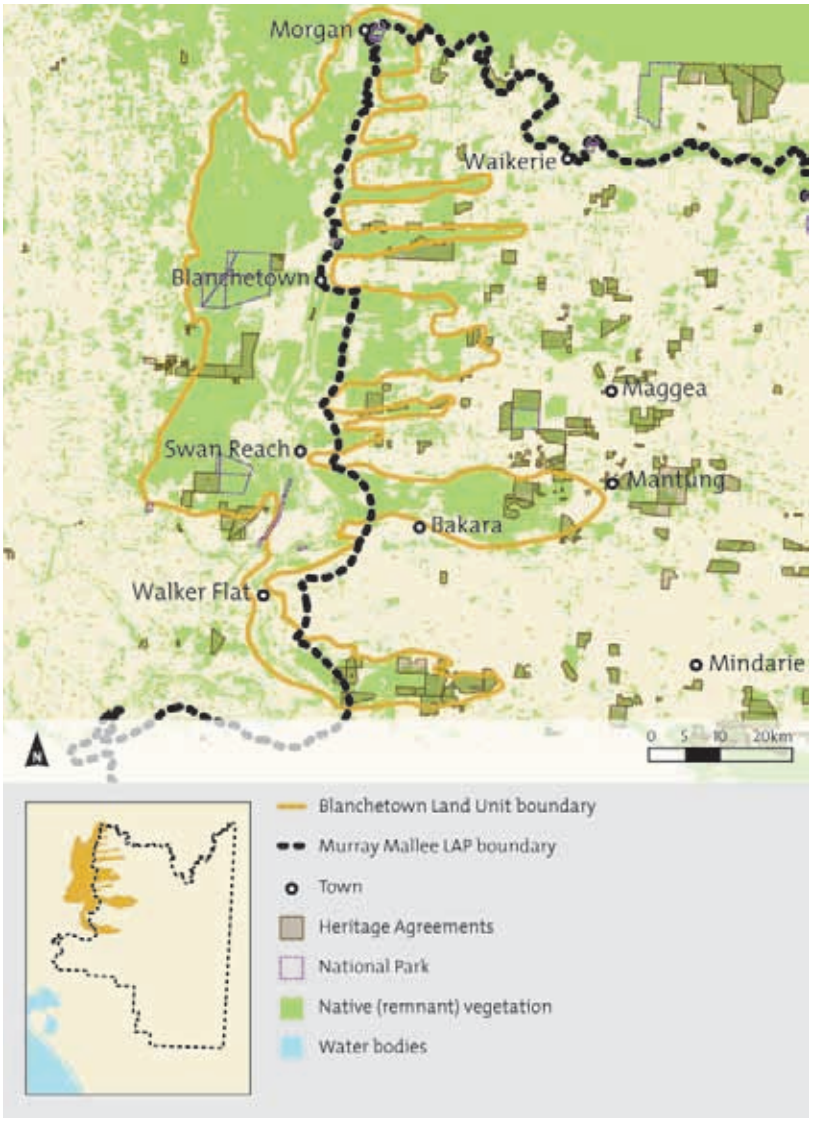

Figure 32: Blanchetown locality map. Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

CONTINUED

BLANCHETOWN

Despite the comparatively high remnancy for the Land Unit, much of it is subject to grazing and is likely to be modified to some degree depending on the grazing intensity. Protection of maintenance of chenopod (Bluebush/Blackbush) remnants within the Blanchetown Land Unit is extremely important given that the vegetation type is not currently well represented. Restoration of remnants through weed control is also recommended to limit competition with native species and encourage natural regeneration. Feral animal control is also important to decrease predation by foxes and cats on native wildlife.

NATIVE VEGETATION

The broadly defined dominant vegetation types occurring within the Blanchetown Land Unit include:

- *Maireana sedifolia, Maireana pyramidata* Very Open Shrubland
- *Stipa* sp. Open Tussock Grassland
- *Eucalyptus gracilis*, *Eucalyptus oleosa* Very Open Mallee
- *Eucalyptus dumosa* +/- *Eucalyptus leptophylla* Mallee
- *Eucalyptus leptophylla* /*Eucalyptus socialis* Open Mallee
- *Acacia nyssophylla* Tall very open shrubland.

CONSERVATION ASSETS

The Blanchetown Land Unit contains large areas of continuous chenopod shrublands, however none of this land type is currently afforded any formal protection. Little information is available regarding the habitat quality and native wildlife utilisation.

The southern portion of the Land Unit, which is located east of Purnong within the Hundreds of Forster, Bandon and Chesson, is recognised by the *Biodiversity Plan for the SAMDB* as a Fragmented Habitat Area (Kahrimanis et al., 2001) (see Section 1). It encompasses a large, almost continuous block of remnant vegetation (Cox Plain) with numerous fragmented blocks to the east, much of which is protected under Heritage Agreements. It is surrounded by widely cleared areas to the north and south and remains an important refuge area, which is considered large enough to sustain native populations of plants and animals into the future (Kahrimanis et al., 2001). The area has also been identified as containing the only remaining examples of *Eucalyptus gracilis*, *E. oleosa*, and *E. leptophylla*, *E. socialis* Very open mallee and *Acacia nyssophylla* Tall very open shrubland within the SAMDB (Kahrimanis et al., 2001). The Blanchetown Land Unit, and in particular the Forster–Chesson High Value Habitat area provides important refuge for many wildlife species, some of which are of conservation significance.

A number of reptile and mammal species have also been recorded from the area. Both the *Murray Mallee Revegetation Plan* (MMLAP, 2001) and the *Biodiversity Plan for the SAMDB* (Kahrimanis et al., 2001) have identified this area as a priority site for the restoration, re-establishment and management of native vegetation. Ratings are abbreviated to Rare (R), Vulnerable (V) and Known (K).

Species of conservation significance:

Flora

- Rohrlach's Bluebush (*Maireana rohrlachii*), SA: R, MM: R
- Streaked Wattle (*Acacia lineata*), SA: R, MM: R

Fauna

- Black-eared Miner (*Manorina melanotis*), Aust: E, SA: E, MM: E
- Malleefowl (*Leipoa ocellata*), Aust: V, SA: V, MM: V
- Red-lored Whistler (*Pachycephala rufogularis*), Aust: V, SA: V, MM: V
- Regent Parrot (*Polytelis anthopeplus*), Aust: V, SA: V, MM: V
- Chestnut Quail-thrush (*Cinclosoma castanotus*), SA: R, MM: V

CONTINUED

BLANCHETOWN

- Major Mitchell's Cockatoo (*Cacatua leadbeateri*), SA: V, MM: V
- Striped Honeyeater (*Plectorhyncha lanceolata*), SA: R, MM: V.

There are a number of large unprotected blocks of mallee vegetation within the Forster–Chesson High Value Habitat Area. Due to their proximity and connectivity to large Heritage Agreements, these areas should be targeted for further protection from threatening processes, such as those discussed below.

KEY THREATENING PROCESSES

- Fragmentation and isolation of remnants.
- Grazing of remnants.
- Feral animals.
- Soil erosion—A number of areas have been identified and mapped under the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003). Erosion appears to have been more severe in the past due to overgrazing and land clearance.
- Weed invasion—The major weeds identified for the Land Unit are: African Boxthorn, African Lovegrass, Athel Pine, Bathurst Burr, Blackberry, Bladder Campion, Boneseed, Branched Broomrape, Bridal Creeper, Caltrop, Cut-Leaf Mignonette, False Caper, Field Garlic, Fountain Grass, Golden Dodder, Horehound, Innocent Weed, Khaki Weed, Lincoln Weed, Noogoora Burr, Olive, Onion Weed, Prickly Pear, Salvation Jane, Silver Nightshade, Skeleton Weed, Soursob, Variegated Thistle and Yellow Burr Weed.

CURRENT MANAGEMENT STRATEGIES

Erosion control

There are areas identified for erosion management within the Blanchetown Land Unit by the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003). The report also identifies which areas have been revegetated between 1998 and 2001. Several small areas south of Murtho and approximately 15 kilometres south-east of Blanchetown have been mapped and classified as severe to moderate, where severe is defined by razorbacks, mobile drift, encroachment of erosion site onto neighbouring land, untrafficable by farm machinery and/or mostly devoid of vegetative cover. Moderate or less severe erosion is defined as actively eroding or beginning to stabilise and mostly devoid of vegetative cover (MMLAP, 2003).

Heritage Agreements

Currently 7 000 hectares is protected under 38 Heritage Agreements. Many of these are to the east and west portions of the mallee block and the majority are connected to other areas of native vegetation. There are several, however, that are isolated. These areas could benefit from buffering and development of wildlife corridors, either in the form of linear corridors or stepping stones (see Figure 16).

RECOMMENDED MANAGEMENT STRATEGIES*

- Protect existing remnants
- buffer existing remnants
- create wildlife corridors
- maintain and improve the condition of remnants
- manage total grazing pressure (including stock)
- maintain and improve the condition of roadside vegetation
- control erosion
- manage feral animals
- protect Heritage Agreements and other reserves and remnants
- retain wildlife habitat.

*See Table 7 (page 51).

HOLDER

Area—4012 km²
Mean annual rainfall—250–300 mm
Primary land uses—Cropping and stock grazing
Remnancy—18.2%

Figure 33: Holder locality map. Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

DESCRIPTION

The Holder Land Unit has been described as 'a gently undulating calcrete plain with low easterly trending sand dunes and shallow depressions. Vegetation varies from disturbed mallee scrub to open parkland and grassland. Wheat cultivation and grazing of wool sheep and beef cattle are the dominant land uses. The views are middleground panoramas with features of mallee remnants and active dunes. Locally, the mallee road verges create perspective views' (Laut et al., 1977).

The entire Holder Land Unit is located in the central and northern areas of the Murray Mallee LAP area. Approximately 18% of the native vegetation has been retained of which 35.5% (or 25 876 hectares) has been protected under 134 Heritage Agreements and the Bakara Conservation Park.

The area has been historically utilised for pastoral purposes which has destabilised soils in some areas, exposing them to wind and water erosion. Clearance for cropping and woodcutting industry also severely fragmented and destroyed the old-growth stands of mallee vegetation dominating the area (Kahrimanis et al., 2001). Some good examples of intact mallee vegetation, including old-growth stands still exists in areas like the Bakara–Mantung–Maggea High Value Habitat area. This area is located within the south central portion of the Holder Land Unit, and adjacent to Bakara CP. It is recognised as a highly significant conservation area. Further information can be obtained from the recently updated *How to Manage Native Vegetation in the Murray Mallee – A Conservation Handbook* (EAC, 2005) (see Section 1: High Value Habitat areas).

The northern section of the Land Unit contains many large and fragmented remnants which have the potential to sustain existing native plants and animal populations within the area, providing management is aimed toward protection, maintenance and restoration. There is also scope for connection of remnant blocks with revegetated wildlife corridors, and buffering of existing native vegetation. Many of the blocks are not currently afforded any formal protection and may be subject to degrading influences such as grazing or weed invasion and/or feral animal predation. It is therefore necessary to target the protection of these blocks in order to assist with long-term protection of the native species within them.

Blue Mallee (*Eucalyptus cyanophylla*) is a threatened species endemic to the South Australian Murraylands region. Much of the association has previously been cleared leaving small pockets scattered throughout the Land Unit. It mainly exists now along road reserves and small remnants on private land. Conservation of the remaining pockets of Blue Mallee is therefore extremely important. Small areas of this vegetation type also occur within the neighbouring Land Units of Pata and Renmark (Payne pers. comm, 2006).

NATIVE VEGETATION

The broadly defined dominant vegetation types occurring within the Holder Land Unit include:

- *Eucalyptus gracilis*, *Eucalyptus oleosa* Very Open Mallee
- *Eucalyptus dumosa* +/- *Eucalyptus leptophylla* Mallee
- *Eucalyptus leptophylla* /*Eucalyptus socialis* Open Mallee
- *Maireana sedifolia, Maireana pyramidata* Very Open Shrubland (poorly conserved in MMLAP)
- *Eucalyptus cyanophylla* Open Mallee
- *Eucalyptus leptophylla*/ *Melaleuca lanceolata* Open Mallee (this is a threatened vegetation community)
- *Stipa* sp. Open Tussock Grassland.

CONSERVATION ASSETS

The Holder Land Unit contains areas such as the Bakara–Mantung–Maggea High Value Habitat area where the large intact blocks of native vegetation make them important from wildlife conservation. Some of these blocks are considered to have experienced less overall disturbance and are able to support larger wildlife populations than the smaller blocks surrounding them (Kahrimanis et al., 2001). This area, together with Bakara CP and numerous other remnant blocks, provides important habitat and refuge for many wildlife species, some of which are of conservation significance. Ratings are abbreviated to Rare (R), Vulnerable (V) and Known (K).

Species of conservation significance:

Flora

- Rohrlach's Bluebush (*Maireana rohrlachii*), SA: R, MM: R
- Streaked Wattle (*Acacia lineata*), SA: R, MM: R
- Rasp Daisy-bush (*Olearia picridifolia*), SA: R, MM: R

Fauna

- Malleefowl (*Leipoa ocellata*), Aust: V, SA: V, MM: V
- Red-lored Whistler (*Pachycephala rufogularis*), Aust: V, SA: V, MM: V
- Regent Parrot (*Polytelis anthopeplus*), Aust: V, SA: V, MM: V
- Chestnut Quail-thrush (*Cinclosoma castanotus*), SA: R, MM: V
- Major Mitchell's Cockatoo (*Cacatua leadbeateri*), SA: V, MM: V
- Striped Honeyeater (*Plectorhyncha lanceolata*), SA: R, MM: V
- Gilbert's Whistler (*Pachycephala inornata*), SA: R, MM: R
- Common Brushtail Possum (*Trichosurus vulpecula*), MM: R.

CONTINUED

HOLDER

KEY THREATENING PROCESSES

- Fragmentation and isolation of remnants.
- Grazing of remnants.
- Feral animals.
- Illegal woodcutting.
- Illegal removal of hollow branches for poaching of threatened species and for the aviary trade has been identified as an active threat in the Northern Mallee Districts (Kahrimanis et al., 2001). Removal of hollows and old-growth mallee from an area can severely reduce the habitat potential for many native wildlife species. Some species of eucalypt can take 200 years to form suitable hollow branches..
- Soil erosion—There are a number of erosion areas that have been identified in the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003) which range from moderate to severe and are located within areas dominated by linear dune complexes.
- Weed invasion—The major weeds identified for the Land Unit are: African Boxthorn, African Lovegrass, Artichoke Thistle, Athel Pine, Bathurst Burr, Blackberry, Boneseed, Bridal Creeper, Caltrop, Cut-Leaf Mignonette, False Caper, Fountain Grass, Golden Dodder, Horehound, Innocent Weed, Khaki Weed, Lincoln Weed, Olive, Onion Weed, Perennial Ragweed, Salvation Jane and Skeleton Weed.

CURRENT MANAGEMENT STRATEGIES

The *Murray Mallee Revegetation Plan* (MMLAP, 2001) has also highlighted the whole of the Northern Mallee Districts Fragmented Habitat Area as a target area for revegetation projects.

Erosion control

There are areas identified for erosion management within the Holder Land Unit by the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003). The report also identifies which areas have been revegetated between 1998 and 2001. Numerous areas north of Wanbi, Mindarie and Alawoona have been classified as severe to moderate, where severe is defined by razorbacks, mobile drift, encroachment of erosion site onto neighbouring land, untrafficable by farm machinery, and/or mostly devoid of vegetative cover. Moderate or less severe erosion is defined as actively eroding or beginning to stabilise and mostly devoid of vegetative cover (MMLAP, 2003). The majority of the revegetation within the Holder Land Unit has been conducted to combat erosion in the Wanbi, Mindarie and Alawoona area (MMLAP, 2003).

Heritage Agreements

Currently 24 849 hectares of remnant mallee vegetation is protected under 134 Heritage Agreements. A group of landholders within the Mantung–Maggea area are currently responsible for 17 Heritage Agreements which together comprise the highest concentration of remnant blocks across the Land Unit. The vast majority of other remnants are isolated from larger blocks and could benefit from development of wildlife corridors, either in the form of linear corridors or stepping stones (see Figure 16).

Feral Animal Control

Annual fox baiting for a period of six weeks in July and August (Laver, pers. comm., 2006).

RECOMMENDED MANAGEMENT STRATEGIES*

- Protect existing remnants
- buffer existing remnants
- create wildlife corridors
- maintain and improve the condition of remnants
- maintain and improve the condition of roadside vegetation
- control erosion
- manage feral animals
- protect Heritage Agreements and other reserves and remnants.

*See Table 7 (page 51).

KAROONDA

Area—3672.5 km²
Mean annual rainfall—350 mm
Primary land uses—Cereal cropping and sheep grazing
Remnancy—6.5%

DESCRIPTION

The Karoonda Land Unit has been described as 'an undulating sandy plain with low dunes and frequent outcrops of calcrete. Remnants of mallee scrub cover many of the dune crests but elsewhere there is a cultural grassland used mainly for cereal cultivation and grazing wool sheep. Locally the mallee verges create perspective views along roads' (Laut et al., 1977).

Approximately 87% of the Karoonda Land Unit is located in the south-western portion of the Murray Mallee LAP area. The vast majority of the vegetation has been removed to make way for agriculture, leaving approximately 6.5% remaining, of which 30.3% (or 7286 hectares) has been protected under 73 Heritage Agreements and the Lowan Conservation Park. Many of the protected blocks occur within Ettrick and Surrounds High Value Habitat area, which is located in the western corner of the Land Unit. In addition to Lowan Conservation Park and a concentration of Heritage Agreements within Ettrick, there are also numerous small remnant areas, some isolated and others connected or in close proximity to other blocks. These areas could benefit from further protection through fencing from grazing animals or Heritage Agreement status. Throughout the remaining areas of the Karoonda Land Unit, there is little vegetation remaining. Those blocks that have been retained, few are protected, and most are small and isolated. Due to a lack of formal protection, most are likely to be degraded from grazing and weed invasion.

Figure 34: Karoonda locality map. Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

CONTINUED

KAROONDA

However, these blocks may help serve as stepping stones for birds and larger wildlife species attempting to move from one larger remnant patch to another, such as Ettrick and surrounds to Forster–Chesson High Value Habitat areas.

NATIVE VEGETATION

The broadly defined dominant vegetation types occurring within the Karoonda Land Unit include:

- *Eucalyptus incrassata* Open Low Mallee
- *Eucalyptus porosa* Low Very Open Woodland
- *Lomandra effusa* Open Tussock Grassland
- *Melaleuca acuminatum*, *Melaleuca lanceolata* +/- *Eucalyptus socialis* +/- *Eucalyptus leptophylla* Tall Open Shrubland
- *Eucalyptus gracilis*, *Eucalyptus oleosa* Very Open Mallee
- *Eucalyptus leptophylla* /*Eucalyptus socialis* Open Mallee
- *Callitris gracilis* Low Open Woodland.

CONSERVATION ASSETS

Lowan CP contains 675 hectares of native vegetation dominated by *Eucalyptus gracilis*, *Eucalyptus oleosa* Very Open Mallee and *Melaleuca acuminatum*, *Melaleuca lanceolata* +/- *Eucalyptus socialis* +/- *Eucalyptus leptophylla* Tall Open Shrubland. It is known to provide habitat to numerous common plants and animals as well as several threatened species including Chestnut Quail-thrush, Malleefowl and Streaked Wattle.

Streaked Wattle has declined as a result of land clearance and grazing of remnants. It has been documented that two large populations exist in the northern Murray Mallee region with several small populations occurring across private properties within the area. A population of approximately 100 individuals occurs next to the Karoonda Road and several others are located nearby along back roads near Wynarka (Simon, pers. comm. 2005).

The Karoonda Land Unit contains the Ettrick High Value Habitat area which is defined by a high concentration of small remnant blocks. 37 individual blocks of native vegetation have been protected under 23 Heritage Agreements and together with numerous unprotected remnants, the total native vegetation cover is approximately 17% (Kahrimanis et al., 2001). This area has been recognised as providing valuable habitat to native wildlife, including some of conservation significance. The retention of old-growth mallee may explain the high incidence of Malleefowl in the area, which is their preferred habitat (Kahrimanis et al., 2001). See the list of threatened species in Section 1 recorded from the Ettrick and Surrounds and the wider Karoonda Land Unit. The area is also thought to provide suitable habitat to the threatened species such as the Black-eared Miner, Red-lored Whistler, Regent Parrot, Striated Grasswren and the Blue-winged Parrot (Kahrimanis et al., 2001). Ratings are abbreviated to Rare (R), Vulnerable (V) and Known (K).

Species of conservation significance:

Flora

- Cleland's Beard-heath (*Leucopogon clelandii*), SA: R, MM: E
- Mallee Wattle (*Acacia montana*), SA: R, MM: R
- Narrow-leaf Wax-flower (*Philotheca angustifolia* ssp. *angustifolia*), SA: R, MM: R
- Rasp Daisy-bush (*Olearia picridifolia*), SA: R, MM: R
- Rohrlach's Bluebush (*Maireana rohrlachii*), SA: R, MM: R
- Scaly Haeckeria (*Ozothamnus pholidotus*),
- Streaked Wattle (*Acacia lineata*), SA: R, MM: R.

Fauna

- Carpet Python (SAMDB subspecies) (*Morelia spilota variagata*), SA: V, MM: V
- Chestnut Quail-thrush (*Cinclosoma castanotus*), SA: R, MM: V
- Malleefowl (*Leipoa ocellata*), Aust: V, SA: V, MM: V
- Olive Snake Lizard (*Delma inornata*), SA: R
- Striped Honeyeater (*Plectorhyncha lanceolata*), SA: R, MM: V.

CONTINUED

KAROONDA

Vegetation communities

The Land Unit contains the following vegetation communities which are considered to be threatened in the Murray Mallee LAP area:

- *Callitris gracilis* Low Open Woodland—5.6% of the 1208 hectares of remaining Native Pine woodland is currently formally protected. See Section 1 under Flagship Species and Communities for further information regarding Native Pine communities.
- *Eucalyptus porosa* Low Very Open Woodland—4% of the 2028 hectares of this vegetation type remaining is formally protected. Aside from the widespread clearance, the remaining examples are known to be highly impacted upon by weeds, particularly Bridal Creeper (Kahrimanis et al., 2001).
- *Lomandra effusa* Open Tussock Grassland—This is a highly threatened community with approximately 1% formally protected in a single block.

Management and /or protection of remnants containing these vegetation types is extremely important.

KEY THREATENING PROCESSES

- Fragmentation and isolation of remnants.
- Grazing of remnants.
- Feral animals.
- Soil erosion—There are a small number of moderate erosion areas that have been identified in the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003).
- Weed invasion—The major weeds identified for the Land Unit are: African Boxthorn, African Lovegrass, Aleppo Pine, Artichoke Thistle, Athel Pine, Bathurst Burr, Blackberry, Bladder Campion, Boneseed, Branched Broomrape, Bridal Creeper, Caltrop, Two-leaf Cape Tulip, Cut-Leaf Mignonette, Dandelion, False Caper, Horehound, Innocent Weed, Khaki Weed, Lincoln Weed, Noogoora Burr, Olive, Onion Weed, Prickly Pear, Salvation Jane, Silver Nightshade, Skeleton Weed, Soldier Thistle, Soursob, Variegated Thistle and Yellow Burr Weed.

CURRENT MANAGEMENT STRATEGIES

Erosion control

There are areas identified for erosion management within the Karoonda Land Unit by the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003). Several small areas north-west, south and west of Wynarka and south-west of Karoonda have been classified as moderately eroded. The report also identifies which areas have been revegetated between 1998 and 2001. Some of these areas include south-west of Karoonda and south of Wynarka (MMLAP, 2003).

Feral animal control

Since 1999, a 24-member group from the Lower Mallee area have been consistently fox baiting 26 000 hectares, which includes the Lowan CP. After a three-year consistent effort, sixty-five percent of the Lower Mallee group have observed a fall in fox numbers.

Heritage Agreements

Currently 3700 hectares of remnant mallee vegetation is protected under 23 Heritage Agreements. Together with the Lowan CP, they comprise the highest concentration of remnant blocks across the Land Unit. The vast majority of other remnants are isolated from larger blocks and could benefit from development of wildlife corridors, either in the form of linear corridors or stepping stones (see Figure 16).

RECOMMENDED MANAGEMENT STRATEGIES*

- Protect existing remnants
- buffer existing remnants
- create wildlife corridors
- maintain and improve the condition of remnants
- maintain and improve the condition of roadside vegetation
- control erosion
- manage feral animals
- protect Heritage Agreements and other reserves and remnants.

*See Table 7 (page 51).

KUNLARA

Area—869 km²
Mean annual rainfall—300 mm
Primary land uses—Cereal cultivation and sheep grazing
Remnancy—7.5%

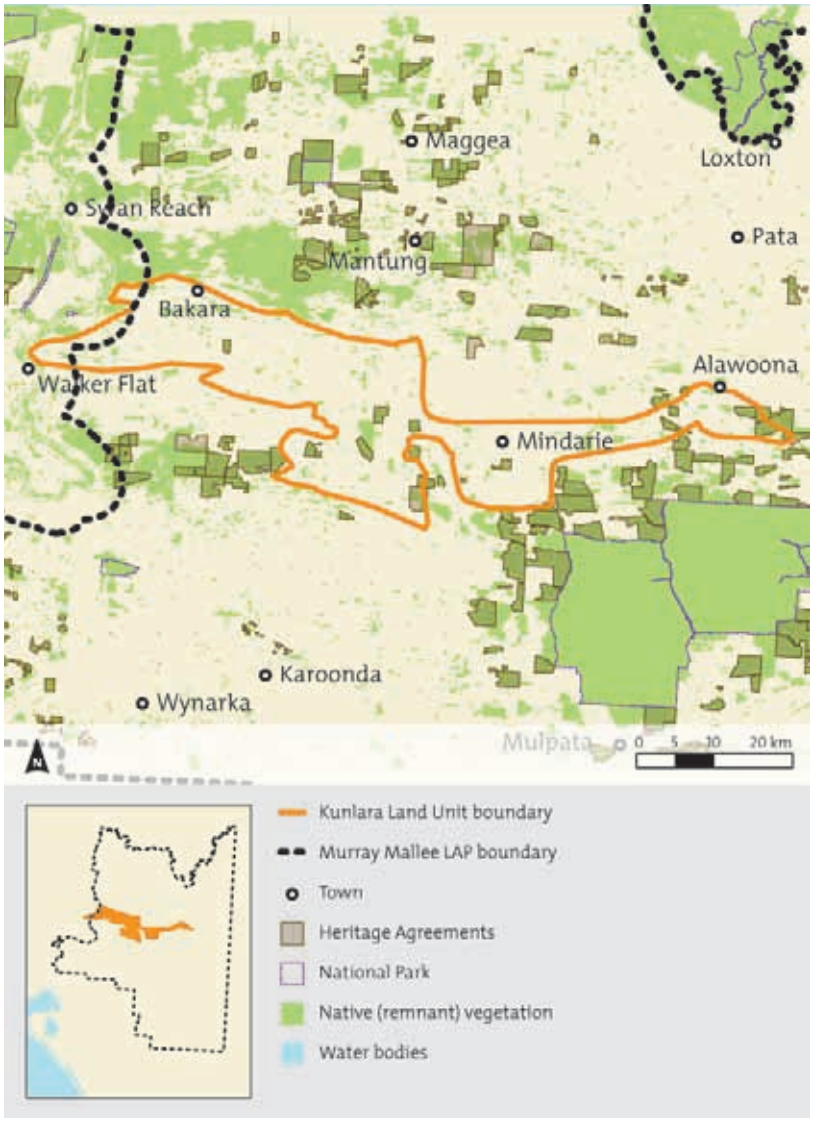

Figure 35: Kunlara locality map. Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

DESCRIPTION

The Kunlara Land Unit has been described as 'an undulating calcrete plain with excessive aeolian sand sheets and low dunes. The dunes have been cleared to an open parkland but elsewhere the vegetative cover is a cultural grassland used for cereal cultivation and grazing. The views are middle ground panoramas with local features of mallee remnants and bare dune crests. Locally, the mallee verges create perspective views along roads' (Laut et al., 1977).

The vast majority (96%) of this land type is located within the Murray Mallee LAP area. It covers 869 km², which runs east of the River Murray through the centre and ends on the northern side of Billiatt CP. Much of the Land Unit has been cleared of vegetation to make way for agriculture. Approximately 7.5%, or 3581 hectares of the original vegetation remains, 54% of which is protected by 21 Heritage Agreements. The area lies between the Forster–Chesson and Mantung–Maggea High Value Habitat areas, and currently provides little scope for movement of wildlife between the areas due to the extremely low remnancy. Many of the remaining blocks are very small and isolated and due to a lack of formal protection, are most likely degraded from grazing and weed invasion. Many of these blocks, which may serve as stepping stones between areas of higher habitat value, could benefit from restoration or maintenance, through feral plant and animal control and/or fencing from grazing. The smaller blocks are more susceptible to the degrading impacts of weed invasion from the edges (edge effects) and may need more regular treatment to keep infestations from spreading throughout the entire block.

NATIVE VEGETATION

The broadly defined dominant vegetation types occurring within the Bandon Land Unit include:

- *Eucalyptus incrassata* Open Low Mallee
- *Eucalyptus leptophylla/Eucalyptus socialis* Open Mallee
- *Eucalyptus gracilis/Eucalyptus oleosa* Very Open Mallee
- *Eucalyptus dumosa* +/- *Eucalyptus leptophylla* Mallee
- *Eucalyptus calycogona/Eucalyptus dumosa* Very Open Mallee.

CONSERVATION ASSETS

Due to the extremely low levels of remaining habitat within the Kunlara Land Unit and that most small remnants have not been surveyed, there are very few native wildlife records from the area. The Major Mitchell's Cockatoo has been recorded from a Heritage Agreement on the western end of the Land Unit. Ratings are abbreviated to Rare (R), Vulnerable (V) and Known (K).

Species of conservation significance:

Fauna

- Major Mitchell's Cockatoo (*Cacatua leadbeateri*), SA: V, MM: V.

KEY THREATENING PROCESSES

- Fragmentation and isolation of remnants.
- Feral animals.
- Grazing of remnants.
- Soil erosion—Erosion potential due to low remnancy levels across the area coupled with a high density of linear dunes to the eastern end of the Kunlara Land Unit. Laut et al., (1977) notes both undulating plains and dune have slight and moderate drift potential respectively.
- Weed invasion—The major weeds identified for the Land Unit are: African Boxthorn, African Lovegrass, Athel Pine, Bathurst Burr, Bladder Campion, Boneseed, Branched Broomrape, Bridal Creeper, Caltrop, Cut-Leaf Mignonette, False Caper, Field Garlic, Golden Dodder, Horehound, Innocent Weed, Noogoora Burr, Onion Weed, Prickly Pear, Salvation Jane, Silver Nightshade, Skeleton Weed, Soursob and Yellow Burr Weed.

CURRENT MANAGEMENT STRATEGIES

Erosion control

There are areas identified for erosion management within the Kunlara Land Unit by the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003). The main areas range from severe to moderate (severe is described as razorbacks, mobile drift, encroachment of erosion site onto neighbouring land, untrafficable by farm machinery, and/or mostly devoid of vegetative cover (MMLAP, 2003)) with various levels of vegetative cover and are mainly located:

- Mindarie and surrounds
- north and west of Halidon
- south and south-west of Wanbi.

The report also identifies which areas have been revegetated between 1998 and 2001. Revegetation has been targeted at the following areas:

- north-west of Mindarie
- north-east of Halidon.

RECOMMENDED MANAGEMENT STRATEGIES*

- Protect existing remnants
- buffer existing remnants
- maintain and improve the condition of remnants
- maintain and improve the condition of roadside vegetation
- control erosion.

*See Table 7 (page 51).

LOWER MURRAY

Area—922 km²
Mean annual rainfall—350 mm
Primary land uses—Irrigated pasture production for dairying
Remnancy—1.3%

Figure 36: Lower Murray locality map. Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

DESCRIPTION

The Lower Murray Land Unit has been described as 'the Murray River floodplain, here incised some 40 metres below the surface of the surrounding calcreted plains. The higher proportion of the floodplain and some of the highest swamps have been drained and reclaimed for pasture and fodder cultivation. Dairy cattle and other livestock are either grazed on these pastures or fed on the fodder harvested from them. The steep cliffs beside the river create local perspective views. From the top of the cliffs, panoramic views are available, with the floodplain, swamps and channel creating foreground features' (Laut et al., 1977).

Approximately half (44.5%) of this land type is located within the Murray Mallee LAP area covering an area of 922 km² along the River Murray corridor. The vast majority of the vegetation has been cleared or severely modified, leaving 1.3%, or 125.5 hectares remaining, of which none is formally protected in the reserve system. The area has been a site of intensive use since early settlement due to its proximity to the River and today it is primarily utilised for dairy pastures, recreation and urban development (Kahrimanis et al., 2001).

Despite the level of degradation, the corridor habitat is still extremely valuable habitat to numerous wildlife species including bats, birds, reptiles, mammals and insects. The declining Brushtail Possum is known from habitats close to the river, where hollow-bearing mature eucalypts provide nesting habitat (Kahrimanis et al., 2001). The Lower Murray Land Unit also provides an effective corridor for the movement of wildlife.

NATIVE VEGETATION

The broadly defined dominant vegetation types occurring within the Lower Murray Land Unit include:

- *Eucalyptus camaldulensis* ssp. *camaldulensis* (River Red Gum) Woodland
- *Eucalyptus largiflorens* (River Box) Woodland
- *Enchylaena tomentosa* (Ruby Saltbush) Low Shrubland.

CONSERVATION ASSETS

The vegetation along the river corridor is highly degraded and modified, however it is known to provide habitat to a large range of wildlife species. Mature River Red Gums along the corridor often possess a range of hollows suitable for bird species (such those listed in Table 6) as well as the regionally significant Major Mitchell's Cockatoo, Brush-tailed Possum, Feather-tail Glider, Yellow-bellied Sheath-tailed Bat, and a range of other common species.

KEY THREATENING PROCESSES

- Grazing of remnant vegetation—Degradation of the understorey species by grazing has modified the composition and structure of many areas along the river corridor. Regeneration of native species is limited whist the protective nature of species such as the Common Reed (*Phragmites australis*) is compromised, leaving the banks further exposed to erosion (Kahrimanis et al., 2001).
- Erosion potential along banks due to heavy utilisation by stock, recreational users and river wave action.
- Feral animals.
- Salinity in the form of local rising saline groundwater.
- Recreational activities continue to degrade the environs within the Lower Murray Land Unit. The area is extremely popular and subsequently recreational use is intensive. Some of the impacts include erosion of banks due to wave action caused by motor boats, over-collection of firewood, vehicle damage to banks and urban developments.
- Weed invasion—The major weeds identified for the Land Unit are: African Boxthorn, African Lovegrass, Aleppo Pine, Athel Pine, Bathurst Burr, Blackberry, Boneseed, Branched Broomrape, Bridal Creeper, Caltrop, Cut-Leaf Mignonette, Dandelion, False Caper, Horehound, Innocent Weed, Lincoln Weed, Noogoora Burr, Olive, Onion Weed, Prickly Pear, Salvation Jane, Silver Nightshade, Skeleton Weed, Soursob, Variegated Thistle, Willow and Yellow Burr Weed.

RECOMMENDED MANAGEMENT STRATEGIES*

- Protect existing remnants
- buffer existing remnants
- create wildlife corridors
- maintain and improve the condition of remnants
- maintain and improve the condition of roadside vegetation
- control erosion
- rehabilitate degraded areas
- retain wildlife habitat.

*See Table 7 (page 51).

MOORLANDS

Area—143.1km²
Mean annual rainfall—375mm
Primary land uses—Cereal cropping and sheep grazing
Remnancy—3.7%

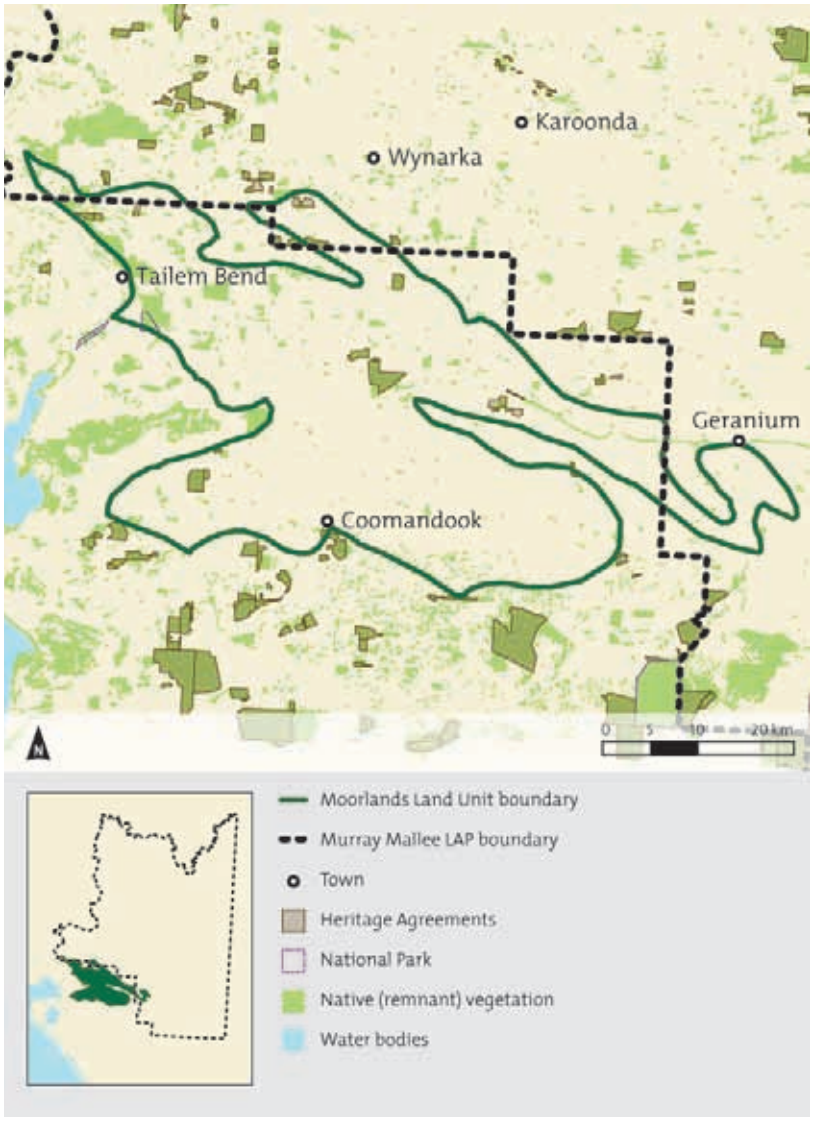

Figure 37: Moorlands locality map. Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

DESCRIPTION

The Moorlands Land Unit has been described as 'an undulating plain on calcreted sands with outcrops of calcrete and isolated dunes. The cover is mainly grassland and locally open parkland. The land is used for grazing and cereal cultivation' (Laut et al., 1977).

Three small sections of the Moorlands Land Unit, amounting to approximately 10% of the entire area fall within the Murray Mallee LAP area. The sections are all located on the south-western boundary of the region. Only 3.7% of the original native vegetation remains within this Land Unit, of which 63%, or 341 hectares, is protected under three small Heritage Agreements. The areas protected under Heritage Agreements constitute the largest remaining blocks on the Land Unit, with all other vegetation made up of tiny fragmented and isolated blocks. Due to their size and a lack of formal protection, most are likely to be degraded from grazing and weed invasion, however they may help serve as small stepping stones for birds and larger wildlife species attempting to move from one larger remnant patch to another.

NATIVE VEGETATION

The broadly defined dominant vegetation types occurring within the Moorlands Land Unit include:

- *Eucalyptus gracilis / Eucalyptus oleosa* Very Open Mallee
- *Melaleuca acuminatum / Melaleuca lanceolata +/- Eucalyptus socialis +/- Eucalyptus leptophylla* Tall Open Shrubland *Lomandra effusa* Open Tussock Grassland
- *Eucalyptus incrassata* Open Low Mallee.

CONSERVATION ASSETS

The three Heritage Agreements are considered to be the only conservation assets within the Land Unit. All other remnant vegetation is contained within small patches which are likely to be degraded and therefore of low habitat value. The Heritage Agreements are isolated from other blocks, however they are located on the south-eastern corner of the Ettrick High Value Habitat Area and may therefore be useful as stepping stones within that area.

There are no records of plant of animal species of conservation significance from the Moorlands Land Unit.

KEY THREATENING PROCESSES

- Fragmentation and isolation of remnants.
- Small remnants (less than one hectare).
- Grazing of remnants.
- Feral animals .
- Soil erosion—There are a small number of moderate erosion areas that have been identified in the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003).
- Weed invasion, the major weeds identified for the Land Unit are: African Boxthorn, African Lovegrass, Bathurst Burr, Bladder Campion, Boneseed, Branched Broomrape, Bridal Creeper, Caltrop, Cut-Leaf Mignonette, False Caper, Horehound, Innocent Weed, Lincoln Weed, Onion Weed, Silver Nightshade, Skeleton Weed, Soldier Thistle, Soursob, Variegated Thistle and Yellow Burr Weed.

CURRENT MANAGEMENT STRATEGIES

Erosion control

There are areas identified for erosion management within the Moorlands Land Unit by the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003). Several small areas south of Wynarka and south of Geranium have been classified as having moderate erosion.

RECOMMENDED MANAGEMENT STRATEGIES*

- Protect existing remnants
- buffer existing remnants
- maintain and improve the condition of remnants
- maintain and enhance the condition of roadside and railway reserve vegetation
- control erosion
- manage feral animals
- protect Heritage Agreements and other reserves and remnants.

*See Table 7 (page 51)

MURTHO

Area—125 km²
Mean annual rainfall—250 mm
Primary land uses—Grazing with some cereal cropping
Remnancy—26.3%

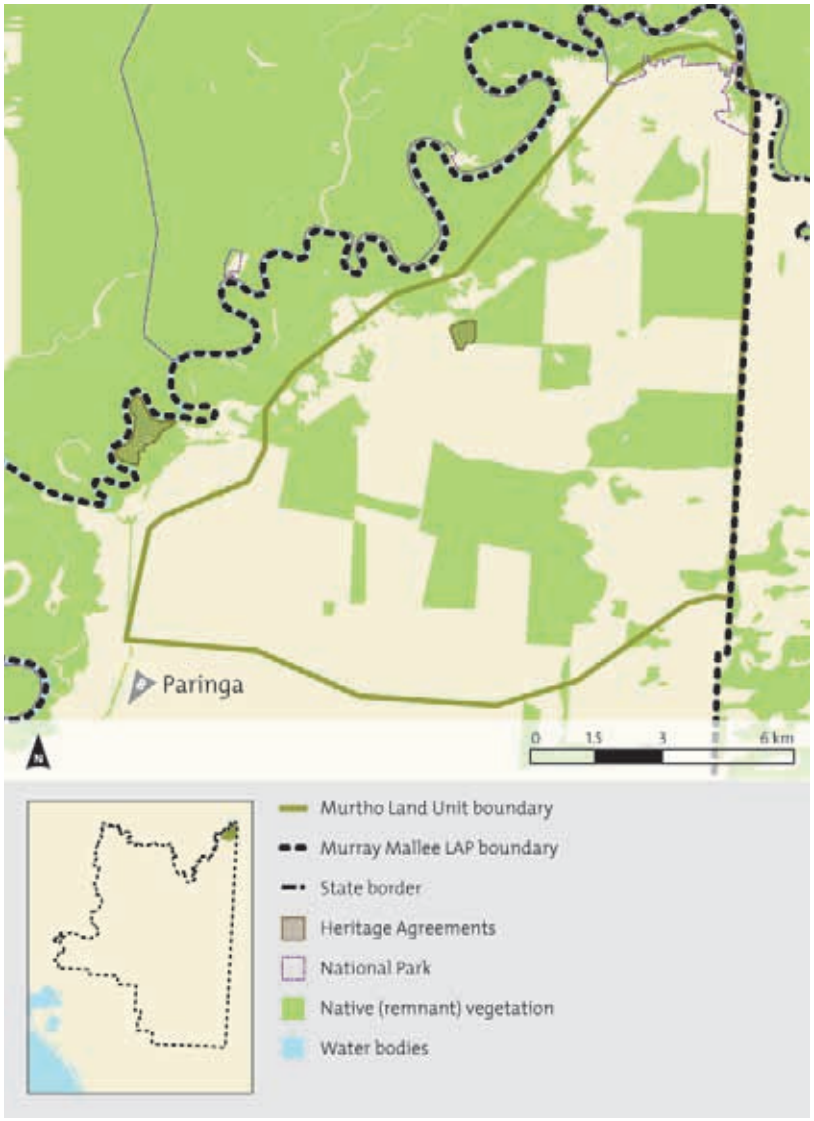

Figure 38: Murtho locality map. Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

DESCRIPTION

The Murtho Land Unit has been described as 'a gently undulating calcrete plain with low discontinuous sand dunes and a grassland or open parkland cover, mainly grazed but with limited wheat cultivation' (Laut et al., 1977).

The entire Murtho Land Unit within South Australia occurs within the Murray Mallee LAP area and is located in its far north-eastern end, bordering the River Murray and the SA–Victoria border. Despite the majority of the Land Unit being cleared of vegetation in the past, a reasonable proportion is still remaining (26.3%). Of this remaining vegetation, a very small proportion is formally protected under one Heritage Agreement (0.83%, or 27.45 hectares). The remnant blocks of vegetation, some of which are over 200 hectares in size, are especially significant due to their proximity to native vegetation along the river corridor. Collectively the blocks may serve as an effective corridor for the movement of wildlife between the river and large areas of mallee vegetation across the Victorian border. The larger unprotected blocks are likely to benefit from restoration or maintenance, through feral plant and animal control and/or fencing from grazing. Connection of remnants using wildlife corridors may encourage greater movement of wildlife species between patches. The smaller blocks are more susceptible to the degrading impacts of weed invasion from the edges (edge effects) and may need more regular treatment to keep infestations from spreading throughout the entire block.

NATIVE VEGETATION

The broadly defined dominant vegetation types occurring within the Murtho Land Unit include:

- *Casuarina pauper* Low Woodland
- *Maireana sedifolia* or *M. pyramidata* Very Open Shrubland
- *Eucalyptus largiflorens* Low Woodland
- *Stipa* sp. Open Tussock Grassland
- *Eucalyptus diversifolia* , *Olearia axillaris* Open Mallee

CONSERVATION ASSETS

There is only one Heritage Agreement contained within the Murtho Land Unit, which represents a tiny proportion of the remaining vegetation. The area is however, connected onto larger remnants including the river corridor. Many of the other unprotected remnants are between 100–200 hectares in size and are most probably grazed by domestic stock. The majority of the degradation is likely to be concentrated around the edges.

There are no records of plants or animals of conservation significance recorded from the Murtho Land Unit, however the remnant blocks in excess of 200 hectares are predicted habitat for species such as Malleefowl, Chestnut Quail-thrush, Major Mitchell's Cockatoo, Regent Parrot and the Striped Honeyeater (Kahrimanis et al., 2001).

KEY THREATENING PROCESSES

- Fragmentation and isolation of remnants.
- Grazing of remnants.
- Feral animals.
- Weed invasion—The major weeds identified for the Land Unit are: African Boxthorn, Bathurst Burr, Boneseed, Bridal Creeper, Caltrop, False Caper, Golden Dodder, Horehound, Innocent Weed, Noogoora Burr, Olive, Onion Weed, Prickly Pear, Salvation Jane, Skeleton Weed, Soursob and Yellow Burr Weed.

RECOMMENDED MANAGEMENT STRATEGIES*

- Protect existing remnants
- buffer existing remnants
- create wildlife corridors
- maintain and improve the condition of remnants
- maintain and enhance the condition of roadside and railway reserve vegetation
- manage feral animals
- protect Heritage Agreements and other reserves and remnants.

*See Table 7 (page 51).

PATA

Area—2052 km²
Mean annual rainfall—275 mm
Primary land uses—Cereal cropping and grazing
Remnancy—6.5%

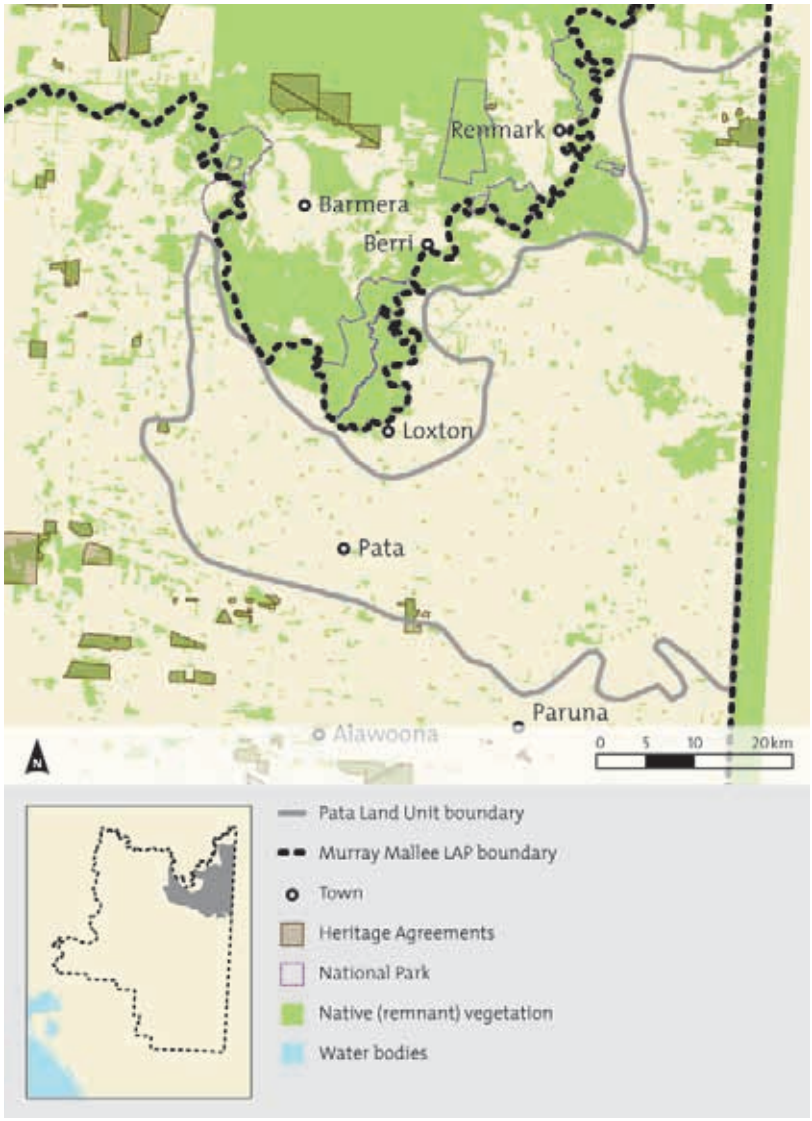

Figure 39: Pata locality map. Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

DESCRIPTION

The Pata Land Unit has been described as 'a gently undulating plain on calcreted sands with easterly trending isolated dunes. Open parkland with pasture understorey and cereal crops. Middle ground panoramic views are dominated by field and pastures, with mallee remnants or bare dune crests as local features. Mallee verges create perspective views along some roads' (Laut et al., 1977).

The entire Pata Land Unit occurs within the Murray Mallee LAP area, and is located in the north-eastern corner bordering the River Murray and the SA–Victoria state border. Clearance of native vegetation has been widespread throughout the Land Unit, with remaining vegetation calculated at 6.5%. Of this remaining vegetation, a very small proportion is protected under eight Heritage Agreements (9.6%, or 1293 hectares).

The southern and western portions of the Pata Land Unit separate the 'Billiatt Complex' from the River channel and much of the remaining vegetation across these areas is small, fragmented and isolated and due to a lack of formal protection, are most likely degraded from grazing and weed invasion. Many of these blocks, which may serve as stepping stones between areas of higher habitat value could benefit from restoration or maintenance, through feral plant and animal control and/or fencing from grazing. The smaller blocks are more susceptible to the degrading impacts of weed invasion from the edges (edge effects) and may need more regular treatment to keep infestations from spreading throughout the entire block.

The north-eastern sections of the Land Unit contain higher levels of native vegetation, although the vast majority of this is not formally protected. Due to their proximity to the river corridor, these areas may benefit from further protection and maintenance. Connection of remnants using wildlife corridors may encourage greater movement of wildlife species between patches.

NATIVE VEGETATION

The broadly defined dominant vegetation types occurring within the Pata Land Unit include:

- *Eucalyptus cyanophylla* Open Mallee
- *Eucalyptus gracilis* / *Eucalyptus oleosa* Very Open Mallee
- *Casuarina pauper* Low Woodland
- *Eucalyptus leptophylla* / *Eucalyptus socialis* Open Mallee
- *Spinifex sericeus*, *Ozothamnus turbinatus*, *Isolepis nodosa* Tussock Grassland
- *Halosarcia* sp. Low Very Open Shrubland.

CONSERVATION ASSETS

The eight Heritage Agreements are considered to be the primary conservation assets within the Pata Land Unit. All other remnant vegetation is contained within unprotected blocks which are likely to be relatively degraded. The Heritage Agreements are isolated from other blocks, however they are four grouped mallee blocks located in the north-east of the Land Unit close to the Victorian border. These have the potential to maintain some level of quality habitat due to their proximity to similar and larger blocks over the border and to the River Murray.

There are no records of plants or animals of conservation significance from the Pata Land Unit, however the state and regionally Vulnerable Major Mitchell's Cockatoo has been recorded from small mallee patches on the east of the Land Unit close to the border and from the north-west close to the river.

Blue Mallee (*Eucalyptus cyanophylla*) is a species endemic to the South Australian Murraylands region. Much of the association has previously been cleared leaving small pockets scattered throughout the Land Unit. It mainly exists now along road reserves and small remnants on private land. Conservation of the remaining pockets of Blue Mallee is therefore extremely important. Small areas of this vegetation type also occur within the neighbouring Land Units of Holder and Renmark (Payne, pers. comm., 2006).

There are numerous important *Callitris gracilis* remnants of varying condition in this Land Unit that should be considered important for targeted conservation (Simon, pers. comm., 2006).

CONTINUED

PATA

KEY THREATENING PROCESSES

- Fragmentation and isolation of remnants.
- Small remnants—Many of the blocks within the central and north-western regions of the Land Unit are less than five hectares in size.
- Grazing of remnants.
- Feral animals.
- Soil erosion—There are a small number of moderate erosion areas that have been identified in the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003).
- Weed invasion—The major weeds identified for the Land Unit are: African Boxthorn, Athel Pine, Bathurst Burr, Boneseed, Bridal Creeper, Caltrop, Cut-Leaf Mignonette, Dandelion, False Caper, Golden Dodder, Horehound, Innocent Weed, Khaki Weed, Lincoln Weed, Noogoora Burr, Olive, Onion Weed, Perennial Ragweed, Prickly Pear, Salvation Jane, Silver Nightshade, Skeleton Weed, Soursob, Variegated Thistle and Yellow Burr Weed.

CURRENT MANAGEMENT STRATEGIES

Erosion control

There are areas identified for erosion management within the Pata Land Unit by the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003). Small areas east of Wunkar and south of Renmark have been identified as having severe erosion (severe is described as razorbacks, mobile drift, encroachment of erosion site onto neighbouring land, untrafficable by farm machinery, and/or mostly devoid of vegetative cover (MMLAP, 2003)).

RECOMMENDED MANAGEMENT STRATEGIES*

- Protect existing remnants
- buffer existing remnants
- maintain and improve the condition of remnants
- maintain and enhance the condition of roadside and railway reserve vegetation
- control erosion
- manage feral animals
- protect Heritage Agreements and other reserves and remnants.

*See Table 7 (page 51).

PINNAROO

Area—1311 km²
Mean annual rainfall—325 mm
Primary land uses—Cereal cropping and grazing
Remnancy—0.75%

DESCRIPTION

The Pinnaroo Land Unit has been described as 'a gently undulating sandy plain with low parallel dunes and locally, small outcrops of calcrete. There is a grassland cover of cereals and pastures. Sparsely vegetated dune crests stand out in middle and background panoramas over fields and pastures. Remnants of the original vegetation are only found along some roads and the railway, providing local perspective views' (Laut et al., 1977).

The entire Pinnaroo Land Unit within South Australia occurs within the southern portion of the Murray Mallee LAP area, between Ngarkat and Billiatt Conservation Parks. Approximately 0.75% of the native vegetation has been retained, with a portion of that occurring within two Heritage Agreements and the road reserve along the Mallee Highway. The vast majority of the vegetation has been removed to accommodate cereal cropping and pastoral activities and consequently this wide cleared area has resulted in a significant barrier to wildlife movement between the Ngarkat and Billiatt Conservation Parks' High Value Habitat areas.

The remaining tiny remnants scattered across the Land Unit are isolated and likely to be highly degraded from weed invasion and grazing, but given the extreme level of clearance, are all very important. These areas may benefit from revegetation in the form of buffering, however they are highly unlikely to provide valuable habitat for viable populations of wildlife. They may however provide some benefit to common bird and possibly small reptile species.

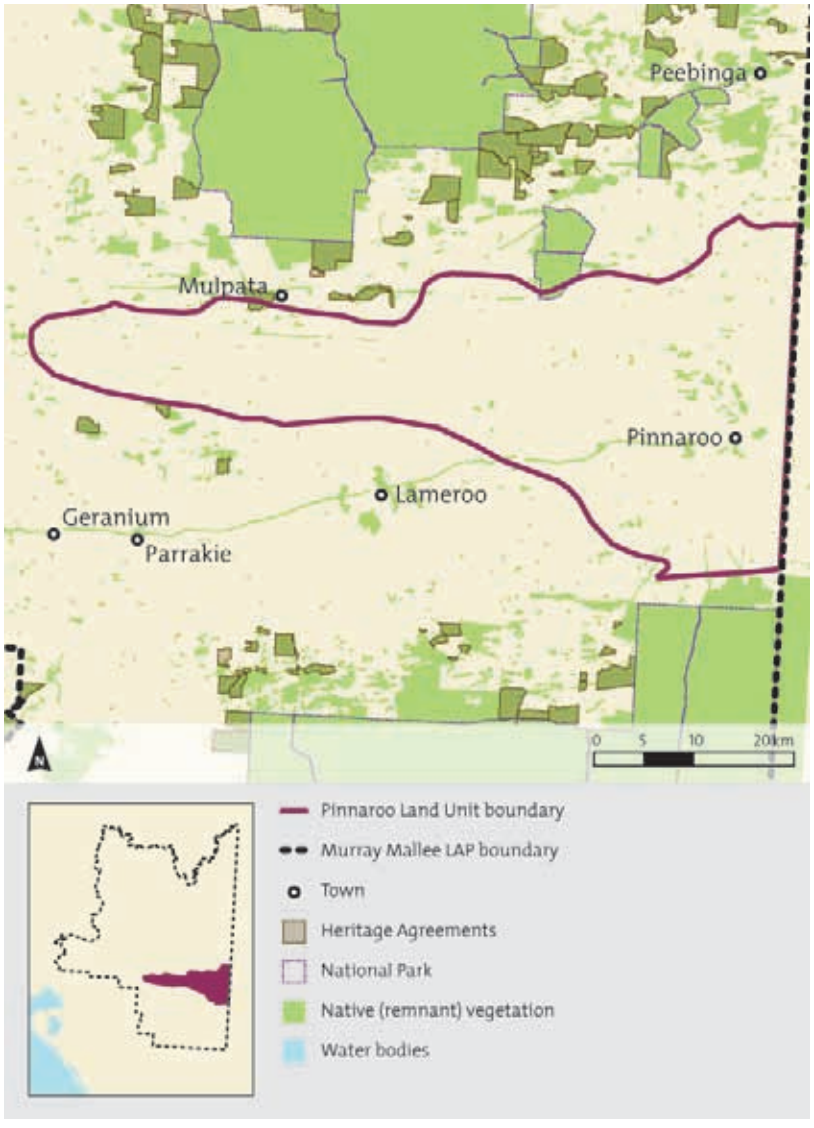

Figure 40: Pinnaroo locality map. Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

CONTINUED

PINNAROO

NATIVE VEGETATION

The broadly defined dominant vegetation types occurring within the Pinnaroo Land Unit include:

- *Eucalyptus dumosa* +/- *Eucalyptus leptophylla* Mallee
- *Eucalyptus incrassata* Open Low Mallee
- *Melaleuca acuminatum*, *Melaleuca lanceolata* +/- *Eucalyptus socialis* +/- *Eucalyptus leptophylla* Tall Open Shrubland
- *Callitris verrucosa* Tall Open Shrubland.

CONSERVATION ASSETS

The two Heritage Agreements located on the boundary of the Pinnaroo Land Unit are considered to be its primary conservation assets. All other remnant vegetation is contained within unprotected blocks which are likely to be severely degraded due to isolation, grazing and weed invasion.

The vegetation contained within the road reserve along the Mallee Highway is one of the last remaining remnants within the Land Unit. The linear shape of a road reserve means that the degrading impacts of weed invasion from the edges (edge effects) results in the condition of the understorey vegetation being compromised. Ongoing weed control is therefore necessary to maintain the biological integrity of the habitat.

There are no records of plants or animals of conservation significance from the Pinnaroo Land Unit.

KEY THREATENING PROCESSES

- Low remnancy—There is very little scope for wildlife movement across the landscape due to the extremely low level of remaining habitat.
- Small remnants—Many of the blocks within the central and north-western regions of the Land Unit are less than one hectare in size.
- Isolation of remnants—The remaining blocks are isolated from all neighbouring blocks, which is likely to generate a significant barrier to the movement of wildlife, particularly small mammals and reptiles. Isolation can inhibit genetic mixing between animals which are unable to move freely between patches and cross-fertilisation between plants.
- Feral animals.
- Grazing of remnants.
- Soil erosion—There are a small number of moderate to severe erosion areas that have been identified in the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003).
- Weed invasion—The major weeds identified for the Land Unit are: African Boxthorn, African Lovegrass, Bathurst Burr, Bladder Campion, Bridal Creeper, Caltrop, Cut-Leaf Mignonette, False Caper, Horehound, Innocent Weed, Khaki Weed, Lincoln Weed, Noogoora Burr, Onion Weed, Prickly Pear, Salvation Jane, Silver Nightshade, Skeleton Weed, Soldier Thistle, Soursob and Yellow Burr Weed.

CURRENT MANAGEMENT STRATEGIES

Erosion control

The typical land types within the Pinnaroo Land Unit which are described as low parallel dunes and undulating sand plains are reported to have slight to moderate sand drift, particularly in the absence of native vegetation (Laut et al., 1977). There are areas identified for erosion management within the Pinnaroo Land Unit by the Murray Mallee Long Term Eroding Land Project (Derby et al., 2003).

Approximately 10–15 small areas south of Parilla have been identified as having moderate erosion and a number of small areas west of Marama are classified as severe (severe is described as razorbacks, mobile drift, encroachment of erosion site onto neighbouring land, untrafficable by farm machinery, and/or mostly devoid of vegetative cover (MMLAP, 2003)). These areas were mapped in 1991 and may have stabilised since then.

RECOMMENDED MANAGEMENT STRATEGIES*

- Buffer existing remnants
- maintain and improve the condition of remnants
- maintain and enhance the condition of roadside and railway reserve vegetation
- control erosion
- manage feral animals
- protect Heritage Agreements and other reserves and remnants.

*See Table 7 (page 51).

RENMARK

Area—612.4 km²
Mean annual rainfall—250 mm
Primary land uses—Horticulture, recreation, grazing
Remnancy—Approximately 56%

Figure 41: Renmark locality map. Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

DESCRIPTION

The Renmark Land Unit has been described as 'the incised ancestral floodplain of the Murray River and adjacent irrigated plains. This association includes a variety of fluvial landforms including discontinuous levees, oxbows, back swamps, lakes and low terraces. Near-vertical cliffs border the old floodplain. Vegetative cover varies from disturbed woodlands and shrublands to orchards and vineyards. Land use includes irrigated horticulture, conservation and water-based recreation. This association has a variety of views' (Laut et al., 1977).

Approximately one third (35%) of the Renmark Land Unit is located within the Murray Mallee LAP area covering of 612 km² along the River Murray Corridor. Approximately half of the vegetation has previously been cleared to make way for a variety of land uses including viticulture, citrus and stone fruit orchards, recreation, tourism and urban development (Kahrimanis et al., 2001). Despite the level of degradation, the corridor habitat, which includes floodplain areas, is still extremely valuable habitat to numerous wildlife species including bats, birds, reptiles, mammals and insects. The declining Brushtail Possum and the nationally Vulnerable Regent Parrot are known from habitats close to the river, where hollow-bearing mature eucalypts provide nesting habitat (Kahrimanis et al., 2001). The eucalypt woodlands along the river corridor have been very susceptible to the altered flows of the river and there is evidence to suggest that the deterioration in flooding patterns has impacted on the both River Red Gum and River Box populations.

In addition, rabbits and stock have heavily grazed and subsequently inhibited natural regeneration in many areas along the river corridor (Kahrimanis et al., 2001).

There are three Heritage Agreements contained within the Land Unit which together make up 202.5 hectares. This represents a very small proportion of the remaining vegetation within this Land Unit.

NATIVE VEGETATION

The broadly defined dominant vegetation types occurring within the Renmark Land Unit include:

- *Eucalyptus camaldulensis* ssp. *camaldulensis* (River Red Gum) Woodland
- *Eucalyptus largiflorens* (River Box) Woodland
- *Eucalyptus cyanophylla* Open Mallee
- *Enchylaena tomentosa* (Ruby Saltbush) Low Shrubland.

CONSERVATION ASSETS

The vegetation along the river corridor is highly degraded and modified, however it is known to provide habitat to a large range of wildlife species. Mature River Red Gums along the corridor often possess a range of hollows suitable for bird species such those listed in Table 6 (see page 29). Other species which are known to utilise this type of riverine and floodplain habitat include the nationally Vulnerable Regent Parrot, the State Vulnerable Bush Stone-curlew, Broad-shelled Tortoise and Southern Bell Frog, the State Threatened Feathertail Glider, the State Rare Striped Honeyeater and Bardick, the regionally significant Major Mitchell's Cockatoo, Brush-tailed Possum, Feather-tail Glider, Yellow-bellied Sheath-tailed Bat, and a range of other common species.

The State Rare Swamp Daisy (*Brachyscome basaltica* ssp. *gracilis*) is recorded from one of the Heritage Agreements located within the Land Unit.

Blue Mallee (*Eucalyptus cyanophylla*) is a species endemic to the South Australian Murraylands region. Much of the association has previously been cleared leaving small pockets scattered throughout the Land Unit. It mainly exists now along road reserves and small remnants on private land. Conservation of the remaining pockets of Blue Mallee is therefore extremely important. Small areas of this vegetation type also occur within the neighbouring Land Units of Holder and Pata (Payne pers. comm, 2006).

CONTINUED

RENMARK

KEY THREATENING PROCESSES

- Grazing of remnant vegetation—Degradation of the understorey species by grazing has modified the composition and structure of many areas along the river corridor. Regeneration of native species is limited or non-existent in areas of heavy grazing, whist the protective nature of species such as the Common Reed (*Phragmites australis*) is compromised, leaving the banks further exposed to erosion (Kahrimanis et al., 2001).
- Erosion along the banks due to heavy utilisation by stock, recreational users and river wave action.
- Feral animals.
- Salinity in the form of local rising saline groundwater.
- Recreational activities continue to degrade the environs within the Renmark Land Unit. The area is extremely popular and subsequently recreational use is intensive. Some of the impacts include erosion of banks due to wave action caused by motor boats, house boat damage to banks, over-collection of firewood, vehicle damage to banks and urban developments.
- Weed invasion—The major weeds identified for the Land Unit are: African Boxthorn, African Lovegrass, Athel Pine, Bathurst Burr, Blackberry, Boneseed, Bridal Creeper, Caltrop, Cut-Leaf Mignonette, False Caper, Fountain Grass, Golden Dodder, Horehound, Innocent Weed, Khaki Weed, Lincoln Weed, Noogoora Burr, Olive, Onion Weed, Prickly Pear, Salvation Jane, Silver Nightshade, Skeleton Weed, Soursob, Variegated Thistle and Yellow Burr Weed.

RECOMMENDED MANAGEMENT STRATEGIES*

- Protect existing remnants
- buffer existing remnants
- create wildlife corridors
- maintain and improve the condition of remnants
- control erosion
- rehabilitate degraded areas
- retain wildlife habitat.

*See Table 7 (page 51).

THE BIG DESERT

Area—2461 km²
Mean annual rainfall—350–400 mm
Primary land uses—Conservation and grazing
Remnancy—73.6%

DESCRIPTION

The Big Desert Land Unit has been described as 'an undulating plain on calcrete with a cover of aeolian sand sheets and dunes. Although the natural vegetation of mallee and heath has been disturbed by fire, very little has been cleared for grazing, and the area is mainly in conservation areas or remains as vacant crown land' (Laut et al., 1977).

A large proportion of The Big Desert Land Unit occurs within the southern end of the Murray Mallee LAP area. In stark contrast to many of the other Land Units across the region, The Big Desert has 73.6% of its original vegetation remaining and approximately 93% (or 168 951.8 hectares) of that vegetation is protected within the reserve system. The protected areas are made up of Ngarkat and Scorpion Springs Conservation Parks and 39 Heritage Agreements. These areas constitute the largest remaining tracts of native vegetation within the Murray Mallee LAP area and are considered extremely important for the conservation of many populations of plants and animals. Together with numerous unprotected remnants, the area is identified as a High Value Habitat area and forms a stronghold for many populations of native plants and animals, some of which are of conservation significance.

There is also enormous potential for connection of the unprotected remnant blocks with revegetated wildlife corridors, and buffering. Restoration of remnants through weed and feral animal control is also recommended in The Big Desert Land Unit where wildlife concentration is higher than many other areas and frequent movement between remnants is likely to be considerable.

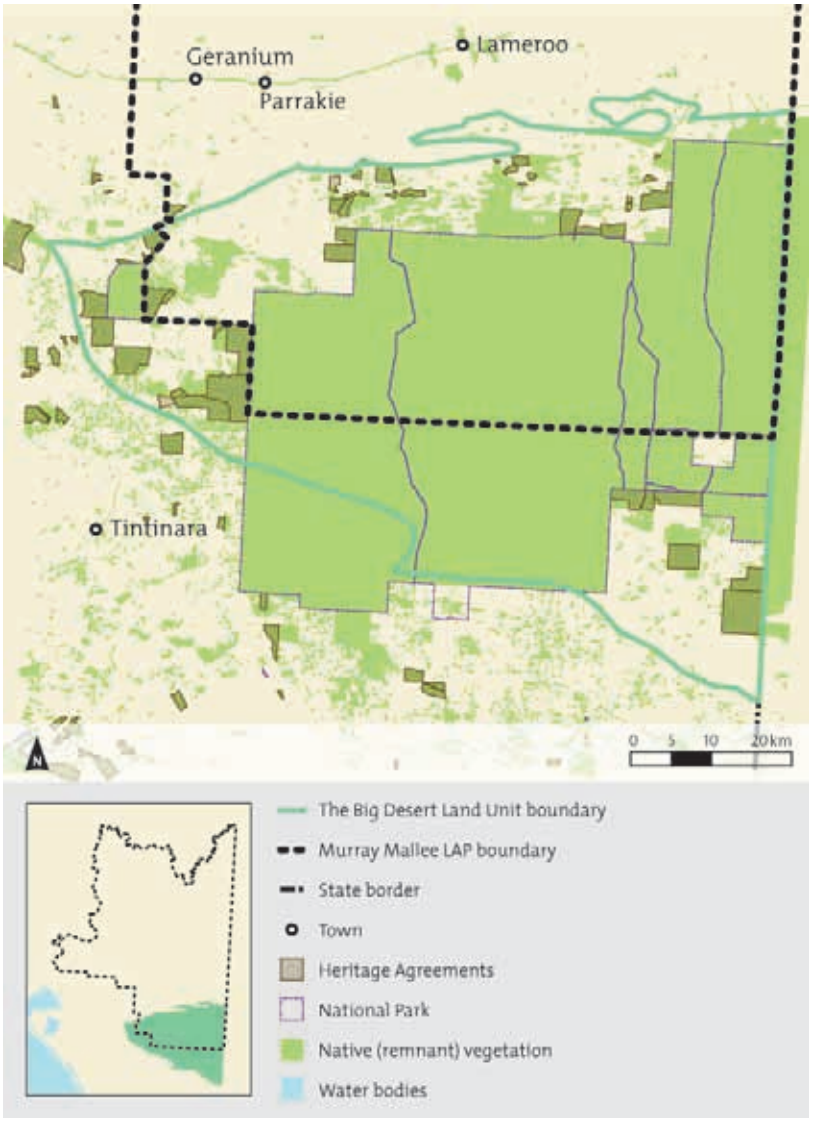

Figure 42: The Big Desert locality map. Map illustration: Ecocreative (based on GIS map supplied by Andy Saulys, DEH)

CONTINUED

THE BIG DESERT

NATIVE VEGETATION

The broadly defined dominant vegetation types occurring within The Big Desert Land Unit include:

- *Eucalyptus incrassata* Open Low Mallee
- *Banksia ornata +/- Allocasuarina pusilla/ Leptospermum coriaceum* Tall Open Shrubland
- *Eucalyptus leptophylla /Eucalyptus socialis* Open Mallee
- *Callitris verrucosa* Tall Open Shrubland
- *Melaleuca acuminatum, Melaleuca lanceolata +/- Eucalyptus socialis +/- Eucalyptus leptophylla* Tall Open Shrubland
- *Allocasuarina luehmannii* (Buloke) Woodland
- *Eucalyptus arenacea* (Sand Stringybark) Open Woodland
- *Eucalyptus leucoxylon* ssp. *stephaniae* (Scrubby Bluegum) Low Woodland.

CONSERVATION ASSETS

The Big Desert Land Unit possesses a number of important features which contribute to its overall conservation significance. The levels of native vegetation retained within the area are high compared with that of many other Land Units across the Murray Mallee LAP area and a large proportion of that vegetation is afforded the protection of the Conservation Parks and 37 Heritage Agreements. Collectively, these areas provide excellent habitat for many native species populations including a high number of those listed as nationally, State and regionally threatened. Ratings are abbreviated to Rare (R), Vulnerable (V) and Known (K).

Species of conservation significance:

Flora

- Sundew (*Drosera whittakeri* ssp. *aberrans*), SA: R, MM: K
- Cleland's Beard-heath (*Leucopogon clelandii*), SA: R, MM: E
- Fringed Heath-myrtle (*Micromyrtus ciliata*), SA: R, MM: R
- Scaly Haeckeria (*Ozothamnus pholidotus*), SA: V, MM: E
- Lowan Phebalium (*Phebalium lowanense*), Aust: V, SA: V, MM: V
- Narrow-leaf Wax-flower (*Philotheca angustifolia* ssp. *angustifolia*), SA: R, MM: R.

Fauna

- Bardick (*Echiopsis curta*), SA: R, MM: R
- Blue-winged Parrot (*Neophema chrysostoma*), SA: V, MM: V
- Chestnut Quail-thrush (*Cinclosoma castanotus*), SA: R, MM: V
- Mallee Emu-wren (*Stipiturus mallee*), Aust: V, SA: V, MM: V
- Malleefowl (*Leipoa ocellata*), Aust: V, SA: V, MM: V
- Painted Button-quail (*Turnix varia*),
- Red-lored Whistler (*Pachycephala rufogularis*), Aust: V, SA: V, MM: V
- Slender-billed Thornbill (*Acanthiza iredalei*), SA: V, MM: V
- Striated Grasswren (*Amytornis striatus*), SA: R, MM: V
- Striped Honeyeater (*Plectorhyncha lanceolata*), SA: R, MM: V
- Western Whipbird (*Psophodes nigrogularis leucogaster*), Aust: V, SA: V, MM: V
- Yellow-tailed Black-Cockatoo (*Calyptorhynchus funereus*), SA: V, MM: V.

Some additional species of significance identified in the *Biodiversity Plan for the SAMDB* as also inhabiting the area are:

- Western Pygmy-possum
- Southern Ningaui
- Elegant Parrot
- Gilbert's Whistler
- Yellow-tailed Black-Cockatoo
- Striated Grasswren
- Common Dunnart
- Fat-tailed Dunnart
- Silky Mouse
- Mitchell's Hopping-mouse (Kahrimanis et al., 2001).

KEY THREATENING PROCESSES

- Grazing of remnants.
- Feral animals.
- Small remnants—Many of the blocks situated to the north of Ngarkat CP are very small).
- Soil erosion—Degradation of vegetation by vehicles can expose sandy soils to erosive forces, particularly wind.
- Inappropriate fire regimes.
- Weed invasion—The major weeds identified for the Land Unit are: African Boxthorn, African Lovegrass, Blackberry, Bridal Creeper, Caltrop, Cut-Leaf Mignonette, False Caper, Horehound, Innocent Weed, Onion Weed, Silver Nightshade, Skeleton Weed, Soldier Thistle, Soursob and Yellow Burr Weed.

CURRENT MANAGEMENT STRATEGIES

Revegetation

The Murray Mallee Long Term Eroding Land Project (MMLAP, 2003) has mapped a number of revegetation areas within the western end of the Land Unit up until 2001. The revegetation is likely to vary between blocks and windbreaks (Pfeiffer, pers. comm., 2005).

Feral animal control

A goat control program, which is proposed for the Ngarkat CP, will be postponed in the short term due to the recent fire in the park (Crawford, pers. comm., 2006). Fox baiting programs are conducted quarterly (February, May, August and November). Rabbits are baited with 1080 oats and warren destruction is achieved with explosives (Laver, pers. comm., 2005).

Weed control

Biological controls include Rust fungus (*Puccinia myrsiphylli*) released for Bridal Creeper, Crown Boring Weevil released for Salvation Jane (Laver, pers. comm., 2005) and Horehound Plume moth for Horehound (Clifford, pers. comm., 2006).

RECOMMENDED MANAGEMENT STRATEGIES*

- Maintain and improve the condition of remnants
- control erosion
- manage feral animals
- protect Heritage Agreements and other reserves and remnants.

*See Table 7 (page 51).

Photograph: Ben Simon / MMLAP

Regional Contacts

Regional Contacts

MURRAY MALLEE LOCAL ACTION PLANNING ASSOCIATION INC.
www.lm.net.au/~murraymalleelap
PO Box 2056 Murray Bridge SA 5253
Telephone (08) 8531 2066
Facsimile (08) 8532 5300
Mobile 040 718 9907

NRM & GOVERNMENT

DEPARTMENT FOR ENVIRONMENT AND HERITAGE (DEH)

Berri office
PO Box 231 Berri SA 5343
Telephone (08) 8595 2111
Facsimile (08) 8595 2110
Bush Management Advisor
Telephone (08) 8595 2174
Mobile 0427 604 254
Regional Ecologist
Telephone (08) 8595 2204

Lameroo Office (Murraylands)
74 Railway Terrace
PO Box 168 Lameroo SA 5302
Telephone (08) 8576 3690
Facsimile (08) 8576 3685

DEH NATIONAL PARKS AND WILDLIFE
District Ranger Mobile 0419 815 046
Senior Ranger Mobile 0419 815 046
Fire management officer Telephone (08) 8595 2172
Regional investigator Mobile 0427 012 576
(to report suspect vegetation clearances and wildlife offences)

NATIVE VEGETATION COUNCIL
GPO Box 2834 Adelaide SA 5001
Telephone (08) 8124 4700
Facsimile (08) 8124 4745

SOUTH AUSTRALIAN MURRAY-DARLING BASIN NATURAL RESOURCES MANAGEMENT BOARD (SAMDB NRM BOARD)
For animal and plant control, contact the SAMDB NRM Board for details of regional Authorised Officers for the Riverland, Mallee and Coorong and Eastern Mount Lofty sub-regions.

Murray Bridge office
PO Box 2343 Murray Bridge SA 5253
Phone: (08) 8532 1432
Facsimile: (08) 8532 5300

Berri office
PO Box 1374 Berri SA 5343
Telephone (08) 8582 4477
Facsimile (08) 8582 4488

LOCAL GOVERNMENT

District Council of Karoonda East Murray
11 Railway Terrace
PO Box 58 Karoonda SA 5307
Telephone (08) 8578 1004
Facsimile (08) 8578 1246
Email council@dckem.sa.gov.au

District Council of Loxton Waikerie
29 East Terrace
PO Box 409 Loxton SA 5333
Telephone (08) 8584 8000
Facsimile (08) 8584 6622
Email council@loxtonwaikerie.sa.gov.au

Mid Murray Council
49 Adelaide Road
PO Box 28 Mannum SA 5238
Telephone (08) 8569 0100
Facsimile (08) 8569 1931
Email postbox@mid-murray.sa.gov.au

Rural City of Murray Bridge
PO Box 421 Murray Bridge SA 5253
Telephone (08) 8539 1100
Facsimile (08) 8532 2766
Email feedback@rcmb.sa.gov.au

Southern Mallee District Council
Pinnaroo office
Day St Pinnaroo SA 5304
Telephone (08) 8577 8002
Facsimile (08) 8577 8443
Email council@southernmallee.sa.gov.au
Lameroo office
Railway Terrace North Lameroo SA 5302
Telephone (08) 8576 3002
Facsimile (08) 8576 3205

SOUTH AUSTRALIAN FARMERS FEDERATION (SAFF) NATURAL RESOURCES
Nigel Long
Telephone (08) 8100 8714
Email nlong@saff.com.au
Sarah Morgan
Telephone (08) 8100 8727
Email smorgan@saff.com.au

TRANSPORT SA
Environmental Operations Unit
(significant roadside sites)
Telephone (08) 8343 2027

WILDLIFE, CONSERVATION & LAND MANAGEMENT

CONSERVATION VOLUNTEERS AUSTRALIA
130 Franklin St Adelaide SA 5000
Telephone (08) 8212 0777

GREENING AUSTRALIA
5 Fitzgerald Road
Pasadena, SA 5042
Telephone (08) 8372 0120
Facsimile (08) 8372 0199

MALLEEFOWL MONITORING
Contact DEH Berri office

MALLEE SUSTAINABLE FARMING
PO Box 5093 Mildura Vic 3502
Telephone (03) 5021 9105
www.msfp.org.au

MANTUNG–MAGGEA LAND MANAGEMENT GROUP
Mick Evans
Chairperson
Telephone (08) 8589 7041

NATURE CONSERVATION SOCIETY OF SA
120 Wakefield St Adelaide SA 5000
Telephone (08) 8223 6301

REVEGETATION CONTRACTORS
Contact the MMLAP Association for full list.

RURAL SOLUTIONS SA
Revegetation consultants
Telephone (08) 8535 6400

THREATENED SPECIES NETWORK
120 Wakefield St Adelaide SA 5000
Telephone (08) 8223 5155

TREES FOR LIFE
5 Fitzgerald Road
Pasadena SA 5042
Telephone (08) 8372 0150
Facsimile (08) 88372 0199

WANBI LAND MANAGEMENT GROUP
Chairperson Telephone (08) 8578 7018
Secretary Telephone (08) 8578 6066

Photograph: Ben Simon / MMLAP

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Photograph: Ben Simon / MMLAP

Appendices

1. WEED SPECIES AND ASSOCIATED MANAGEMENT TECHNIQUES WITHIN THE MMLAP AREA

2. METHODS OF WEED CONTROL (BROAD METHODOLOGIES OF WEED REMOVAL)

3. PLANT LISTS FOR TYPICAL VEGETATION COMMUNITIES WITHIN THE MMLAP AREA

4. METHODS OF FERAL ANIMAL CONTROL AND MONITORING OF EFFECTIVENESS

5. CONSERVATION RATINGS AND PRIORITIES

APPENDIX 1: WEED SPECIES AND MANAGEMENT TECHNIQUES WITHIN THE MMLAP AREA

Where 'suggested control methods' recommend 'spraying', seek technical advice from the SAMDB NRM Board Authorised Officers (see Regional Contacts, page 87). Mowing is usually adopted to induce fresh growth and absorption of herbicides. The removal of immature seeds can reduce seed setting and dispersal over time.

Refer also to Appendix 2: Methods of weed control (broad methodologies of weed removal).

Table 8: Weed species and management techniques within the MMLAP area

Common Name, *Scientific name*	Declared†	Suggested control method	Timing
African Boxthorn, *Lycium ferocissimum*	Yes	Spray	Autumn/winter/early spring, before flowering while actively growing.
		Foliar application (Feb–May).	
		Cut and swab basal bark (may require re-treatment).	
		Only mow whilst seedlings.[1]	
African Lovegrass, *Eragrostis curvula*	Yes	Spray.	Spring, prior to flowering and seed set.
		Can use fire as a tool to control.	
		Mow at any time except in seed.[2]	
Aleppo Pine, *Pinus halepensis*	Yes	Cut and swab mature trees. Ringbark if unable to fell.	Cut mature trees anytime.
		Pull or spot–spray young seedlings. Follow up.[1]	
Boneseed, *Chrysanthemoides monilifera*	Yes	Hand-pull smaller bushes and seedlings.	Spring, prior to flowering.
		Do not mow or grade seedlings in native vegetation.	
		Spray.	
		Cut and swab larger bushes immediately.	
		Follow up all treatments.[2]	
Branched Broomrape, *Orobanche ramosa*	Yes	All infestations must be reported to the Branched Broomrape Control Hotline (1800 245 704) and SAMDB NRM Board Authorised Officers*.	Early spring after germination and host attachment and prior to flowering.
		Do not mow, grade, walk or drive over infestation.	
		Decontaminate footwear and vehicle tyres that have contacted infestation.	
		Spray.	
Bridal Creeper, *Asparagus asparagoides*	Yes	Spray.	Winter, before or during flowering, before seeds set and fruits form.
		Mowing ineffective.	
		Do not grade.	
		Grub small isolated patches first.	
		Integrating herbicide, biological control and revegetation with native grasses is most effective.[1]	
Broad-leaf Cotton-bush, *Asclepias rotundifolia*	No	Seek control information from SAMDB NRM Board Authorised Officers*.	

Table 8: Weed species and management techniques within the MMLAP area			
Common Name, *Scientific name*	**Declared†**	**Suggested control method**	**Timing**
Caltrop, *Tribulus terrestris*	Yes	Spray with non-selective, selective or residual herbicide.	Spring or summer as immature plant or prior to flowering.
		Do not grade or mow.[2]	
Common Heliotrope, *Heliotropium europaeum*	No	Seek control information from SAMDB NRM Board Authorised Officers*.	
Common Iceplant, *Mesembryanthemum crystallinum*	No	Seek control information from SAMDB NRM Board Authorised Officers*.	
False Caper, *Euphorbia terracina*	Yes	Spray.	Winter to early spring prior to flowering
		Grade, but do not mow.[2]	
Fountain Grass, *Pennisetum setaceum*	Yes	Cut and remove top growth, spray regrowth.	Spring/early summer, before rhizome growth and flowering.
		Do not mow or grade.	
		Control outbreaks from large infestations as soon as possible.[2]	
Galenia	No	Spray, or cut and swab.	
Gazania	No	Seek control information from SAMDB NRM Board Authorised Officers*.	
Golden Dodder, *Cuscuta campestris*	Yes	All infestations must be reported to SAMDB NRM Board Authorised Officers*.	Most effective prior to flowering and seed set. Germination can occur from August to March, and flowering begins within two weeks.
		Spray followed by burning.	
		Do not grade, slash or cut stems (they will attach to new hosts).	
		Follow up treatments as necessary.[2]	
Horehound, *Marrubium vulgare*	Yes	Spray.	Autumn and spring as immature plant prior to flowering.
		Mow or grade.	
		Follow-up treatments necessary.[2]	
		Biological Control Program (Horehound Plume Moth, *Pterophorus spilodactylus*, released in 1994 and the Horehound Clearwing Moth, *Chamaesphecia mysiniformis*, released in 1997).[3]	
Innocent Weed, *Cenchrus incertus / longispinus*	Yes	Spray.	Spring to early summer as immature plant prior to flowering.
		Burn with diesel.	
		Hand pull effective for small areas.	
		May require follow-up treatments.[2]	
Match-head Plant, *Psilocaulon tenue*	No	Seek control information from SAMDB NRM Board Authorised Officers*.	
Olive, *Olea europaea*	Yes	Pull or grub seedlings in winter. Spray. Cut stems of mature plants close to ground, frill bark at root stem junction and swab immediately. Annual follow-up.[1]	Spraying and mechanical control in early spring, before flowering. Cut and swab any time.
Onion Weed, *Asphodelus fistulosus*	Yes (only in Mid-Murray Council)	Spray.	Spring and summer, as an immature plant before flowering.
		Mow, do not grade.	
		Does not compete well with native perennial species, revegetation with suitable plants can be incorporated into an integrated management program.[2]	

>> table continued overleaf >>

APPENDIX 1: WEED SPECIES AND MANAGEMENT TECHNIQUES WITHIN THE MMLAP AREA

<< table continued from previous page <<

Table 8: Weed species and management techniques within the MMLAP area

Common Name, *Scientific name*	Declared†	Suggested control method	Timing
Perennial Veldt Grass		Pull or grub young plants prior to seeding to rhizome formation. Grub or spot spray tussocks.[1]	Prior to October–November.
Prickly Pear, *Opuntia* sp.	Yes	Spray.	Early spring, prior to flowering.
		Mechanical control with annual follow-up. Cactoblastis or Cochineal insects may be used to thin infestations.[2]	
Red Eyed Wattle, *Acacia cyclops*		Cut and swab with recommended herbicide.	Prior to seeding in early summer.
Rhodes Grass, *Chloris gayana*		For most recent control techniques seek advice from SAMDB NRM Board Authorised Officers* on chemical use.	
Sage, *Salvia* sp.		Seek control information from SAMDB NRM Board Authorised Officers*.	
Salvation Jane, *Echium plantagineum*	Yes	Spray.	Autumn and winter, prior to stem growth and flowering.
		Follow-up treatment necessary. Mow or grade.[2]	
Scabious, *Scabiosa atropurpurea*		Spray.	Autumn and winter prior to flowering.
Silver Nightshade, *Solanum elaeagnifolium*	Yes	Spray.	Autumn and spring as immature plant prior to flowering.
		Do not mow or grade.[2]	
Smooth Mustard, *Sisymbrium erysimoides*		Seek control information from SAMDB NRM Board Authorised Officers*.	
Soursob, *Oxalis pes-caprae*	Yes	Spray. Mow but do not grade.[2]	Autumn to early winter, after tuber is depleted, prior to formation of new bulbils, during flowering.
Tree Tobacco, *Nicotiana glauca*		Seek control information from SAMDB NRM Board Authorised Officers*.	
Ward's Weed, *Carrichtera annua*		Seek control information from SAMDB NRM Board Authorised Officers*.	
Wild Artichoke, *Cynara cardunculus*	Yes	Integrated strategy including chemicals, mechanical removal, slashing for long-term control. Remove taproot to prevent regrowth. Mow before flowering. Do not grade.[2]	Spring, prior to flowering.
Wild Turnip, *Brassica tournefortii*		Seek control information from SAMDB NRM Board Authorised Officers*.	
Yellow Burr weed, *Amsinckia* ssp.	Yes	Spray.	Late autumn and winter as rosette or immature plant prior to flowering and seed set.
		Mow or grade.[2]	
		Notify SAMDB NRM Board Authorised Officers*.	
		May need repeat treatments.	

* SAMDB NRM Board Authorised Officers perform the same duties as former Animal and Plant Control Officers (see Regional Contacts, page 87).

†Weed is declared under the *NRM Act 2004*.

Control methods obtained from the following sources:
[1] Robertson (1994)
[2] Transport SA (2004)
[3] CSIRO Australia (1997).

APPENDIX 2: METHODS OF WEED CONTROL (BROAD METHODOLOGIES OF WEED REMOVAL)

It is recommended that the following methods should be used as a guide only and that prior to implementing a weed control program, you seek technical advice and assistance from the SAMDB NRM Board Authorised Officers (former Animal and Plant Control Officers). This is particularly important with respect to chemical use.

There are a variety of weed control methods that can be utilised to effectively control different weed species. Some weed control methods include cutting and swabbing, stump injection, drilling and filling, spot spraying and hand pulling. Suggested methods of control can be obtained from Appendix 1.

CUT AND SWAB

Cut off all stems as low as possible using a chainsaw or pruning saw, secateurs or long-handled loppers. The cut must be horizontal so that the herbicide rests on the cut area while being absorbed, rather than running down the side of the stem.

Liberally swab all cut surfaces *immediately* with a herbicide mixture. This must be done within half a minute as the cut surface cannot be allowed to dry out, otherwise the herbicide will be much less effective. Use a paintbrush, swabber or squeeze bottle (laboratory) to apply the herbicide mixture. Add a dye to the herbicide mixture that will help indicate where swabbing has already been done.

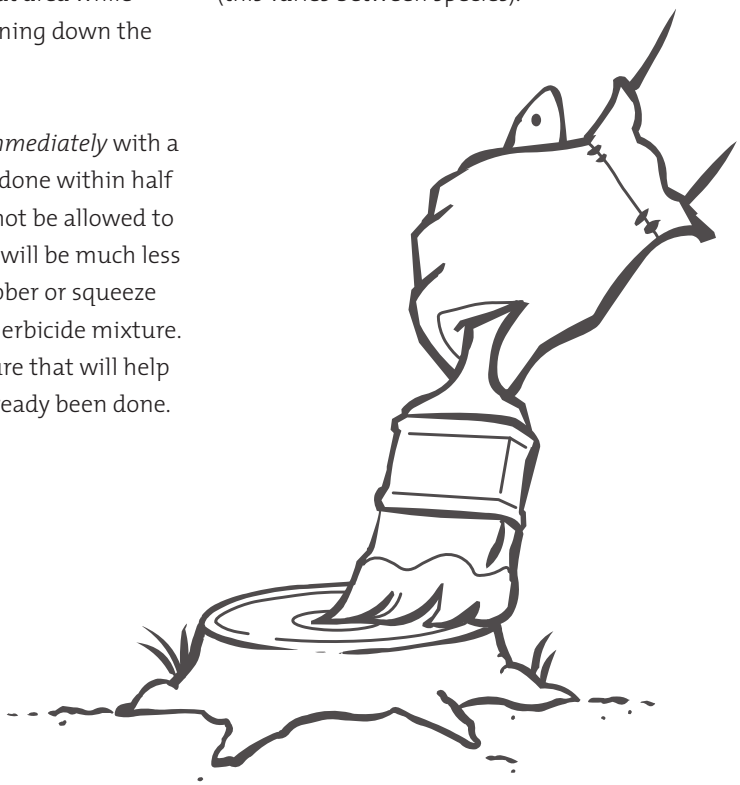
Stumps will be left in the ground so as to not disturb the soil and reduce the likelihood of soil erosion.

Remove all stems from the stump, so that no active (or green) branches/shoots remain, no matter how small they are.

The tissues that take up and move the poison are immediately under the bark layer, so concentrate on applying the poison around the outer rim of the stump.

Follow-up work may be required. If the stumps re-sprout, which can be common with some species, then cut and swab or spray the new regrowth with the herbicide.

The most effective time of the year to cut and swab plants is when they are actively growing (this varies between species).

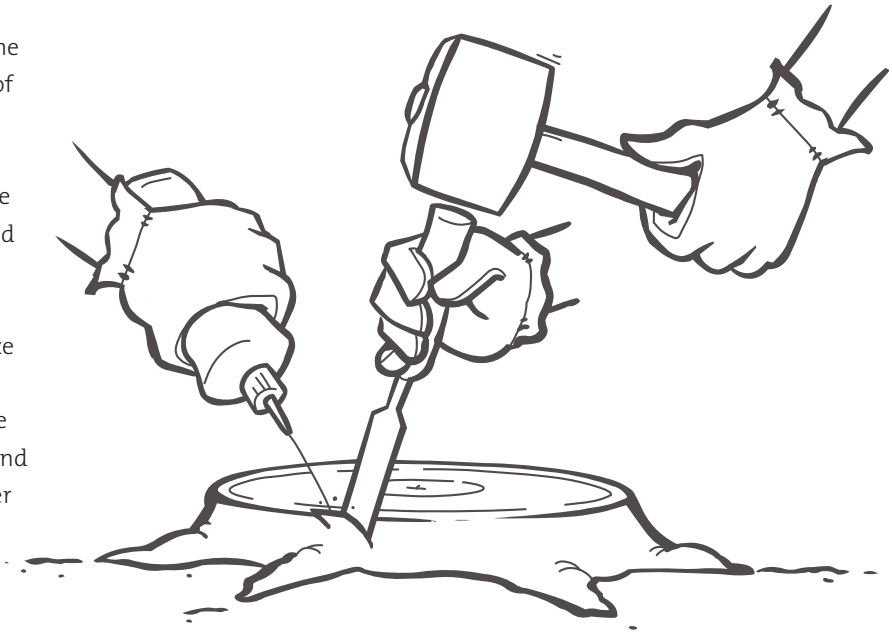


Weed control illustrations by Ecocreative.

STUMP INJECTION

For large and medium-sized trees and shrubs with a large stump or lignotuber the following 'stump injection' method is recommended. It can be used in conjunction with the cut and swab method to get a higher dose of herbicide into the plant, and to get a more thorough application of herbicide.

After the plant has been cut and swabbed, make regular extra cuts into the remaining stump and any exposed roots with a hammer and chisel to expose the sapwood. *Immediately* fill the chisel marks with the herbicide mixture in the squeeze bottle. This provides more surface area for the herbicide to penetrate, and ensures a good dose is administered. Used in conjunction with cut and swab, this method should provide a much better kill rate when compared to the cut and swab method by itself.



DRILL AND FILL

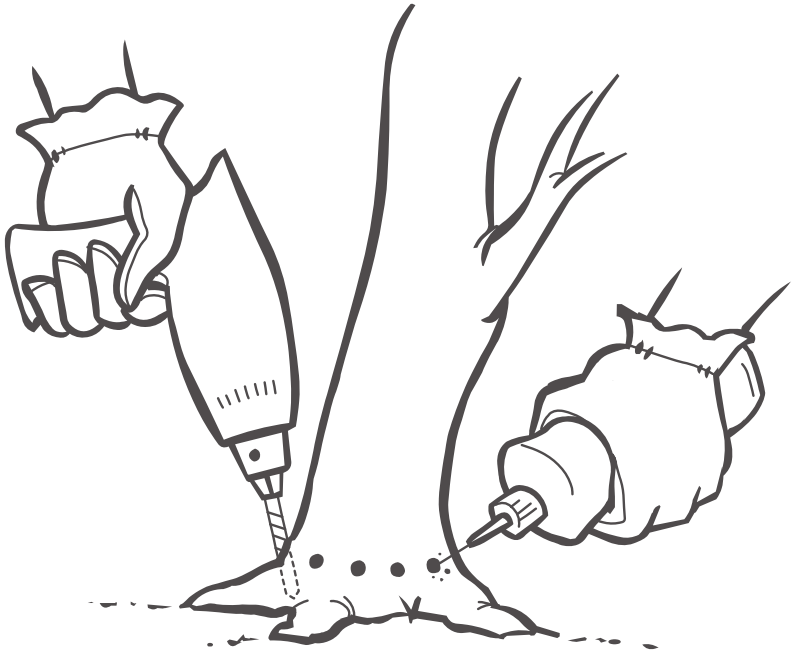
Drill a steeply angled hole into the plant's cambium layer (where sap flows just beneath the bark layer) with a cordless drill, using a 10 mm drill-bit.

The holes should be as close to the base of the plant as possible, and it is essential for the hole to be steeply angled otherwise the herbicide will not be absorbed into the sap flow.

Immediately after the hole has been drilled, it should be filled with concentrated herbicide. Syringes (without the needle) or squeeze bottles can be used to administer the herbicide.

Drill holes every 2.5–5 cm until the base of the plant has been encircled.

Follow-up work may be required. If the plant resprouts, which can be common with some species, then the process needs to be repeated.



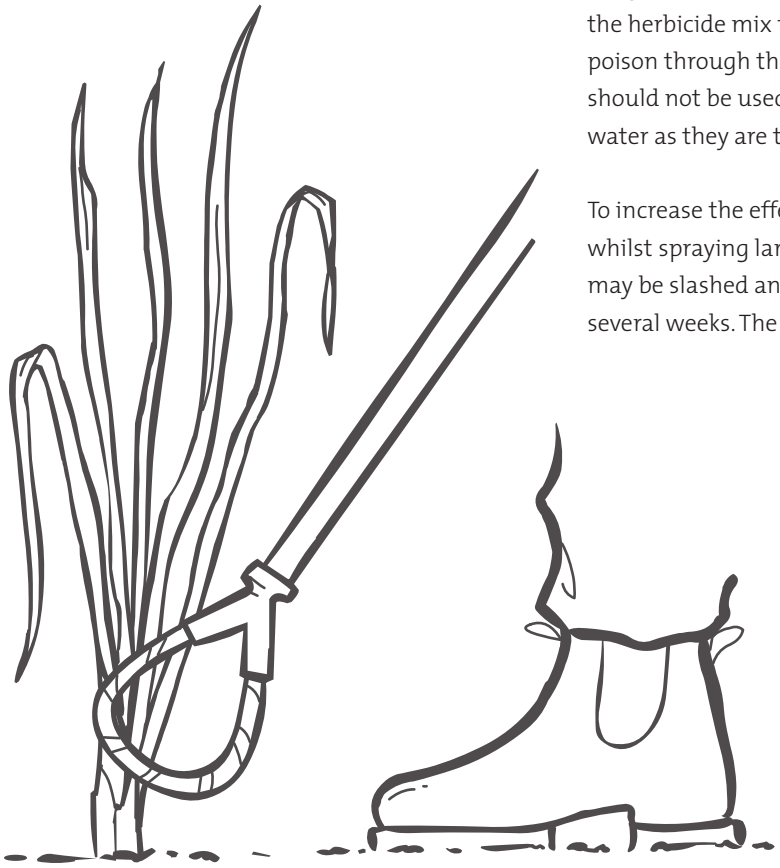
APPENDIX 2: METHODS OF WEED CONTROL (BROAD METHODOLOGIES OF WEED REMOVAL)

SPRAYING AND WICK WIPERS

The most effective time of the year to spray is when the plant is actively growing.

Look for native plants and cover them with plastic bags or sheeting while spraying. If there are too many native plants amongst the weeds then the spray method should not be used.

Where weeds have narrow vertical leaves, spraying might result in herbicide running off or drifting onto non-target plants. In this situation, wipe on the herbicide mixture with a weed wand, sponge or wick applicator.



Always read the label on the herbicide container, follow the instructions and wear protective clothing. Dilute the mixture as recommended. Add a dye to the herbicide mixture that will help to indicate where spraying has already been done. If spraying near creeks or other water bodies, do not spray herbicide in or near the water, because it can have a negative effect on aquatic fauna such as frogs. It is preferable to use other more accurate methods such as cutting and swabbing along creeklines.

Surfactants can also be used when spraying plants such as Bridal Creeper which have a waxy leaf surface. A surfactant can be added to the herbicide mix to increase the uptake of the poison through the waxy leaf surface. Surfactants should not be used on or near plants growing in water as they are thought to affect frogs.

To increase the effectiveness of the herbicide whilst spraying large tussocks of grass, the grass may be slashed and then left to re-grow for several weeks. The regrowth can then be sprayed.

HAND PULLING

Pulling seedlings and smaller plants out by hand is easiest in the wetter months of the year when the soil is soft.

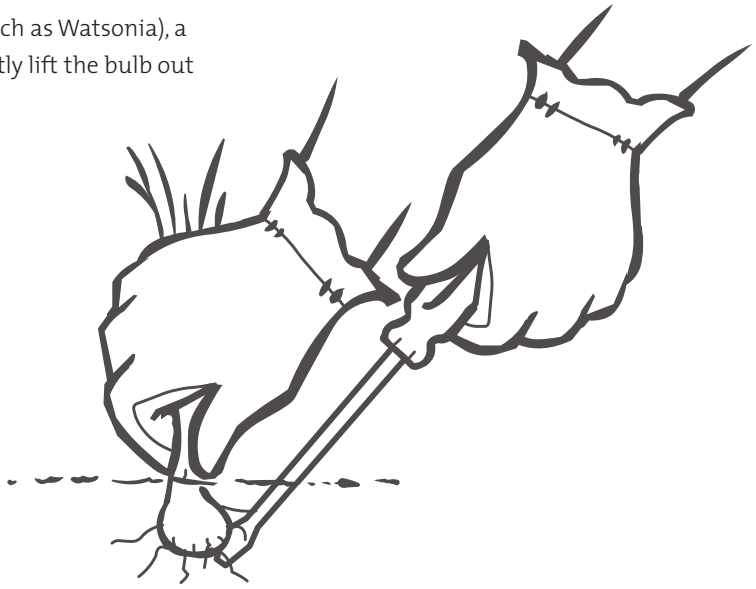
If the weed is a seedling, take hold of the plant at ground level and pull. If you pull at any point higher on the stem it may break and the plant will then require swabbing with herbicide.

If the weed is a small woody plant, take hold of the stem at ground level and gently rock the plant back and forth until it comes away cleanly.

For species that have a bulb (such as Watsonia), a screwdriver can be used to gently lift the bulb out of the ground.

If possible, place both feet or fingers on either side of the plant when pulling out. This helps to keep the soil in place and avoids unnecessary disturbance of the soil.

Following treatment of most weed varieties there are often seeds left in the soil or root material which can rapidly resprout. An essential component of any successful weed control program is follow-up work.



APPENDIX 3: PLANT LISTS FOR TYPICAL VEGETATION COMMUNITIES WITHIN THE MMLAP AREA

Vegetation lists have been sourced from *A Biological Survey of the South Australian Murray Mallee* (2000). There are 21 species lists representing a range of broad vegetation associations and threatened associations mapped across the region. As there are many variations within the broadly defined communities, the lists are a guide only. They should not be used to design revegetation projects. It is recommended that advice be sought from the DEH Bush Management Advisor or Murray Mallee Local Action Planning Association. See Regional Contacts (page 87).

Photograph: Chris Obst

Callitris gracilis (Southern Cypress Pine) Low Open Woodland

- *Allocasuarina luehmannii*, Bull Oak
- *Callitris gracilis*, Southern Cypress Pine
- *Danthonia* sp., Wallaby-grass
- *Dodonaea viscosa* ssp. *angustissima*, Narrow-leaf Hop-bush
- *Einadia nutans*, Climbing Saltbush
- *Enchylaena tomentosa* ssp. *tomentosa*, Ruby Saltbush
- *Sclerolaena diacantha*, Grey Bindyi
- *Senecio lautus*, Variable Groundsel
- *Senna artemisioides*, Desert Senna
- *Stipa elegantissima*, Feather Spear-grass
- *Stipa* sp., Spear-grass
- *Vittadinia dissecta* ssp. *hirta*, Dissected New Holland Daisy.

Photograph: Tonia Brown

Stipa sp. (Spear Grass) Open Tussock Grassland

- *Callitris preissii*, Southern Cypress Pine
- *Danthonia* sp., Wallaby-grass
- *Dodonaea viscosa* ssp. *angustissima*, Narrow-leaf Hop-bush
- *Enchylaena tomentosa* ssp. *tomentosa*, Ruby Saltbush
- *Sclerolaena diacantha*, Grey Bindyi
- *Sclerolaena obliquicuspis*, Oblique-spined Bindyi
- *Stipa* sp., Spear-grass
- *Vittadinia dissecta* ssp. *hirta*, Dissected New Holland Daisy
- *Zygophyllum ammophilum*, Sand Twinleaf.

Photograph: Todd Berkinshaw

Maireana sedifolia (Pearl Bluebush) / *Maireana pyramidata* (Blackbush) Very Open Shrubland

- *Acacia nyssophylla,* Spine Bush
- *Alectryon oleifolius* ssp. *canescens,* Bullock Bush
- *Atriplex stipitata,* Bitter Saltbush
- *Atriplex vesicaria,* Bladder Saltbush
- *Dissocarpus paradoxus,* Ball Bindyi
- *Enchylaena tomentosa* ssp. *tomentosa,* Ruby Saltbush
- *Eriochiton sclerolaenoides,* Woolly-fruit Bluebush
- *Ixiolaena leptolepis,* Narrow Plover-daisy
- *Lawrencia squamata,* Thorny Lawrencia
- *Maireana pyramidata,* Black Bluebush
- *Maireana sedifolia,* Bluebush
- *Maireana turbinata,* Top-fruit Bluebush
- *Myoporum platycarpum,* False Sandalwood
- *Rhagodia spinescens,* Spiny Saltbush
- *Rhagodia ulicina*, Intricate Saltbush
- *Sclerolaena diacantha/uniflora,* Grey Bindyi
- *Sclerolaena obliquicuspis,* Oblique-spined Bindyi
- *Sclerolaena patenticuspis,* Spear-fruit Bindyi
- *Stipa* sp., Spear-grass
- *Zygophyllum ammophilum,* Sand Twinleaf
- *Zygophyllum aurantiacum,* Soap Bush
- *Zygophyllum crenatum,* Notched Twinleaf.

Photograph: Chris Obst

Eucalyptus gracilis (Yorrell) / *Eucalyptus oleosa* (Red Mallee) Very Open Mallee

- *Beyeria opaca*, Dark Turpentine Bush
- *Chenopodium desertorum*, Desert Goosefoot
- *Enchylaena tomentosa* ssp. *tomentosa,* Ruby Saltbush
- *Eucalyptus dumosa*, White Mallee
- *Eucalyptus gracilis*, Yorrell
- *Eucalyptus oleosa*, Red Mallee
- *Maireana pentatropis*, Erect Mallee Bluebush
- *Sclerolaena diacantha/uniflora,* Grey Bindyi
- *Stipa elegantissima*, Feather Spear-grass
- *Stipa* sp., Spear-grass
- *Westringia rigida*, Stiff Westringia
- *Zygophyllum apiculatum*, Pointed Twinleaf
- *Zygophyllum aurantiacum,* Soap Bush.

APPENDIX 3: PLANT LISTS FOR TYPICAL VEGETATION COMMUNITIES WITHIN THE MMLAP AREA

Photograph: MMLAP

Photograph: Chris Obst

Melaleuca acuminatum (Mallee Honey-myrtle), *Melaleuca lanceolata* (Dryland Teatree)+/- *Eucalyptus socialis* (Red Mallee)+/- *Eucalyptus leptophylla* (Narrow-leaf Mallee) Tall Open Shrubland

- *Clematis microphylla*, Old Man's Beard
- *Danthonia* sp., Wallaby-grass
- *Dianella revoluta* ssp. *revoluta*, Black-anther Flax-lily
- *Eucalyptus dumosa*, White Mallee
- *Eucalyptus gracilis*, Yorrell
- *Eucalyptus incrassata*, Ridge-fruited Mallee
- *Eucalyptus leptophylla*, Narrow-leaf Red Mallee
- *Eucalyptus socialis*, Beaked Red Mallee
- *Gahnia deusta*, Limestone Saw-sedge
- *Helichrysum leucopsideum*, Satin Everlasting
- *Hibbertia riparia*, Guinea-flower
- *Lepidosperma congestum*, Clustered Sword-sedge
- *Lepidosperma viscidum*, Sticky Sword-sedge
- *Melaleuca acuminata*, Mallee Honey-myrtle
- *Melaleuca lanceolata* ssp. *lanceolata*, Dryland Tea-tree
- *Senecio lautus*, Variable Groundsel
- *Stipa* sp., Spear-grass.

Eucalyptus leptophylla (Narrow-leaf Mallee) /*Eucalyptus socialis* (Red Mallee) Open Mallee

- *Callitris verrucosa*, Scrub Cypress Pine
- *Chenopodium desertorum*, Desert Goosefoot
- *Danthonia* sp., Wallaby-grass
- *Eucalyptus dumosa*, White Mallee
- *Eucalyptus incrassata*, Ridge-fruited Mallee
- *Eucalyptus leptophylla*, Narrow-leaf Red Mallee
- *Eucalyptus socialis*, Beaked Red Mallee
- *Goodenia willisiana*, Silver Goodenia
- *Halgania cyanea*, Rough Blue-flower
- *Helichrysum leucopsideum*, Satin Everlasting
- *Lepidosperma viscidum*, Sticky Sword-sedge
- *Lomandra leucocephala* ssp. *robusta*, Woolly Mat-rush
- *Melaleuca lanceolata* ssp. *lanceolata*, Dryland Tea-tree
- *Sclerolaena parviflora*, Small-flower Bindyi
- *Stipa mollis*, Soft Spear-grass
- *Stipa* sp., Spear-grass
- *Triodia irritans complex*, Spinifex
- *Vittadinia dissecta* ssp. *hirta*, Dissected New Holland Daisy.

Photograph: Chris Obst

Eucalyptus dumosa (White Mallee)+/- *Eucalyptus leptophylla* (Narrow-leaf Mallee) Mallee

- *Callitris verrucosa*, Scrub Cypress Pine
- *Chenopodium desertorum*, Desert Goosefoot
- *Danthonia* sp., Wallaby-grass
- *Dianella revoluta* ssp. *revoluta*, Black-anther Flax-lily
- *Dodonaea bursariifolia*, Small Hop-bush
- *Eucalyptus dumosa*, White Mallee
- *Eucalyptus incrassata*, Ridge-fruited Mallee
- *Eucalyptus leptophylla*, Narrow-leaf Red Mallee
- *Eucalyptus socialis*, Beaked Red Mallee
- *Eutaxia microphylla* ssp. *microphylla*, Common Eutaxia
- *Halgania cyanea*, Rough Blue-flower
- *Helichrysum leucopsideum*, Satin Everlasting
- *Lepidosperma concavum/congestum/laterale*, Sword-sedge
- *Lomandra effusa*, Scented Mat-rush
- *Melaleuca acuminata*, Mallee Honey-myrtle
- *Melaleuca lanceolata* ssp. *lanceolata*, Dryland Tea-tree
- *Melaleuca uncinata*, Broombush
- *Sclerolaena diacantha*, Grey Bindyi
- *Senecio lautus*, Variable Groundsel
- *Stipa mollis*, Soft Spear-grass
- *Stipa* sp., Spear-grass
- *Triodia irritans complex*, Spinifex
- *Vittadinia dissecta* ssp. *hirta*, Dissected New Holland Daisy
- *Westringia rigida*, Stiff Westringia.

Photograph: Chris Obst

Eucalyptus leptophylla (Narrow-leaf Mallee) *Melaleuca lanceolata* (Dryland Teatree) Open Mallee

- *Acacia spinescens*, Spiny Wattle
- *Baeckea crassifolia*, Desert Baeckea
- *Callitris verrucosa*, Scrub Cypress Pine
- *Calytrix tetragona*, Common Fringe-myrtle
- *Cryptandra leucophracta*, White Cryptandra
- *Cryptandra tomentosa*, Heath Cryptandra
- *Danthonia* sp., Wallaby-grass
- *Dianella revoluta* ssp. *revoluta*, Black-anther Flax-lily
- *Eucalyptus dumosa*, White Mallee
- *Eucalyptus incrassata*, Ridge-fruited Mallee
- *Eucalyptus leptophylla*, Narrow-leaf Red Mallee
- *Eucalyptus socialis*, Beaked Red Mallee
- *Glischrocaryon behrii*, Golden Pennants
- *Halgania cyanea*, Rough Blue-flower
- *Helichrysum leucopsideum*, Satin Everlasting
- *Hibbertia riparia*, Guinea-flower
- *Hibbertia virgata*, Twiggy Guinea-flower
- *Lepidosperma carphoides*, Black Rapier-sedge
- *Lepidosperma concavum/congestum/laterale*, Sword-sedge
- *Lomandra leucocephala* ssp. *robusta*, Woolly Mat-rush
- *Melaleuca lanceolata lanceolata*, Dryland Tea-tree
- *Senecio quadridentatus*, Cotton Groundsel
- *Stipa mollis*, Soft Spear-grass
- *Stipa* sp., Spear-grass
- *Westringia rigida*, Stiff Westringia.

APPENDIX 3: PLANT LISTS FOR TYPICAL VEGETATION COMMUNITIES WITHIN THE MMLAP AREA

Photograph: Chris Obst

Eucalyptus cyanophylla (Blue-leaf Mallee) +/- *Eucalyptus socialis* (Red Mallee)

Open Mallee

- *Acacia wilhelmiana*, Dwarf Nealie
- *Beyeria opaca*, Dark Turpentine Bush
- *Cassytha melantha*, Coarse Dodder-laurel
- *Chenopodium desertorum*, Desert Goosefoot
- *Dodonaea bursariifolia*, Small Hop-bush
- *Einadia nutans*, Climbing Saltbush
- *Eucalyptus cyanophylla*, Blue-leaf Mallee
- *Eucalyptus incrassata*, Ridge-fruited Mallee
- *Eucalyptus socialis*, Beaked Red Mallee
- *Helichrysum leucopsideum*, Satin Everlasting
- *Maireana pentatropis*, Erect Mallee Bluebush
- *Melaleuca lanceolata* ssp. *lanceolata*, Dryland Tea-tree
- *Sclerolaena diacantha*, Grey Bindyi
- *Sclerolaena parviflora*, Small-flower Bindyi
- *Senecio lautus*, Variable Groundsel
- *Stipa elegantissima*, Feather Spear-grass
- *Stipa* sp., Spear-grass
- *Triodia irritans complex*, Spinifex
- *Vittadinia dissecta* ssp. *hirta*, Dissected New Holland Daisy
- *Westringia rigida*, Stiff Westringia
- *Zygophyllum ammophilum*, Sand Twinleaf.

Photograph: Chris Obst

Eucalyptus calycogona (Square-fruited Mallee) / *Eucalyptus dumosa* (White Mallee)

Very Open Mallee

- *Beyeria opaca*, Dark Turpentine Bush
- *Chenopodium desertorum*, Desert Goosefoot
- *Danthonia* sp., Wallaby-grass
- *Dianella revoluta* ssp. *revoluta*, Black-anther Flax-lily
- *Dodonaea bursariifolia*, Small Hop-bush
- *Einadia nutans*, Climbing Saltbush
- *Eucalyptus calycogona* ssp. *calycogona*, Square-fruit Mallee
- *Eucalyptus dumosa*, White Mallee
- *Eucalyptus oleosa*, Red Mallee
- *Eucalyptus socialis*, Beaked Red Mallee
- *Melaleuca acuminata*, Mallee Honey-myrtle
- *Melaleuca lanceolata* ssp. *lanceolata*, Dryland Tea-tree
- *Melaleuca uncinata*, Broombush
- *Sclerolaena diacantha*, Grey Bindyi
- *Senecio lautus*, Variable Groundsel
- *Stipa* sp., Spear-grass
- *Vittadinia dissecta* ssp. *hirta*, Dissected New Holland Daisy
- *Westringia rigida*, Stiff Westringia.

Photograph: Chris Obst

Eucalyptus brachycalyx (Gilja)

Open Low Mallee

- *Billardiera cymosa*, Sweet Apple-berry
- *Carpobrotus modestus/rossii*, Native Pigface
- *Cassinia uncata*, Sticky Cassinia
- *Chenopodium desertorum*, Desert Goosefoot
- *Dodonaea bursariifolia*, Small Hop-bush
- *Eucalyptus brachycalyx*, Gilja
- *Eucalyptus socialis*, Beaked Red Mallee
- *Exocarpos sparteus*, Slender Cherry
- *Gahnia deusta*, Limestone Saw-sedge
- *Goodenia varia*, Sticky Goodenia
- *Halgania andromedifolia*, Scented Blue-flower
- *Melaleuca lanceolata* ssp. *lanceolata*, Dryland Tea-tree
- *Olearia brachyphylla*, Short-leaf Daisy-bush
- *Olearia floribunda* ssp. *floribunda*, Heath Daisy-bush
- *Olearia lepidophylla*, Clubmoss Daisy-bush
- *Pimelea serpyllifolia* ssp. *serpyllifolia*, Thyme Riceflower
- *Stipa elegantissima*, Feather Spear-grass
- *Stipa* sp., Spear-grass
- *Westringia rigida*, Stiff Westringia.

Photograph: Chris Obst

Eucalyptus incrassata (Ridge-fruited Mallee)

Open Low Mallee

- *Babingtonia behrii*, Silver Broombush
- *Baeckea crassifolia*, Desert Baeckea
- *Brachyloma ericoides* ssp. *ericoides*, Brush Heath
- *Callitris verrucosa*, Scrub Cypress Pine
- *Calytrix tetragona*, Common Fringe-myrtle
- *Danthonia* sp., Wallaby-grass
- *Eucalyptus incrassata*, Ridge-fruited Mallee
- *Eucalyptus leptophylla*, Narrow-leaf Red Mallee
- *Glischrocaryon behrii*, Golden Pennants
- *Helichrysum leucopsideum*, Satin Everlasting
- *Hibbertia riparia*, Guinea-flower
- *Hibbertia virgata*, Twiggy Guinea-flower
- *Lepidosperma concavum/congestum/laterale*, Sword-sedge
- *Leptospermum coriaceum*, Dune Tea-tree
- *Melaleuca uncinata*, Broombush
- *Stipa mollis*, Soft Spear-grass
- *Stipa* sp., Spear-grass.

APPENDIX 3: PLANT LISTS FOR TYPICAL VEGETATION COMMUNITIES WITHIN THE MMLAP AREA

Photograph: Jody Gates

Banksia ornata (Desert Banksia) +/- *Allocasuarina pusilla* (Dwarf Oak-bush) / *Leptospermum coriaceum* (Green Teatree) Tall Open Shrubland

- *Allocasuarina muelleriana* ssp. *muelleriana*, Common Oak-bush
- *Allocasuarina pusilla*, Dwarf Oak-bush
- *Aotus subspinescens*, Mallee Aotus
- *Astroloma conostephioides*, Flame Heath
- *Astroloma humifusum*, Cranberry Heath
- *Babingtonia behrii*, Silver Broombush
- *Baeckea crassifolia*, Desert Baeckea
- *Banksia ornata*, Desert Banksia
- *Boronia coerulescens* ssp. *coerulescens*, Blue Boronia
- *Brachyloma ericoides* ssp. *ericoides*, Brush Heath
- *Callitris verrucosa*, Scrub Cypress Pine
- *Calytrix tetragona*, Common Fringe-myrtle
- Cassytha glabella forma dispar, Slender Dodder-laurel
- *Correa reflexa* ssp. *reflexa*, Common Correa
- *Cryptandra leucophracta*, White Cryptandra
- *Cryptandra tomentosa*, Heath Cryptandra
- *Dillwynia hispida*, Red Parrot-pea
- *Eucalyptus incrassata*, Ridge-fruited Mallee
- *Eucalyptus leptophylla*, Narrow-leaf Red Mallee
- *Goodenia geniculata*, Bent Goodenia
- *Hakea muelleriana*, Heath Needlebush
- *Hibbertia riparia*, Guinea-flower
- *Hypolaena fastigiata*, Tassel Rope-rush
- *Lepidosperma carphoides*, Black Rapier-sedge
- *Lepidosperma concavum/congestum/laterale*, Sword-sedge
- *Leptospermum coriaceum*, Dune Tea-tree
- *Leptospermum myrsinoides*, Heath Tea-tree
- *Leucopogon rufus*, Ruddy Beard-heath
- *Lomandra collina*, Sand Mat-rush
- *Lomandra juncea*, Desert Mat-rush
- *Lomandra leucocephala* ssp. *robusta*, Woolly Mat-rush
- *Neurachne alopecuroidea*, Fox-tail Mulga-grass
- *Phyllota pleurandroides*, Heathy Phyllota
- *Schoenus breviculmis*, Matted Bog-rush
- *Spyridium subochreatum*, Velvet Spyridium
- *Stipa mollis*, Soft Spear-grass
- *Triodia irritans complex*, Spinifex.

Photograph: Tonia Brown

Callitris verrucosa (Scrub Cypress Pine)
Tall Open Shrubland

- *Babingtonia behrii*, Silver Broombush
- *Billardiera cymosa*, Sweet Apple-berry
- *Brachyloma ericoides* ssp. *ericoides*, Brush Heath
- *Callitris verrucosa*, Scrub Cypress Pine
- *Calytrix tetragona*, Common Fringe-myrtle
- *Danthonia* sp., Wallaby-grass
- *Eucalyptus incrassata*, Ridge-fruited Mallee
- *Eucalyptus leptophylla*, Narrow-leaf Red Mallee
- *Hibbertia riparia*, Guinea-flower
- *Lepidosperma concavum/congestum/laterale*, Sword-sedge
- *Leptospermum coriaceum*, Dune Tea-tree
- *Senecio quadridentatus*, Cotton Groundsel
- *Stipa mollis*, Soft Spear-grass
- *Stipa* sp., Spear-grass.

Photograph: Chris Obst

Photograph: Todd Berkinshaw

Halosarcia sp. (Samphire)
Low Very Open Shrubland

- *Atriplex vesicaria,* Bladder Saltbush
- *Disphyma crassifolium* ssp. *clavellatum*, Round-leaf Pigface
- *Frankenia foliosa*, Sea-heath
- *Frankenia sessilis*, Sea-heath
- *Halosarcia pergranulata*, Black-seed Samphire
- *Halosarcia* sp., Samphire
- *Maireana oppositifolia*, Salt Bluebush
- *Sclerolaena diacantha*, Grey Bindyi
- *Senecio lautus*, Variable Groundsel
- *Stipa* sp., Spear-grass.

APPENDIX 3: PLANT LISTS FOR TYPICAL VEGETATION COMMUNITIES WITHIN THE MMLAP AREA

Photograph: Chris Obst

NO IMAGE AVAILABLE

Alectryon oleifolius ssp. *canescens* (Bullock Bush) Tall Open Shrubland

- *Acacia nyssophylla,* Spine Bush
- *Alectryon oleifolius* ssp. *canescens,* Bullock Bush
- *Atriplex vesicaria,* Bladder Saltbush
- *Chenopodium desertorum*, Desert Goosefoot
- *Enchylaena tomentosa* ssp. *tomentosa,* Ruby Saltbush
- *Eriochiton sclerolaenoides,* Woolly-fruit Bluebush
- *Geijera linearifolia*, Sheep Bush
- *Myoporum platycarpum,* False Sandalwood
- *Rhagodia spinescens,* Spiny Saltbush
- *Sclerolaena diacantha/uniflora,* Grey Bindyi
- *Sclerolaena obliquicuspis,* Oblique-spined Bindyi
- *Senna artemisioides*, Desert Senna
- *Stipa* sp., Spear-grass
- *Zygophyllum ammophilum,* Sand Twinleaf.

Acacia nyssophylla (Spine Bush) / *Acacia ligulata* (Sandhill Wattle) Tall Very Open Shrubland

- *Acacia ligulata*, Umbrella Bush
- *Acacia nyssophylla,* Spine Bush
- *Amyema preissii*, Wire-leaf Mistletoe
- *Chenopodium curvispicatum*, Cottony Goosefoot
- *Chenopodium desertorum*, Desert Goosefoot
- *Einadia nutans*, Climbing Saltbush
- *Enchylaena tomentosa* ssp. *tomentosa,* Ruby Saltbush
- *Eremophila longifolia*, Weeping Emubush
- *Eucalyptus dumosa*, White Mallee
- *Eucalyptus socialis*, Beaked Red Mallee
- *Exocarpos aphyllus*, Leafless Cherry
- *Helichrysum leucopsideum*, Satin Everlasting
- *Lomandra effusa*, Scented Mat-rush
- *Maireana rohrlachii*, Rohrlach's Bluebush
- *Rhagodia parabolica*, Mealy Saltbush
- *Rhagodia spinescens,* Spiny Saltbush
- *Sclerolaena diacantha*, Grey Bindyi
- *Senna artemisioides*, Desert Senna
- *Stipa elegantissima*, Feather Spear-grass
- *Stipa* sp., Spear-grass
- *Zygophyllum ovatum*, Dwarf Twinleaf.

Photograph: Todd Berkinshaw

Eucalyptus arenacea / baxteri
(Brown Stringybark) Low Woodland

- *Acacia myrtifolia* ssp. *myrtifolia*, Myrtle Wattle
- *Acrotriche affinis*, Ridged Ground-berry
- *Adenanthos terminalis*, Yellow Gland-flower
- *Allocasuarina muelleriana* ssp. *muelleriana*, Common Oak-bush
- *Aotus subspinescens*, Mallee Aotus
- *Astroloma conostephioides*, Flame Heath
- *Astroloma humifusum*, Cranberry Heath
- *Babingtonia behrii*, Silver Broombush
- *Baeckea crassifolia*, Desert Baeckea
- *Banksia marginata*, Silver Banksia
- *Banksia ornata*, Desert Banksia
- *Boronia coerulescens* ssp. *coerulescens*, Blue Boronia
- *Brachyloma daphnoides*, Daphne Heath
- *Calytrix alpestris*, Snow Heath-myrtle
- *Calytrix tetragona*, Common Fringe-myrtle
- *Correa reflexa* ssp. *reflexa*, Common Correa
- *Danthonia* sp., Wallaby-grass
- *Eucalyptus arenacea*, Dune Stringybark
- *Eucalyptus incrassata*, Ridge-fruited Mallee
- *Eucalyptus leptophylla*, Narrow-leaf Red Mallee
- *Goodenia robusta*, Woolly Goodenia
- *Hakea muelleriana*, Heath Needlebush
- *Hibbertia riparia*, Guinea-flower
- *Hibbertia sericea* ssp. *sericea*, Silky Guinea-flower.
- *Hybanthus floribundus* ssp. *floribundus*, Shrub Violet
- *Hypolaena fastigiata*, Tassel Rope-rush
- *Kunzea pomifera*, Muntries
- *Lepidosperma concavum/congestum/laterale*, Sword-sedge
- *Lepidosperma semiteres*, Wire Rapier-sedge
- *Leptospermum coriaceum*, Dune Tea-tree
- *Leucopogon cordifolius*, Heart-leaf Beard-heath
- *Leucopogon rufus*, Ruddy Beard-heath
- *Lomandra collina*, Sand Mat-rush
- *Lomandra juncea*, Desert Mat-rush
- *Lomandra leucocephala* ssp. *robusta*, Woolly Mat-rush
- *Melaleuca uncinata*, Broombush
- *Neurachne alopecuroidea*, Fox-tail Mulga-grass
- *Olearia ciliata* ssp. *ciliata*, Fringed Daisy-bush
- *Phyllota pleurandroides*, Heathy Phyllota
- *Phyllota remota*, Slender Phyllota
- *Pimelea octophylla*, Woolly Riceflower
- *Spyridium subochreatum*, Velvet Spyridium
- *Triodia irritans complex*, Spinifex
- *Xanthorrhoea semiplana* ssp. *semiplana*, Yacca.

APPENDIX 3: PLANT LISTS FOR TYPICAL VEGETATION COMMUNITIES WITHIN THE MMLAP AREA

Photograph: Keith Payne

Casuarina pauper (Black Oak)

Low Woodland

- *Acacia oswaldii*, Umbrella Wattle
- *Alectryon oleifolius* ssp. *canescens,* Bullock Bush
- *Casuarina pauper*, Black Oak
- *Chenopodium curvispicatum*, Cottony Goosefoot
- *Chenopodium desertorum*, Desert Goosefoot
- *Dodonaea viscosa* ssp. *angustissima*, Narrow-leaf Hop-bush
- *Einadia nutans*, Climbing Saltbush
- *Enchylaena tomentosa* ssp. *tomentosa,* Ruby Saltbush
- *Eremophila glabra*, Tar Bush
- *Exocarpos aphyllus*, Leafless Cherry
- *Maireana pentatropis*, Erect Mallee Bluebush
- *Olearia muelleri*, Mueller's Daisy-bush
- *Olearia pimeleoides* ssp. *pimeleoides*, Pimelea Daisy-bush
- *Pittosporum angustifolium*, Native Apricot
- *Rhagodia spinescens,* Spiny Saltbush
- *Scaevola spinescens*, Spiny Fanflower
- *Sclerolaena diacantha*, Grey Bindyi
- *Senecio lautus*, Variable Groundsel
- *Senna artemisioides*, Desert Senna
- *Stipa elegantissima*, Feather Spear-grass
- *Stipa* sp., Spear-grass
- *Vittadinia dissecta* ssp. *hirta*, Dissected New Holland Daisy
- *Zygophyllum apiculatum*, Pointed Twinleaf
- *Zygophyllum aurantiacum,* Soap bush.

Photograph: Chris Obst

Eucalyptus porosa (Mallee Box)

Low open woodland

- *Clematis microphylla*, Old Man's Beard
- *Danthonia* sp., Wallaby-grass
- *Einadia nutans*, Climbing Saltbush
- *Enchylaena tomentosa* ssp. *tomentosa,* Ruby Saltbush
- *Eucalyptus leptophylla*, Narrow-leaf Red Mallee
- *Eucalyptus porosa*, Mallee Box
- *Gahnia lanigera*, Black Grass Saw-sedge
- *Helichrysum leucopsideum*, Satin Everlasting
- *Hibbertia riparia*, Guinea-flower
- *Lomandra effusa*, Scented Mat-rush
- *Melaleuca lanceolata* ssp. *lanceolata*, Dryland Tea-tree
- *Pittosporum phylliraeoides* ssp. *microcarpa*, Native Apricot
- *Sclerolaena diacantha*, Grey Bindyi
- *Senecio lautus*, Variable Groundsel
- *Stipa elegantissima*, Feather Spear-grass
- *Stipa mollis*, Soft Spear-grass
- *Stipa* sp., Spear-grass
- *Triodia irritans complex*, Spinifex
- *Vittadinia dissecta* ssp. *hirta*, Dissected New Holland Daisy
- *Vittadinia megacephala*, Giant New Holland Daisy.

Photograph: Tonia Brown

Lomandra effusa (Scented Mat-rush)

Open Tussock Grassland

- *Cryptandra amara* ssp. *amara*, Spiny Cryptandra
- *Einadia nutans*, Climbing Saltbush
- *Eucalyptus porosa*, Mallee Box
- *Helichrysum leucopsideum*, Satin Everlasting
- *Lepidosperma carphoides*, Black Rapier-sedge
- *Lepidosperma concavum/congestum/laterale*, Sword-sedge
- *Lomandra effusa*, Scented Mat-rush
- *Melaleuca lanceolata* ssp. *lanceolata*, Dryland Tea-tree
- *Stipa acrociliata group*, Branched Spear-grass
- *Stipa* sp., Spear-grass
- *Vittadinia australasica*, Sticky New Holland Daisy.

APPENDIX 4: METHODS OF FERAL ANIMAL CONTROL AND MONITORING OF EFFECTIVENESS

Threat Abatement Plans have been written for feral goats, feral cats, foxes and rabbits by the Biodiversity Group, Environment Australia (BGEA) in 1999. An intensive review of the available literature on feral animal management identified these abatement plans as the primary source of information for the management of feral animals. The various available control methods discussed below are adapted from these Abatement Plans.

Information regarding control techniques for other feral species, such as deer, wild dogs, hares and problem native animals such as galahs, corellas and kangaroos can be obtained by contacting the SAMDB NRM Board Authorised Officer (former Animal and Plant Control Officer). See Regional Contacts, page 87.

GOATS

There are a number of control methods that can be implemented for controlling goats. It is likely that no single method will effectively control goats and therefore an integrated multi-method approach is often warranted. The method of control implemented depends largely on the available budget, the management strategy and desired outcomes. Prior to control efforts being implemented, the outcomes of the program need to be determined, for example, whether the aim is to eradicate goats from the property or to reduce numbers to a more manageable level.

The different control options for feral goats are discussed in the following pages.

Mustering and trapping

Two general methods of goat mustering are generally utilised. Helicopters or light aircraft are often used to flush goats out of rough country or move animals closer to yards. The goats can then be herded into yards by horseback or by motorbikes, usually with the aid of dogs. In accessible country, horseback or motorbikes are often used as a sole method (Parkes et al., 1996).

Often landholders use an opportunistic approach to mustering, where it is not undertaken until a large group of goats is noticed. The advantage of this is that the goats are aggregated into a single large mob making mustering easier. The disadvantage is that goats do not always aggregate into large mobs and therefore goat numbers can build to undesirable numbers before mobs are large enough to trigger an opportunistic muster. The opportunistic approach needs to be combined with monitoring so that control takes place at suitable times (Parkes et al., 1996).

Advantages

- Costs of control can be offset by the sale of goats
- can be done by landholders
- goats can be flushed out of tough terrain.

Disadvantages

- Only economical and efficient at high goat densities
- labour-intensive
- several animal welfare issues
- landholders may come to rely on the goats as an extra income source and do not aim to eradicate them.

Animal welfare

- Conditions of capture, transport and slaughter need to be considered.

Trapping at water

The reliance of many goat populations on artificial water supplies in semi-arid and arid areas renders them vulnerable to control via trapping. Trapping involves the construction of goat-proof fences around water points with a number of one-way entrances (spear gates, swinging one-way gates) or jump-down ramps (one-metre-high jumps are recommended) to allow the goats access to the water, but prevent their leaving (Parkes et al., 1996). Once captured, the goats may be sold to offset the costs of capture or they may be humanely destroyed. The successful use of traps requires a period of training to enable all animals using the water to develop a familiarity and routine with the trap yard (Parkes et al., 1996). Traps must be cleared regularly to avoid starvation and stress, and operated only during the daytime to avoid catching kangaroos (Parkes et al., 1996).

This technique is most effective during dry times when goats are reliant on particular watering points and there is limited access to alternative water sources, but is less effective in areas where water is more readily available. Trapping may require the fencing of some water points to force goats to use other water sources were trapping is more convenient.

Advantages

- Costs of control can be offset by the sale of goats
- can be done by landholders
- traps can also be used to muster sheep
- low technology requirements
- reasonably inexpensive.

Disadvantages

- Several animal welfare issues
- only effective during dry periods
- ineffective where extensive bodies of permanent water occur
- alternate sources of water may require fencing off, including natural sources which may impact native fauna
- need to train animals (domestic, ferals and native)
- traps require daily checking
- requires a commitment of time and resources on behalf of the land manager.

Animal welfare

- Goats can be loyal to one water source. If this source is fenced off to force goats to a water source with trap, loyal goats may die
- if goats are shot, this needs to be undertaken humanely
- conditions of capture, transport and slaughter need to be considered.

Shooting from the ground

Ground-based shooting can be used in both vegetated and open pastoral areas, especially when goats are forced to visit water points. Ground shooting is a technique that has been successful in its own right, but it is often used in conjunction with other control methods. It is a technique often used to follow-up aerial shooting programs or mustering.

Advantages

- Proven method
- can target particular goats
- does not impact non-target animals.

Disadvantages

- Requires skilled shooters to ensure humane kills
- ineffective in inaccessible terrain.

Animal welfare

- Recognised as a humane method if properly trained personnel are utilised
- in rough terrain may not be able to follow-up and kill animals that are wounded.

APPENDIX 4: METHODS OF FERAL ANIMAL CONTROL AND MONITORING OF EFFECTIVENESS

GOATS / CONTINUED

Aerial shooting

Aerial shooting generally involves using helicopters as a shooting platform (BGEA, 1999). This method can be costly—costs tend to rise exponentially with decreasing goat density (Parkes, 1993b; Maas and Choquenot, 1995).

This control method can potentially be used to manage feral goats at both high and low densities, inaccessible populations, or to remove survivors of other control campaigns. Aerial shooting is particularly effective in steep inaccessible terrain, however it tends to be less effective in heavily wooded areas where clear shots at goats are difficult to obtain.

Advantages

- Can locate goats in inaccessible terrain
- can be used to manage goats at high and low densities
- can cover large areas quickly
- does not impact non-target animals
- cost-effective method.

Disadvantages

- Requires skilled pilots and shooters
- can be expensive
- difficult in heavily wooded areas.

Animal welfare

- Recognised as a humane method if properly trained personnel are utilised.

Biological control

No natural pathogen to control feral goats in Australia is available or acceptable. Most exotic diseases and parasites of goats that might be candidates as control agents would not be welcome in Australia because of their likely effects on domestic animals (Parkes et al., 1996).

Fencing

Fences are generally used in conjunction with other control methods, however they can be an important management tool to:

- create short-term manageable units during an eradication campaign (Baker and Reeser, 1972; as cited in Parkes et al., 1996)
- limit recolonisation during sustained control (Parkes, 1990)
- exclude goats from water points to encourage them to use other water points where they can be trapped (BGEA, 1999a)
- contain captured animals (Parkes et al., 1996).

Advantages

- Can limit dispersal
- can compartmentalise larger areas during control campaigns
- can exclude goats from some water supplies and force them to drink at sites with traps
- can exclude goats from damaging significant sites (ecological and cultural).

Disadvantages

- Very expensive
- eventually breached by goats.

FOXES

Shooting and trapping

Trapping and shooting of foxes has the potential to produce a commercial industry through the sale of pelts, however the falling prices of pelts, the absence of bounties and the fact that it is labour-intensive, means that few landholders undertake it as a management option. Furthermore, while trapping and shooting may have some effect on overall fox densities, it is generally agreed that reductions will be minimal (Saunders et al., 1995).

Shooting of foxes is usually undertaken at night from a vehicle with the use of spotlights (100 watts). This technique requires either luring the fox out from cover using a rabbit whistle or approaching without the fox retreating. This method is not suitable where there is dense vegetative cover.

Foxes can be trapped, however the capture of foxes is relatively difficult. Traditionally, steel-jawed traps were used for this purpose, however their use is now illegal in South Australia and other states and territories (Saunders et al., 1995) on humane grounds and due to considerable risk of non-target catches. Extensive effort has been put into producing more humane traps (Novak, 1987). The treadle snare trap is used in urban areas in Victoria. This trap is more humane, but is difficult to set and needs to be checked every 4–8 hours so that captured animals can be humanely removed and destroyed (Saunders et al., 1995).

Advantages / shooting

- Potential commercial value through selling of pelts
- when dogs are used, this method can trap wary animals not tempted by other control methods.

Advantages / trapping

- Can target individual animals where den sites are known.

Disadvantages / shooting

- Time-consuming
- not suitable where there is dense cover for foxes
- fox drives are suitable only for small areas and provide only temporary localised reduction
- some animal welfare issues
- reductions likely to be minimal.

Disadvantages / trapping

- Can be difficult to set (treadle snare)
- capture is relatively difficult and labour-intensive
- impractical for large-scale programs
- potential for non-target catches
- need to be checked on a regular basis (every 4–8 hours).

Animal welfare / shooting

- Using small terrier dogs to flush out foxes is not condoned.

Den destruction or fumigation

Den fumigation can be effective to reduce fox numbers at the time cubs are born (August/September), however, adult animals are often absent from the den when the fumigant is applied. The current fumigant recommended for fox control is 'Dencofume' and carbon dioxide.

Fox dens are notoriously difficult to locate, but if a den is located and is accessible it can be destroyed by deep ripping. The use of explosives is also possible but can cause considerable damage to surrounding flora.

Advantages

- Can be effective to reduce numbers at the time cubs are born.

Disadvantages

- Adult animals are often absent from the den
- no fumigants are registered for foxes
- potential to affect non-target species
- fox dens are difficult to locate.

APPENDIX 4: METHODS OF FERAL ANIMAL CONTROL AND MONITORING OF EFFECTIVENESS

FOXES / CONTINUED

Poisoning

The most effective method for fox control to date is poisoning. The only widely recommended poison for fox control is 1080 (sodium monofluoroacetate). 1080 is odourless, virtually tasteless and highly soluble in water. By law, 1080 powder can only be obtained by government or semi-government agencies which in turn prepare bait for use by land managers. In Western Australia, some native fauna have evolved tolerance to the toxin (fluoroacetate) relative to the fox, since it occurs naturally in a number of Australian plants in the region. In other areas (including South Australia), where the native fauna have not developed 1080 tolerance potential, bait consumption by non-target species is an issue.

Target specificity can be increased by:

- using baits highly attractive to foxes
- minimising poison content and maximising bait size to achieve low 1080 concentration in the bait
- placing baits in the best areas to encounter foxes (Saunders et al., 1995)
- burying baits, already a mandatory requirement in South Australia
- if using meat as bait material, drying of the meat will make it too tough for consumption by smaller carnivores, marsupials and birds (Calver et al., 1989).

Burying baits increases labour costs, but these can be offset by using fewer baits and ensuring greater target specificity. When burying baits, they should be covered lightly with litter or soil to a depth of 5–10 cm. Buried baits are suggested to be more attractive to foxes than exposed baits.

Bait materials

In South Australia, the recommended bait materials include meat, eggs and manufactured baits (Saunders et al., 1995). Meat is very palatable to foxes and is relatively target-specific, being attractive only to a limited number of carnivores and omnivores.

The manufactured bait, Foxoff, consists of a soft, meat-like substitute. The advantages to this type of bait are a prolonged shelf life, ease of distribution, packaging incorporating education information encouraging responsible use, and factory quality control. The disadvantage is that the long shelf life renders it vulnerable to sporadic or irregular use (Saunders et al., 1995). Foxoff is fully registered by the National Registration Authority in south-eastern Australia, and there is support from state governments for its use.

PAPP is an alternative vertebrate poison to 1080 which is currently being tested in Victoria (Harvey, pers. comm., 2006). It is anticipated that it may be effective in the control of foxes, wild dogs, feral cats and pigs.

Frequency and intensity of baiting

Factors such as available resources for sustained control, fox density, the rareness of the prey, amount of cover, prey vulnerability and area of habitat will determine the level of effort required to control foxes (Saunders et al., 1995). In general, approximately 10 000 hectares or less requires frequent baiting because they are rapidly recolonised. Monthly baiting regimes have been adopted in Western Australia, and three-monthly interval baiting schemes have had some success (Saunders et al., 1995).

Method of baiting

The trail of baits should be accessible by vehicle and preferably follow a known feature such as a fence line so that baits can be easily relocated. Baits are best buried at regular intervals (100–500 m), with a general guide of 50 baits per 400 hectares. The baiting program should last 2–3 weeks with baits being inspected every 2–4 days and replaced if taken (Saunders et al., 1995). Bait should be offered until no more is being taken.

Timing of control

Although not tested, there is the potential to take advantage of fox behaviour during baiting programs:

- Breeding vixens may be most vulnerable during late gestation and lactation (spring) when their food demands are sufficiently high to increase foraging activity.
- Dominant males may be more exposed during the mating season (winter) when they are moving over much larger areas in search of mating opportunities.

Advantages / 1080

- Odourless and virtually tasteless
- some native fauna have developed a tolerance (in WA)
- inexpensive
- can cover a large area
- very effective when undertaken properly.

Disadvantages / 1080

- Potential kills of non-target animals, which can be minimised if precautions are taken.

Animal welfare / 1080

- Some discussion as to whether it is humane (suffering is difficult to gauge).

Biological

An effective form of biological control appeals as a long-term and cost-effective method for fox management over large areas, however one is not yet available for use. For the fox, no specific viruses have been found that will not affect domestic dogs and dingoes. Current research in Australia aims at developing and immunosterilisation technique for use against foxes in Australia. Therefore reducing fox fertility is not yet a practical technique for reducing fox numbers.

Advantages / pathogens

- Appeals as a long-term and cost effective method
- can be effective over large areas.

Advantages / fertility

- Can be species-specific
- useful for species with short breeding seasons such as foxes
- trials have been conducted showing success
- preferred by welfare groups.

Disadvantages / pathogens

- Currently not species-specific (also affect dogs)
- possible consequences to human health, domestic stock, companion animals and native fauna.

Disadvantages / fertility

- Not yet a practical technique
- reducing fertility will not necessarily lead to a population decline or a decline in damage caused by foxes
- likely to be expensive
- can be less effective than poisons.

APPENDIX 4: METHODS OF FERAL ANIMAL CONTROL AND MONITORING OF EFFECTIVENESS

RABBITS

Possible control methods

Rabbit management programs aim to affect two main aspects of rabbit biology, reducing survival (e.g. poisoning) and reducing breeding (e.g. destroying warrens).

Prior to the release of Myxomatosis, poisoning, fencing and various forms of biological control had little success. The methods available for use are discussed below.

Fencing

Advantages / stock

- Better management of pastures and stock
- facilitates poisoning operations.

Advantages / rabbit-proof fencing

- Enables effective control even if there is a lack of control on adjacent land
- enables sequential control in large areas
- eradication may be possible within enclosures
- functions also as a stock fence
- facilitates poisoning operations.

Disadvantages / stock

- Initial cost
- may require additional water points for stock.

Disadvantages / rabbit proof

- Cost
- requires high maintenance
- may require additional water points for stock
- some rabbits may climb over
- may restrict movement of native animals (Echidnas, lizards etc).

Pasture management

Advantages

- Low cost
- better management of pastures and soils.

Disadvantages

- Unsuitable for rangelands.

Photograph: Bill Sarver

Poisoning

Poisoning is a commonly used management technique for rabbits. However, many poisoning campaigns kill insufficient rabbits due primarily to their 'bait-shy' behaviour and the effects of poisoning on rabbit populations is usually short-lived, since warrens remain intact and are available for recolonisation. Therefore, its principal uses should be to reduce dense rabbit populations prior to warren ripping, exploding or fumigation and for use where rabbits are predominantly surface-dwelling. Used in this way, it can be a cheap and effective component of integrated rabbit management. Prior to any rabbit poisoning control program, it is recommended that you seek technical advice from the SAMDB NRM Board Authorised Officer (see Regional Contacts, page 87).

Poisons available for use

Sodium monofluoracetate (1080)

1080 is the most commonly used poison for rabbit control, predominantly due to its low cost and effectiveness. 1080 is administered predominantly by the use of oats laced with poison, with three 1080-free feeds recommended prior to a poisoned feed.

Rabbait 'Pindone' Oat Bait

This is the referred chemical for controlling rabbits in semi-urban areas and around farm buildings. Pindone has a reduced risk of secondary poisoning for dogs and is biodegradable and non-cumulative.

Methods to maximise species-selectivity in poison use

Direct off-target kills and indirect secondary poisoning of predators are a potential environmental impact of poison bait use for the control of rabbits. The species-selectivity of poisoning can be enhanced by:

- free-feeding rabbits with un-poisoned bait and ensuring that only rabbits are taking the bait
- using baits most attractive to rabbits
- using the minimal concentration of poison sufficient to kill rabbits
- placing the bait in prime feeding areas of rabbits
- collecting carcasses of poisoned rabbits to minimise secondary poisoning.

The effectiveness of a poisoning campaign can be increased by poisoning:

- when rabbits are not breeding and are least territorial
- when available forage is low (summer/autumn) (Williams et al., 1995).
- in summer/autumn, when:
  - young rabbits only feed on trails close to the warren
  - 1080 less likely to be leached by rain in summer/autumn
  - rabbit populations are at their lowest in summer/autumn and poisoning is more likely to have an impact.

Method of application

- Suitable bait materials include carrots, cereal pellets or oat grains.
- Baits should be laid in the main areas of rabbit activity (a rabbit is not attracted to a bait if it does not encounter it during its normal daily pattern of movement).
- Baits are generally delivered by baitlayers towed by vehicles or manually, but aerial delivery has been used.

Advantages / Rabbait or Pindone Oat Bait

- A suitable control method for rabbits in urban areas and around farm buildings
- inexpensive
- has a reduced risk of secondary poisoning for dogs
- biodegradable and non-cumulative.

Advantages / 1080

- Some native animals have a high tolerance
- cheap
- does not persist in livestock
- degrades rapidly in the field.

Disadvantages / Rabbait or Pindone Oat Bait

- Effects are short-lived
- warren remains intact and recolonisation is common
- potential kills of non-target animals, which can be minimised if precautions are taken
- bait shyness and poison aversion
- requires dry conditions with little available food.

Disadvantages / 1080

- No antidote
- potential kills of non-target animals, which can be minimised if precautions are taken
- requires a period of free-feeding
- baits do not resist rain and dew
- does not degrade rapidly in dead rabbits
- warren remains intact and recolonisation is common.

Animal Welfare / Rabbait or Pindone Oat Bait

- Potentially inhumane.

Animal Welfare / 1080

- Some discussion as to whether it is humane (suffering is difficult to gauge).

APPENDIX 4: METHODS OF FERAL ANIMAL CONTROL AND MONITORING OF EFFECTIVENESS

Warrens. Photograph: Ben Simon / MMLAP

Warren destruction (ripping, explosives and fumigation)

The key to the rabbits' success are their warrens. Rabbits do not dig new warrens readily, therefore effective and long-term management is through destruction of warren networks with explosives or rippers mounted on tractors and bulldozers.

Ripping

Where rabbits use warrens, ripping is the most cost-effective and enduring of the available single techniques, and the most suitable method for treating large areas. Warrens should be ripped as deeply as possible, at least 0.5 m below the surface, but preferably deeper. It is preferable that ripping is conducted when the soil is dry, offering better results (Harvey, pers. comm., 2006).

A recent innovation is a ripper mounted on a mobile hydraulic arm (drag-arm ripper). This enables ripping in difficult areas such as gullies, sloping banks, amongst trees and along roadside verges (Williams et al., 1995). This technique can be used in areas that are heavily vegetated, but any impact on native vegetation must be minimised.

Advantages

- Long-lasting
- cost-effective
- relatively cheap
- compatible with prior poisoning and follow-on fumigation
- suitable for large-scale operations.

Disadvantages

- Unsuitable for steep slopes and rocky land
- unsuitable in areas where rabbits are predominantly surface dwellers
- availability of necessary equipment
- potential for erosion.

Animal welfare

- Warrens must be ripped at a sufficient depth, or rabbits may be trapped in air pockets and die slowly.

Explosives

When using explosives to destroy warren systems, operators must be trained and licensed in handling explosives. This method is particularly effective for destruction of warrens amongst rocks and boulders, and in areas of significant vegetation. Only enough explosive material should be used so that the warrens are destroyed but there is limited damage to anything else in the surrounding area.

Advantages

- Effective in rocky and inaccessible places
- compatible with follow-on fumigation
- humane.

Disadvantages

- Effectiveness depends on the skill of operator
- expensive
- dangerous
- unsuitable around settled areas
- potential destruction of native vegetation.

Fumigation

There are two fumigation methods: pressure fumigation, in which the fumigant gases or vapours are generated outside the warren and forced into the warren under pressure, usually from a pump; and diffusion fumigation, in which the gases or vapours are generated inside the warren through which they diffuse (Williams et al., 1995).

There are two fumigants that are generally used, Fostoxin tablets and Lavacide which is put in the fumigator. Fostoxin is a fumigant that contains aluminium phosphide and is manufactured in tablet form. In the presence of moisture, phosphide gas (phosphide) is released. The rate of application is one tablet per hole. Fumigation however, does not destroy the warren system and therefore, re-opening of the warren can occur, sometimes as little as eight days after the treatment (Bromell, 1968). This decreases the effectiveness of the control campaign.

A suggested method of reducing re-opening is securely blocking the entrances by plugging them with low-grade wool, or other available materials such as rocks. When conducted in areas where the soil is damp the soil can be dug to seal the entrances.

Fumigation is very hazardous for the user. When handling fumigants, a full-face mask respirator with an acid gas canister needs to be worn and the use of nirile gloves is recommended. A second person with personal protective equipment needs to assist during the fumigation.

Advantages / Lavacide

- Useful in inaccessible places
- suitable near settled areas
- effective follow-up to ripping
- indicator smoke often locates unseen entrances.

Advantages / Fostoxin

- Useful in inaccessible places
- suitable near settled areas
- little equipment is required
- effective follow-up to ripping
- suitable for impromptu treatment of isolated or re-opened warrens.

Disadvantages / Lavacide

- Non-target wildlife may also utilise burrows
- effectiveness depends on the skill of the operators
- treated warrens are readily recolonised
- labour-intensive and slow
- expensive
- not suitable for large areas
- uncomfortable and tiring for operators
- poison is cumulative.

Disadvantages / Fostoxin

- Non-target wildlife may also utilise burrows
- warrens are readily recolonised
- labour-intensive and slow
- not suitable for large areas
- tiring for operators.

Animal welfare / Lavacide

- Inhumane.

Biological

There has been some significant success with the use of biological control to reduce and manage rabbit numbers in Australia.

Myxomatosis

Myxomatosis, is caused by myxoma pox virus. After the introduction of Myxomatosis into Australian wild rabbit populations in 1950, rabbit numbers fell by approximately 95% in most of southern South Australia and by approximately 100% in marginal habitats. Although initially it was extremely effective, the virus quickly weakened and rabbits with a genetic resistance to the disease became more common, but have remained more or less constant since (BGEA, 1999b). Current field strains kill about 40–60% of the susceptible rabbits in field populations. On average, present densities in Australia are approximately 5% of pre-Myxomatosis in higher rainfall and approx 25% in rangelands (BGEA, 1999b).

Prior to the release of Myxomatosis, poisoning, fencing and various forms of biological control had little success.

Rabbit Calicivirus Disease (RCD)

RCD is a viral disease which affects only European rabbits. It was first reported in China in 1984, after which the virus was taken into quarantine at the CSIRO Australian Animal Health laboratory for comprehensive testing over three years from June 1991 (CSIRO, 2003). During field trials in 1995 it escaped from Wardang Island, South Australia, with more than 30 million rabbits dying in Australia during October–November 1995 as a result. An official state co-ordinated release of the virus followed in 1996. The virus has since spread throughout most of Australia mainly by natural spread (CSIRO, 2003).

APPENDIX 4: METHODS OF FERAL ANIMAL CONTROL AND MONITORING OF EFFECTIVENESS

RABBITS / CONTINUED

The effectiveness of the disease does rely on age, with rabbits less than three-weeks-old not affected and only 60% of rabbits between three and six-weeks-old affected. If young animals are infected and survive, they become immunised against infection when they are older (CSIRO, 2003).

Studies indicate that the disease is species-specific. Disease is highly infectious by contact and may also be spread by insects. It kills quickly, but is also spread rapidly.

Although Myxomatosis and RCD have caused large reductions in rabbit populations and continue to maintain numbers with some level of effectiveness, rabbit control cannot become complacent and solely rely on these diseases as a cure. No reliance should be placed on their continued efficiency as it is possible that rabbits will continue to develop resistance to these diseases. Therefore it should be combined with traditional control methods such as baiting and the ripping of warrens. New biological control agents, including fertility control vaccines, are being developed.

European and Spanish fleas

European rabbit fleas (*Spilopsyllus cuniculi*), have been utilised as a 'vector' to spread Myxomatosis and RCD among rabbit populations within the agricultural regions of SA. A Spanish rabbit flea (*Xenopsylla cunicularis*) appears to be a more effective 'vector' in arid areas where it has the ability to persist longer in the hot and dry environment. It is currently being trialled at Venus Bay Conservation Park on Eyre Peninsula to determine its effectiveness in arid and coastal environments.

Advantages / Myxomatosis

- Effective
- species-specific.

Advantages / RCD

- Effective
- species-specific
- highly virulent and also achieves high infection levels.

Disadvantages / Myxomatosis

- Genetic resistance can develop
- virulent strains kill quickly and never achieve high infection levels.

Disadvantages / RCD

- Effectiveness relies on age
- infected individuals that survive become immunised.

Possible impacts of control

Reducing rabbit numbers could impact negatively on native birds of prey, including owls and Wedge-tailed Eagles, as they rely on rabbits to make up part of their diet. To address this, control should be undertaken over a number of years and rabbit numbers reduced slowly to allow prey animals time to change their diet.

Since rabbits are the primary food of foxes and cats in most of Australia, when rabbit numbers are greatly reduced, cats and foxes may turn to native fauna as alternative prey. However, this increased impact on native fauna is potentially only short-term. A long-term reduction in rabbit density might actually reduce cat and fox densities, and so reduce their effect on native fauna in the longer term (BGEA, 1999d).

FERAL CATS

Possible control methods

On islands, feral cat control is feasible, however, existing methods are not suitable for broad-scale control of feral cats over most of mainland Australia, due to the lack of effective and humane techniques. However, it is possible to remove feral cats from small areas and to manage the effects of feral cats in localised areas with variable levels of success.

Shooting

Spotlight shooting has been used to some effect to reduce feral cat numbers. Shooting is often carried out by recreational shooters. For example, the former South Australian Department of Environment and Natural Resources used recreational hunters to complement other methods of feral cat control in some areas (Naismith, pers. comm., as cited in BGEA, 1999d). However, the magnitude of the success of this technique is not well measured, and as a technique it is labour intensive (needing to be applied for an extended period of time) and currently there is no code of practice for the humane destruction of feral cats. It is a difficult method of control for feral cats since they generally avoid human contact (BGEA, 1999d).

If being used as a control method, shooting should be timed to take advantage of opportunities that expose feral cats to such control actions, such as wet season flooding.

Advantages

- Sporting shooters can be used (which is cost-effective).

Disadvantages

- Success is not well measured
- labour-intensive
- cats generally avoid human contact.

Animal welfare

- Potentially humane if trained personnel are used.

Trapping

Steel-jaw traps are illegal. Soft-jawed traps, such as the Victor Soft Catch™ traps, are humane, and are often used for the live capture of feral cats and represent a viable option for control. Soft Catch traps have the additional advantage in that they have an adjustable pan that tensions the trap to prevent lighter non-target species from being caught (BGEA, 1999d).

Cage traps are also widely used, but are generally ineffective for trapping feral cats. To successfully trap feral cats, the attractant chosen is most important. Research on a number of lure types is currently being undertaken (BGEA, 1999d). Trapping as a control method is labour-intensive.

Advantages

- Humane traps exist
- lighter non-target species are not impacted upon.

Disadvantages

- Labour-intensive.

Animal welfare

- Traps such as steel-jawed traps and neck snares are considered inhumane.

Baiting

Baiting techniques for feral cats have been successfully trialled in Western Australia and are now being used in remote areas (Kuys, pers. comm., 2005). Other research within Australia is currently examining audio and visual attractants that will lure feral cats to baits. Bait additives that enhance smell and taste are also being evaluated. Certain lures being examined may also be used to trap cats and monitor cat abundance (BGEA, 1999d).

Other difficulties with baiting feral cats are that they are often found in low densities, can have large home ranges, are disinclined to feed on carrion except during drought or during food shortages, and are naturally wary. Therefore, the timing of a baiting program is critical for the successful baiting of feral cats (Short et al., 1997, Algar pers. comm. cited in BGEA, 1999d).

Available toxins

Cyanide has been used to assess bait preferences of feral cats (Friend and Algar 1995; Algar and Sinagra, 1996), predominantly because the poison was fast-acting and therefore was seen as being

APPENDIX 4: METHODS OF FERAL ANIMAL CONTROL AND MONITORING OF EFFECTIVENESS

FERAL CATS / CONTINUED

humane. However, the use of cyanide in Australia for pest control is currently illegal except under permit for research (BGEA, 1999d).

Advantages

- Potentially operational and cost-effective.

Disadvantages

- Less effective than for other feral species
- a widely used bait has not been developed
- felid-specific toxin is not yet available.

Fumigants

Feral cats are known to occasionally use rabbit warrens as dens or shelter. They can therefore be vulnerable to techniques such as fumigation. The method would be the same as that discussed for fumigating rabbit warrens.

Advantages

- Can be effective.

Disadvantages

- Effectiveness depends on the skill of operator
- labour-intensive and slow
- expensive
- not suitable for large areas
- uncomfortable and tiring for operators.

Biological control

Feline panleucopenia occurs in feral cat populations on all large land masses including mainland Australia and Tasmania. This disease showed potential as a biological control method for feral cats, causing a significant reduction in cat population numbers when it was introduced to sub-Antarctic Marion Island by South African wildlife authorities to control feral cats in 1977 (Van Rensburg et al., 1987). However, the reason for the initial success of biological control is that the cats had no immunity to the disease. Although this disease causes high mortality in non-immune populations, it confers immunity on survivors. Screening of blood samples in Australian feral cats indicates that there is widespread immunity to the disease (Moodie, 1995), suggesting that the disease is already circulating through feral cat populations and any control effect is already operating. For mainland situations this disease has little tactical value. For Australia, it seems unlikely that there are any felid-specific pathogens that may be suitable as biological control agents, that is, any that are sufficiently virulent, humane and from which domestic cats can be protected (Moodie, 1995).

Advantages / other pathogens

- Can appeal as a long-term and cost-effective method
- can be effective over large areas.

Disadvantages / Feline panleucopenia

- Confers immunity to survivors
- widespread immunity in feral cats in Australia.

Disadvantages / other pathogens

- No felid-specific pathogens available for use in Australia
- domestic cats may be affected.

Animal welfare

- Potentially inhumane
- domestic cats may be effected.

Fertility control

Substantial efforts are being made to develop immunocontraceptive vaccines for several vertebrate pests, particularly foxes, rabbits and mice, with a major benefit being that they are humane. Currently there are no effective chemical sterilants which produce permanent sterility in cats (Moodie, 1995).

Advantages

- Favoured by animal welfare
- can be species-specific.

Disadvantages

- No effective sterilants for cats.

APPENDIX 5: CONSERVATION RATINGS AND PRIORITIES

CONSERVATION STATUS CODES

Extinct/presumed extinct

Not located despite thorough searching of all known and likely habitats; known to have been eliminated by the loss of localised population(s); or not recorded for more than 50 years from an area where substantial habitat modification has occurred.

Endangered

Rare and in danger of becoming extinct in the wild.

Threatened

Likely to be either Endangered or Vulnerable but insufficient data for a more precise assessment.

Vulnerable

Rare and at risk from potential threats or long-term threats which could cause the species to become endangered in the future.

Uncertain

Likely to be either Threatened or Rare but insufficient data for a more precise assessment.

Rare

Has a low overall frequency of occurrence (may be locally common with a very restricted distribution or may be scattered sparsely over a wider area). Not currently exposed to significant threats, but warrants monitoring and protective measures to prevent reduction of population sizes.

Uncommon

Less common species of interest but not rare enough to warrant special protective measures.

Not of particular significance/Common

Also indicated by a blank entry.

NEAGLE'S CONSERVATION PRIORITIES

Description of Neagle's Conservation priorities for plant association categories found in the Murray Mallee LAP area that are not conserved or poorly conserved in South Australia (Neagle, 1995).

***Eucalyptus cyanophylla* Open Mallee**

Priority 3

Poorly conserved in South Australia. Most remaining examples are small and/or degraded and/or atypical.

***Eucalyptus porosa* Woodland**

Priority 5

Poorly conserved in South Australia. Numerous moderately large examples still remain in South Australia but many examples have degraded understoreys and/or are currently under threat.

***Allocasuarina luehmannii* (Buloke) Low Woodland**

Priority 6 Endangered Ecological Community under EPBC Act

Moderately conserved interstate. Nil conservation in South Australia. Very rare and endangered in South Australia.

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