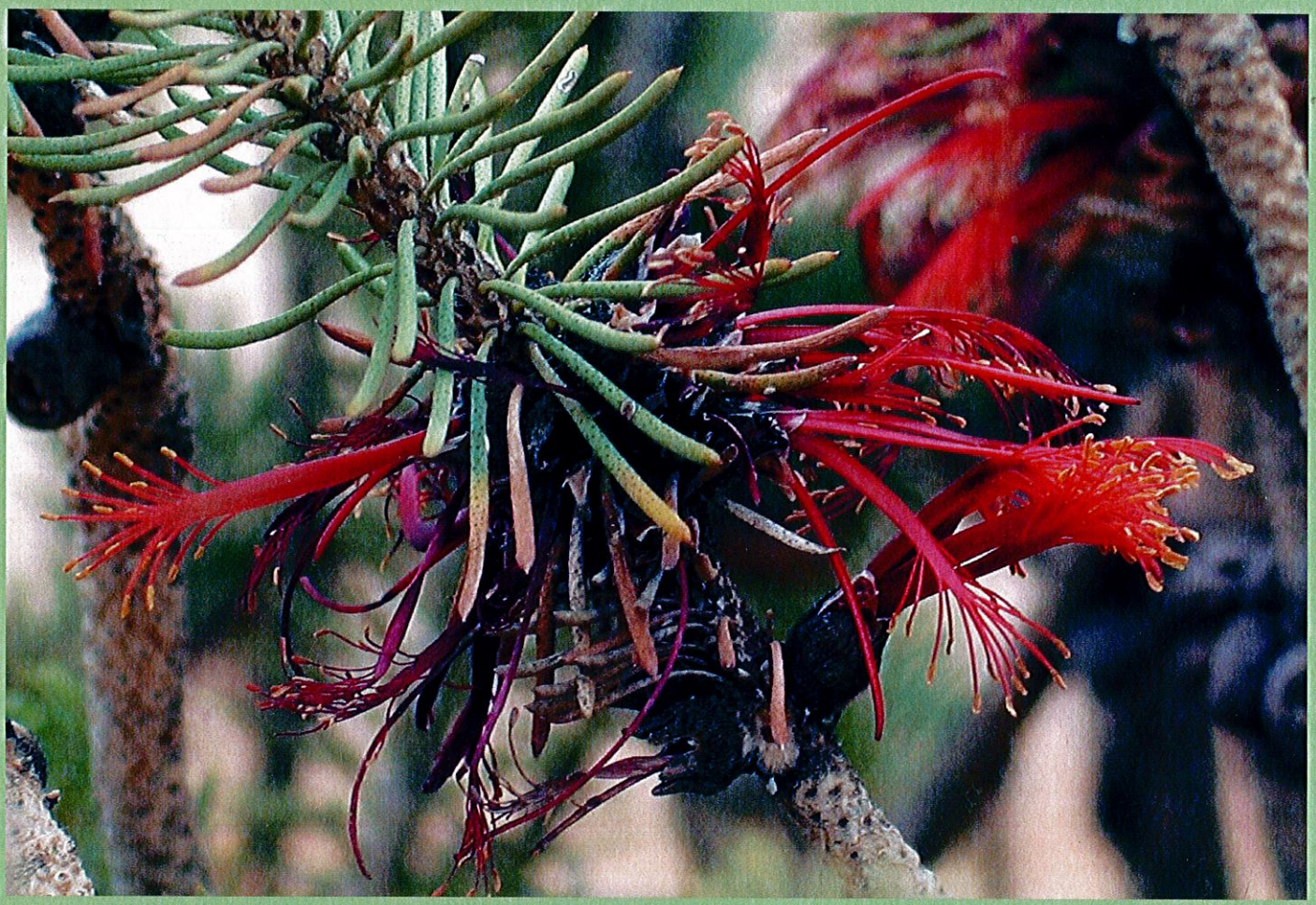
DECLARED RARE AND POORLY KNOWN FLORA

Largely Restricted to the Shire of Wongan-Ballidu

By Gillian Stack, Nicole Willers, Mike Fitzgerald and Andrew Brown



2006

Wildlife Management Program No. 39

GOVERNMENT OF WESTERN AUSTRALIA
DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA
Natural Heritage Trust
Helping Communities Helping Australia

Western Australian Wildlife Management Program No. 39

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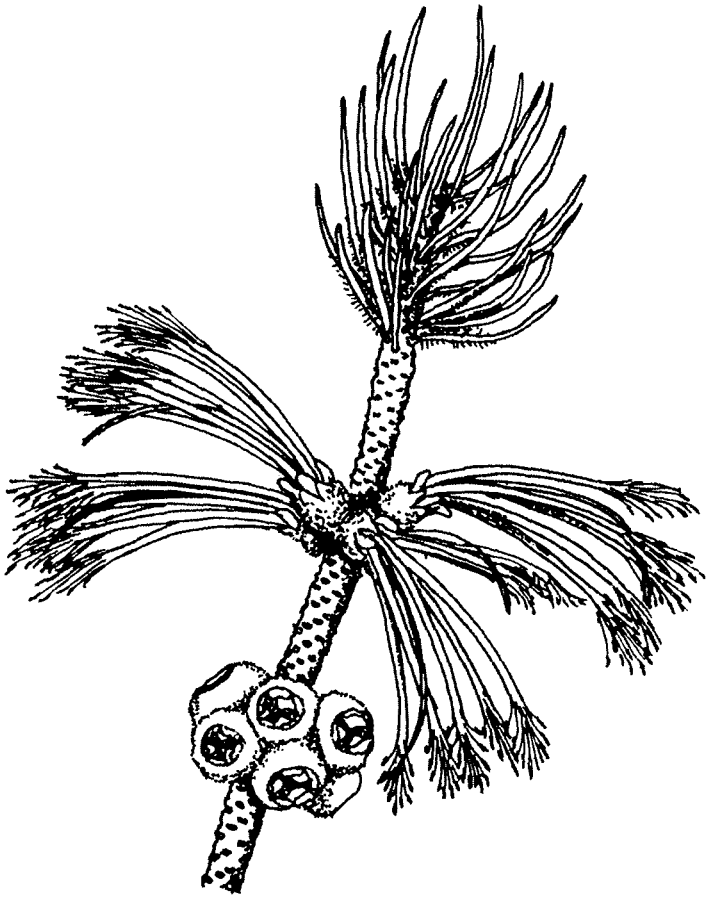

Title page illustration of the recently rediscovered *Calothamnus accedens* drawn by Susan Patrick

Cover Page Photograph by Rosemarie Rees

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FOREWORD

Western Australian Wildlife Management Programs are a series of publications produced by the Department of Conservation and Land Management (CALM). The programs are prepared in addition to Regional Management Plans and species' Recovery Plans to provide detailed information and guidance for the management and protection of certain threatened and Priority species within a particular area.

This program provides a brief description of the appearance, distribution, habitat and conservation status of flora declared as rare under the Western Australian Wildlife Conservation Act (Threatened Flora) and poorly known flora (Priority Flora) in the Shire of Wongan-Ballidu and makes recommendations for research and management action necessary to ensure their continued survival. By ranking the Declared Rare Flora in priority order for these requirements, Departmental staff and resources can be allocated to plant taxa most urgently in need of attention.

Priority Flora that are under consideration for declaration are dealt with to a lesser extent than the Declared Rare Flora. However, the information available should assist in the ongoing work of assessment of their conservation status.

This Program was approved by the Department of Conservation and Land Management as at 19 September 2005.

Approved programs are subject to modification as dictated by new findings, changes in species' status and completion of recovery actions.

Information in the Plan was accurate at April 2005.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

Work on this document has been undertaken over several years by several different authors with the help of a large number of other people who provided advice and assistance during that time.

Field surveys were undertaken by Mike Fitzgerald and Nicole Willers in 2000 and 2001, often with valuable assistance from the Toodyay Naturalists' Club and other CALM staff.

Kate Roy-Chowdhury and Paul Blechynden from CALM's Merredin District have provided advice and have been extremely helpful and supportive during the writing of this document, as has Jill Pryde from CALM's Species and Communities Branch.

We are grateful to a number of botanists who have provided slides to illustrate these plant taxa, including Anne Cochrane, Andrew Crawford, Elizabeth George, Steve Hopper, Bruce Maslin, Leonie Monks, Sue Patrick and Margaret Pieroni.

Ted Griffin from the Western Australian Agriculture Department provided advice and recent mapping data about the soils in the Shire of Wongan-Ballidu.

Anne Cochrane and Andrew Crawford from CALM's Threatened Flora Seed Centre made available their data regarding seed collections and interpreted the results of germination trials.

The Botanic Gardens and Parks Authority's Nursery Manager Amanda Shade provided a great deal of information about propagation techniques that were either known to be or thought likely to be effective for these threatened plant taxa.

Ken Atkins, Liesl Rohl, John Riley and Melanie Harding from CALM's Species and Communities Branch all provided information and assistance.

PART ONE: INTRODUCTION

1. The need for management

Western Australia has a unique flora, world-renowned for its diversity and high level of endemism. WACENSUS, the database of plant names for the State, lists 13 575 current plant taxa (species, subspecies and varieties) (May 2004), with the total likely to exceed 16 000 once botanists have completed surveying, searching and describing the flora. A significant proportion of the Western Australian flora are concentrated in the South West Botanical Province, where there are many endemic plant taxa due to a long history of isolation, general climatic and geological stability and the mosaic of landscapes and soil types produced by smaller scale erosion and recurring climatic stresses in the transitional rainfall zone of 300-800 mm (Hopper 1979). According to Briggs and Leigh (1996) the State has 45.9 percent of the Australian total of threatened, rare or poorly known plant taxa, with 79 percent of those restricted to the south-west. Currently, 362 Western Australian plant taxa are declared as rare flora, and a further 2,138 are listed as priority flora on the Department of Conservation and Land Management's (CALM) Priority Flora List because they are thought to be rare and possibly threatened but require further survey or are rare but not currently threatened (Atkins, 2005).

Although some plants are rare because of their requirement for a specific restricted habitat, the majority have become rare or threatened because of the activities of humans. Extensive land clearing and modification of the environment has resulted in the extinction of some plant taxa and threatens the survival of many others. Continued land clearing, road works, grazing by domestic stock and rabbits, plant pathogens (particularly *Phytophthora* species), exotic weeds and insects, inappropriate fire regimes and rising saline water tables continue to threaten many plant taxa.

The *Wildlife Conservation Act 1950* and the *Conservation and Land Management Act 1984* provide the guidelines and legislative basis for the conservation of the State's indigenous plant and animal taxa. CALM is responsible for the administration of the Wildlife Conservation Act, and hence, is responsible for the protection and conservation of flora and fauna on all lands and waters throughout the State. Section 23F of the Act states 'Where the Minister is of the opinion that any class or description of protected flora is likely to become extinct or is rare or is otherwise in need of special protection he may, by notice published in the Government Gazette declare that class or description of flora to be rare flora for the purposes of this section throughout the State.' This gives the Minister for Environment statutory responsibility for the protection of those plant taxa that are listed as rare flora. The plant taxa addressed in this Program that are currently specially protected by the Wildlife Conservation Act are listed in Table 1. This table also reflects the IUCN categories of threat under which the Declared Rare flora addressed in this Program are currently ranked (see Section 4 of the Introduction for further information about these categories).

Table 1: Plant taxa addressed in this Program that are listed under the *Wildlife Conservation Act* as at 2005

Status according to IUCN criteria	**Taxon**
Critically Endangered	*Acacia cochlocarpa* subsp. *velutinosa*
	Acacia pharangites
	Calothamnus accedens
	Gastrolobium glaucum
	Grevillea dryandroides subsp. *dryandroides*
	Lysiosepalum abollatum
	Verticordia staminosa subsp. *staminosa*
Endangered	*Acacia pygmaea*
	Conostylis wonganensis
	Melaleuca sciotostyla
	Philotheca wonganensis
	Stylidium coroniforme
Vulnerable	*Eremophila ternifolia*
	Eucalyptus recta
	Microcorys eremophiloides
	Rhagodia acicularis

A second layer of legislative protection is provided at the Federal level in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This Act focuses on addressing matters of national environmental significance (such as migratory species and species or communities listed under the EPBC Act or covered under National and International agreements), and on the conservation of Australia's biodiversity. Currently, not all plant taxa considered threatened under State legislation are listed under the EPBC Act, and there are many discrepancies between State and Commonwealth lists in the threat categories that plant taxa are ascribed to. However, this is currently being addressed. Plant taxa addressed in this Program that are currently listed under the EPBC Act are shown in Table 2.

Table 2: Plant taxa addressed in this Program that are listed under the *EPBC Act* as at 2005

Status	Taxon
Presumed Extinct	*Calothamnus accedens*
Endangered	*Acacia pharangites*
	Acacia pygmaea
	Eremophila ternifolia
	Gastrolobium glaucum
	Grevillea dryandroides subsp. *dryandroides*
	Melaleuca sciotostyla
	Philotheca wonganensis
	Stylidium coroniforme
	Verticordia staminosa subsp. *staminosa*
Vulnerable	*Acacia semicircinalis*
	Daviesia spiralis
	Rhagodia acicularis

Currently, 362 extant Western Australian plant taxa are listed as Declared Rare Flora and a further 14 listed as Presumed Extinct. In addition to those that are declared rare, 2,138 plant taxa were listed on CALM's informal Priority Flora List in February 2005 - 586 Priority 1 plant taxa, 615 Priority 2 plant taxa, 612 Priority 3 plant taxa and 325 Priority 4 plant taxa (Atkins, 2005). Priority 1, 2 and 3 plant taxa require further detailed survey to accurately assess their conservation status while Priority 4 plant taxa are rare but not currently threatened, and require monitoring every 5-10 years.

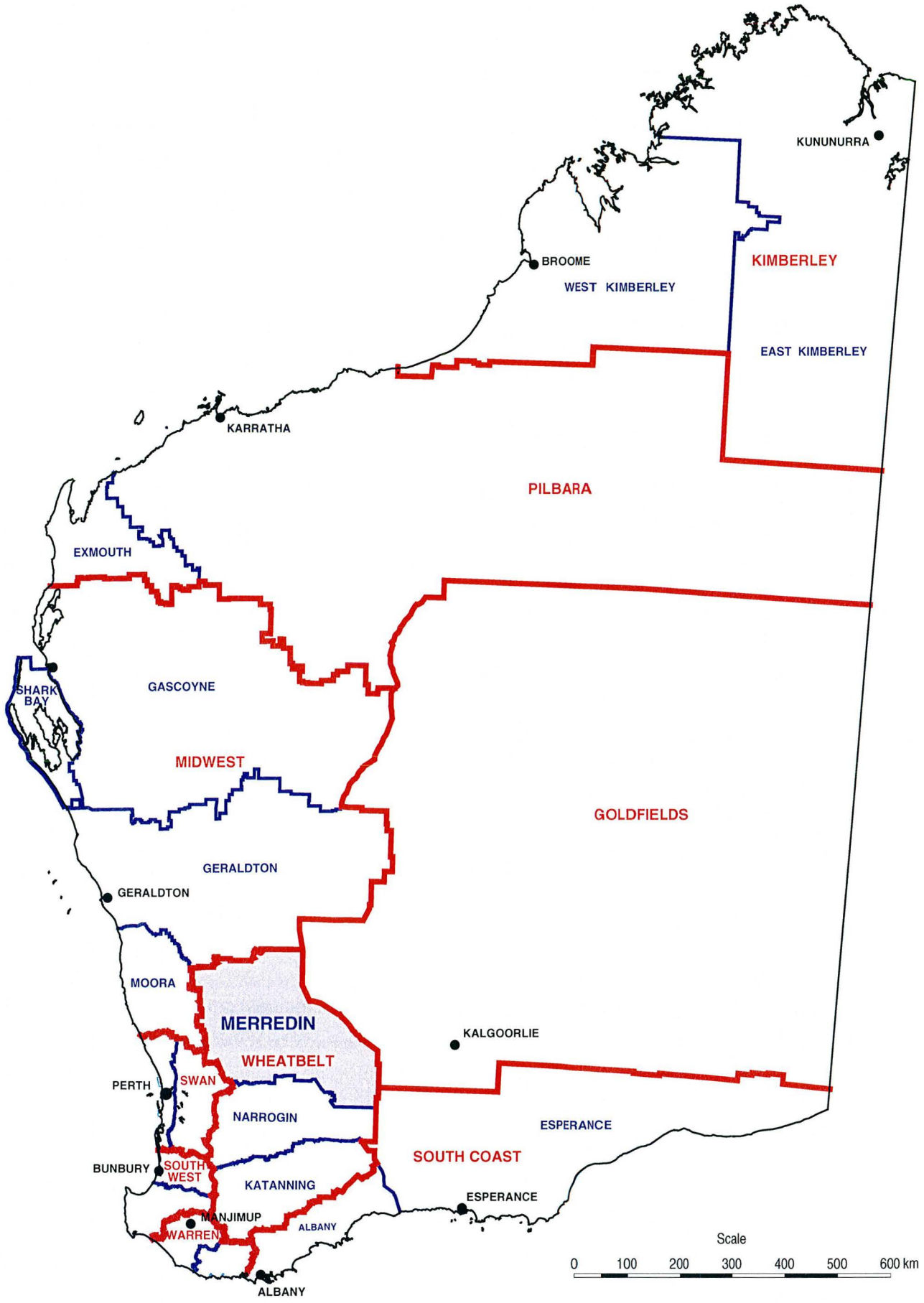
Further information can be found in *Western Australia's Threatened Flora* (Brown *et al.*, 1998) which provides illustrations of many Declared Rare plant taxa, discusses the conservation of Western Australia's threatened plant taxa and reviews the relevant legislation and the policy, research and management activities of CALM.

This Wildlife Management Program collates the available biological and management information on the Declared Rare and Priority plant taxa that are restricted predominantly to the Shire of Wongan-Ballidu, as at April 2005. Plant taxa whose range includes the Shire of Wongan-Ballidu but extend significantly beyond it are addressed within the document *Declared Rare and Other Plants in Need of Special Protection in the Merredin District* (Mollemans *et al.*, 1993).

CALM's Merredin District occurs at the northern end of the Wheatbelt Region, and covers approximately 63 000 km^2. Figure 1 shows the location of the Merredin District in relation to the other CALM Management Regions of the State. The Shire of Wongan-Ballidu occurs on the western side of the Merredin District, as shown in Figure 2. It is approximately 3,350 km^2 in area, much of which has been cleared for agriculture. It has only 5.2% (17,454 ha) natural vegetation cover remaining (Shepherd, Beeston and Hopkins, 2002), which is comparable with many wheatbelt shires. This figure is boosted by the large area of natural vegetation associated with the Wongan Hills. The flora of the Wongan-Ballidu shire was excluded from the Wildlife Management Program for Merredin District (Mollemans, Brown and Coates, 1993) in the belief that it warranted a separate plan. The planning for management of the Wongan-Ballidu Shire's flora was conducted separately to that of the rest of the Merredin District due to the high number of plant taxa that occur in this localised area, an unusually high proportion of which are endemic to the shire (i.e, they occur nowhere else). This is true of plant taxa from the sandplain as well as those of the Wongan Hills. Figure 3 illustrates the soil types and relief of the Shire of Wongan-Ballidu in

more detail. A heavy clustering of threatened flora can be seen on the soils of the Wongan Hills system, but this clustering is also partly due to the relatively high percentage of remnant vegetation in that area. The outline of remnant vegetation areas can be seen in Figure 4, which also illustrates various land tenures in the Shire of Wongan-Ballidu.

Figure 1. Location of the Merredin District



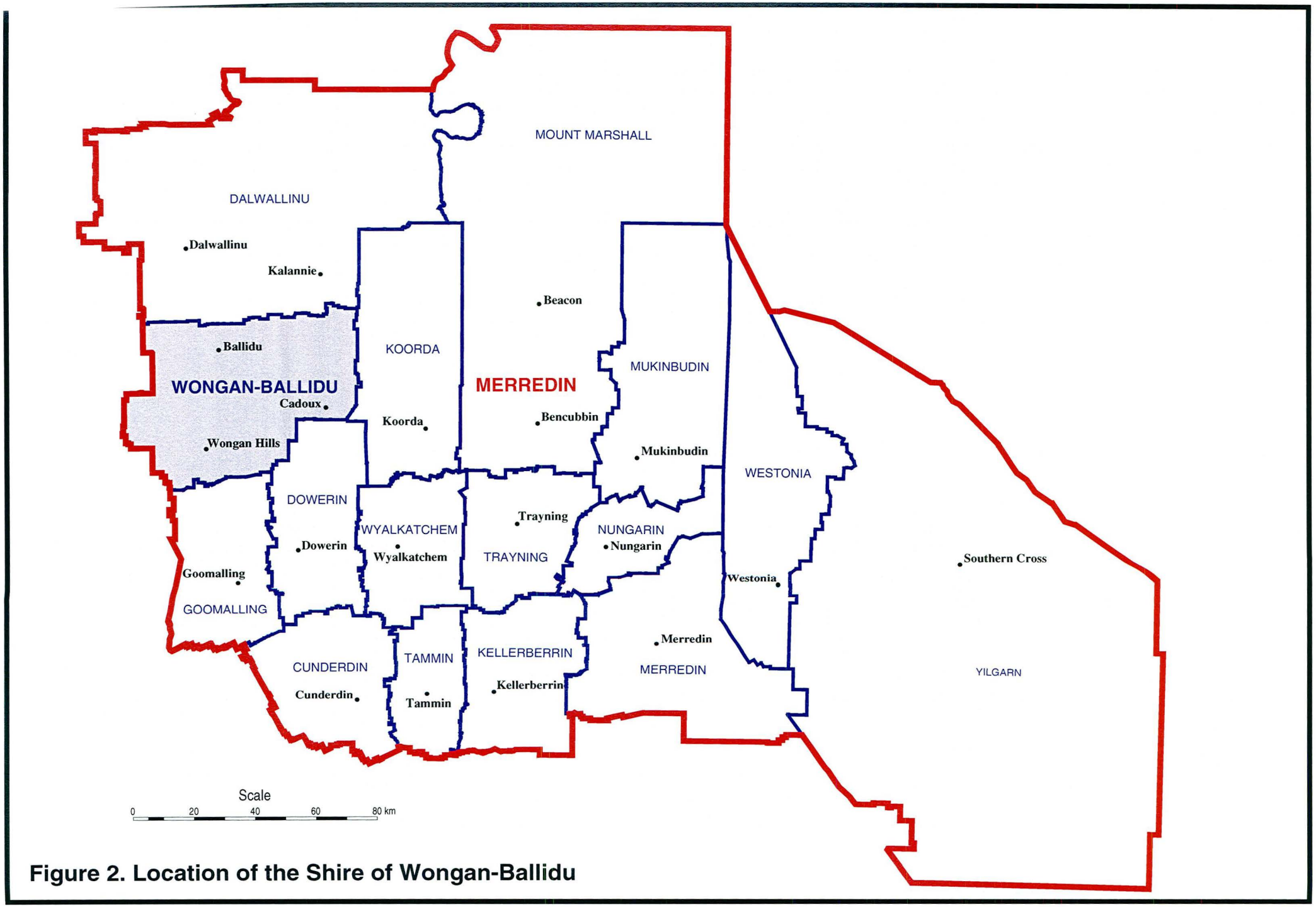
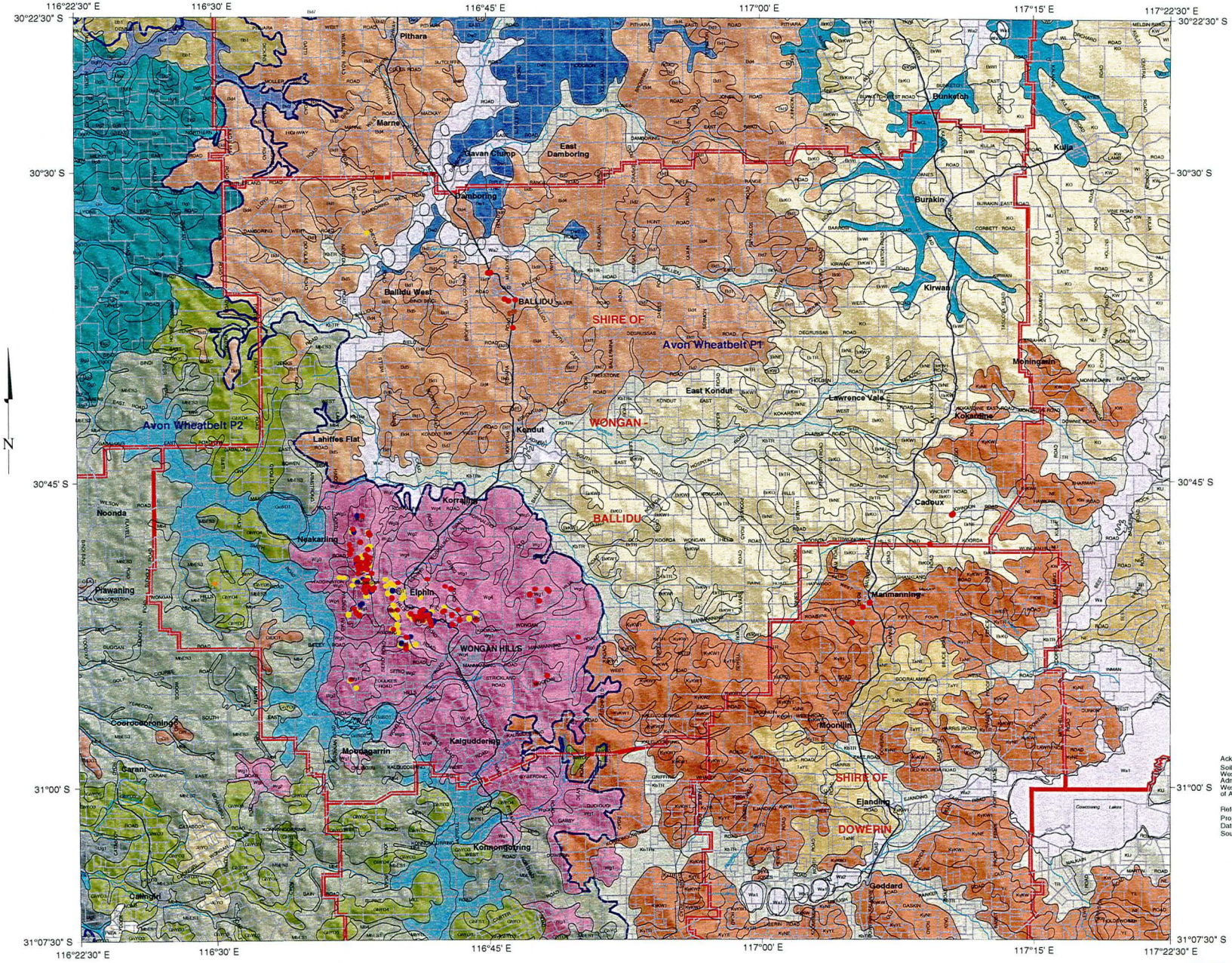


Figure 2. Location of the Shire of Wongan-Ballidu

Figure 3. Soil-Landscape of the Shire of Wongan-Ballidu



Legend

Declared Rare and Priority Flora

- R (DRF - Extant Taxa)
- X (DRF - Presumed Extinct Taxa)
- Priority 1
- Priority 2
- Priority 4

Mir Frahmand and Gerard Grealish
Department of Agriculture Western Australia

Eastern Darling Range Zone

- Ug **Udamong System:**

Northern Zone of Rejuvenated Drainage

- Bg **Burabidge Hill System:**
- Bv **Berkshire Valley System:**
- Gh **Greenhills System:**
- Go **Goomalling System:**
- Gt **Glentrome System:**
- Jc **Jelcobine System:**
- Mb **Morbinning System:**
- Ps **Phillips Sandplain System:**
- Wg **Wongan Hills System:**

Northern Zone of Ancient Drainage

- Bb **Balgerbine System:**
- Bd **Ballidu System:**
- Be **Beacon System:**
- Br **Bonnie Rock System:**
- Dw **Dalwallinu System:**
- Kb **Kellerberrin System:**
- Ky **Kwolyin System:**
- Ta **Tandegin System:**
- Wa **Wallambin System:**

Note: Refer to Appendix 1 for map unit chararcteristics

Acknowledgements
Soil survey by Mir Frahmand and Gerard Grealish, Department of Agriculture Western Australia. Digital cadastre base supplied by the Department of Land Administration. Map prepared by P.M. Goulding, Department of Agriculture Western Australia. Funded by the National Landcare Program and Department of Agriculture Western Australia.

Reference
Projection: Universal Transverse Mercator Zone 50
Datum: Geocentric Datum of Australia 1994
Source data: Field survey and interpretation of aerial photography and satellite imagery.

GDA

- Soil-landscape boundary
- Cadastral road boundary
- River/stream
- Local Government Authority boundary
- IBRA boundary (Added by CALM)
- Railways (Added by CALM)

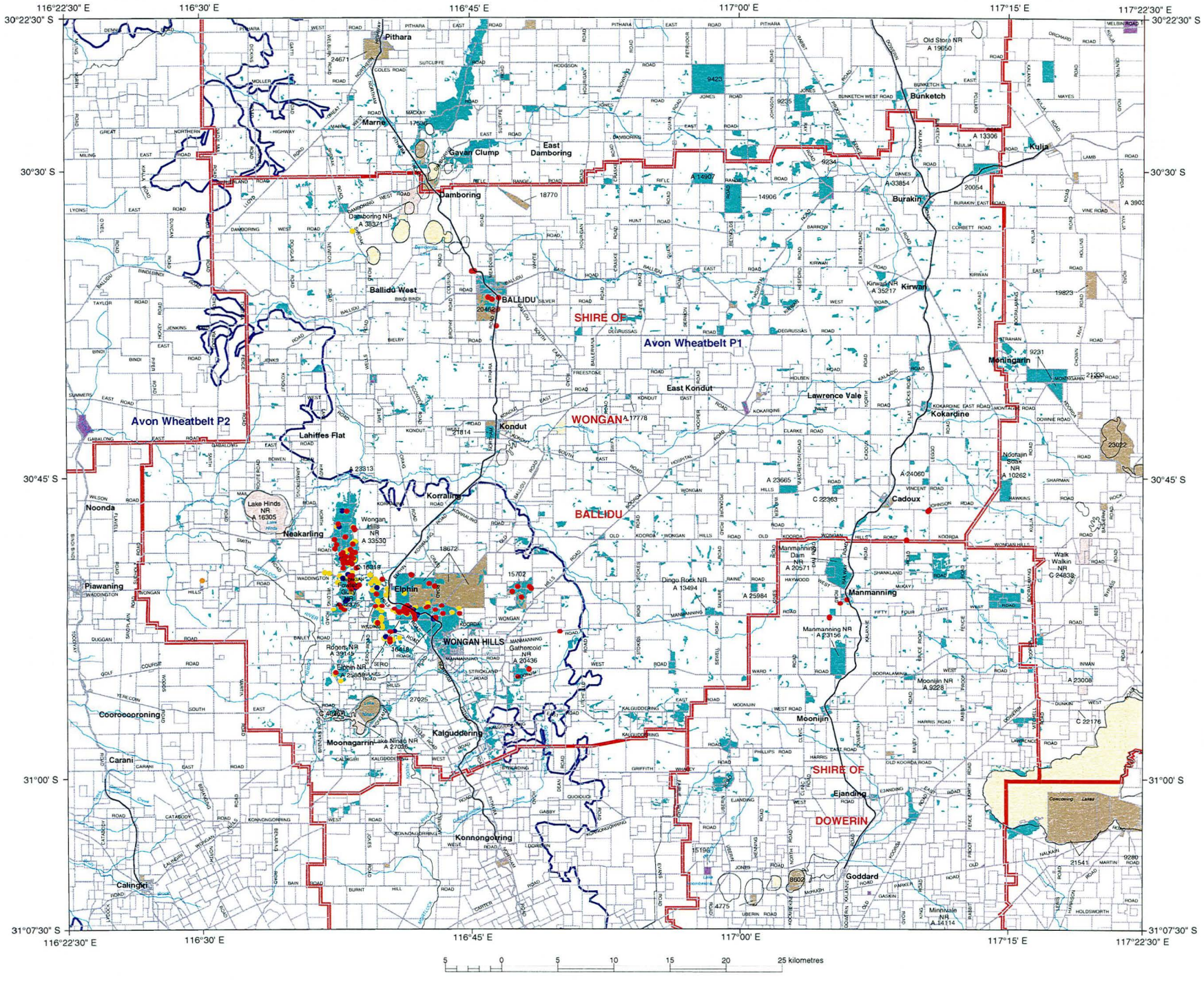
5 0 5 10 15 20 25 kilometres

Additional information provided by Information Management Branch, CALM June 2003 Job Number: 03022520

NATIONAL LANDCARE PROGRAM

Department of Conservation and Land Management
Department of Agriculture
Government of Western Australia

Figure 4. Tenure Map of the Shire of Wongan-Ballidu



2. Objective of the program

The objective of the Wildlife Management Program (flora) for the Shire of Wongan-Ballidu is:
To ensure and enhance, by appropriate management, the continued survival in the wild of populations of Declared Rare Flora and other plants in need of special protection.

It aims to achieve this by:

- providing a useful reference for CALM staff and other land managers for the day-to-day management and protection of Declared Rare Flora populations and populations of other plant taxa that are poorly known and may be at risk;
- directing Departmental resources within the Wongan-Ballidu Shire to those plant taxa most urgently in need of attention;
- assisting in the identification of Declared Rare plant taxa and other plant taxa potentially at risk, and their likely habitats; and
- fostering an appreciation and increased awareness of the importance of protecting and conserving Declared Rare Flora and other plant taxa potentially at risk or in need of special protection.

3. Rare flora legislation and guidelines for gazettal

The *Wildlife Conservation Act 1950* protects all classes of indigenous flora throughout the State. Protected flora includes:

Spermatophyta - flowering plants, conifers and cycads
Pteridophyta - ferns and fern allies
Bryophyta - mosses and liverworts
Thallophyta - algae, fungi and lichens

Section 23F of the Act provides special protection to those plant taxa (species, subspecies, varieties, hybrids) considered by the Minister to be:

- In danger of extinction - the taxon is in serious risk of disappearing from the wild state within one or two decades if present land use and other causal factors continue to operate;
- Rare - less than a few thousand adult plants of the taxon existing in the wild;
- Deemed to be threatened and in need of special protection - the taxon is not presently in danger of extinction but is at risk over a longer period through continued depletion, or occurs largely on sites likely to experience changes in land use which could threaten its survival in the wild;

  or

- Presumed Extinct - plant taxa which have not been collected, or otherwise verified over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.

In addition, hybrids or suspected hybrids which satisfy the above criteria must also be:

- a distinct entity, that is, the progeny are consistent with the agreed taxonomic limits for that taxon group;
- capable of being self-perpetuating, that is, not reliant on the parental plant taxa for replacement; and
- the product of a natural event, that is, both parents are naturally occurring and cross fertilisation was by natural means.

Protection under Section 23F is achieved by declaring flora to be 'rare flora' by notice published in the Government Gazette. CALM's Policy Statement No. 9 Conservation of Threatened Flora in the Wild, 1992b (soon to be replaced by Policy Statement No. 9 Conserving Threatened Species and Ecological Communities, 2003) discusses the legislation relating to Declared Rare Flora and outlines the criteria for gazettal.

Under the provisions of Section 23F, the 'taking', by any person, of Declared Rare Flora is prohibited on any category of land throughout the State without the written consent of the Minister. A person breaching the Act is liable to a penalty of up to $10,000. The legislation refers only to wild populations and applies equally to Government officers and private citizens on Crown and private land.

To 'take' in relation to any flora includes 'to gather, pluck, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means'. This includes not only direct destruction or injury by human hand or machine but also such activities as allowing grazing by stock, introducing pathogens, altering water tables so as to inundate or deprive the flora of adequate soil moisture, allowing air pollutants to harm foliage, and burning.

The Schedule published in the Government Gazette is revised annually to accommodate additions and deletions to the list of Declared Rare Flora. To qualify for gazettal, plants must satisfy certain requirements as defined in Policy Statement No. 9 (CALM, 1992b), namely:

- the taxon (species, subspecies, variety) must be well-defined, readily identifiable and represented by a voucher specimen in a State or National Herbarium. It need not be formally described under conventions in the International Code of Botanical Nomenclature, but such a description is preferred and should be undertaken as soon as possible after listing on the Schedule;
- the taxon must have been thoroughly searched for in most likely habitats in the wild by competent botanists during the past five years; and
- the searches have established that the plant in the wild is either rare, endangered or otherwise and in need of special protection.

Plants may be deleted from the Declared Rare Flora Schedule where:

- recent botanical survey has shown that the taxon is no longer rare, endangered or in need of special protection;
- the taxon is no longer in danger of extinction because it has been adequately protected by reservation of land on which it occurs or because population numbers have increased beyond the danger point.

4. IUCN Red List categories

The International Union for the Conservation of Nature and Natural Resources (IUCN) Red List Categories form a system for the classification of a wide range of organisms according to their risk of global extinction. The IUCN have produced Red Data Books and Red Lists for almost 30 years. In earlier years the categories were quite subjective, and in 1989 the IUCN Species Survival Commission started to develop a more objective classification system. The most recent version accepted by the IUCN Council is Version 3.1 (IUCN, 2000). This document outlines categories of threat that are intended to provide consistent, objective and comparable rankings across plant taxa.

Staff from CALM's Western Australian Threatened Species and Communities Unit periodically rank all Western Australia's Declared Rare plant taxa according to their degree of threat. Recommended rankings are submitted to the independent Threatened Species Scientific Committee (TSSC), which is composed of scientists representing a range of specialist expertise. This committee then makes recommendations to be considered and endorsed by the Minister for Environment. This process facilitates the allocation of resources to those threatened plant taxa that most urgently require them, at a State and also Federal level.

Declared Rare plant taxa are ranked into the following categories according to the highest level of IUCN criteria met.

Extinct (EX)

A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Extinct in the Wild (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalised populations (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Critically Endangered (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see IUCN, 2001), and it is therefore considered to be facing an extremely high risk of extinction in the wild.

Endangered (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see IUCN, 2000), and it is therefore considered to be facing a very high risk of extinction in the wild.

Vulnerable (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see IUCN, 2000), and it is therefore considered to be facing a high risk of extinction in the wild.

Near Threatened (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

Least Concern (LC)

A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant plant taxa are included in this category.

Data Deficient (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well-studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data deficient is therefore not a category of threat. Listing of plant taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

Not Evaluated (NE)

A taxon is Not Evaluated when it has not yet been evaluated against the criteria.

5. CALM's Priority Flora list

CALM maintains a Priority Flora List to determine priorities for survey of plants of uncertain conservation status. In 2005 the List comprised 2,138 plant taxa (Atkins, 2003) that are poorly known and in need of high priority survey or are adequately surveyed but in need of monitoring. Only those plants considered to be threatened or presumed extinct on the basis of thorough survey can be included on the Declared Rare Flora Schedule.

The Priority Flora List is divided into the following categories according to the degree of perceived threat.

Priority One - Poorly Known Plant Taxa

Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

Priority Two - Poorly Known Plant Taxa

Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

Priority Three - Poorly Known Plant Taxa

Taxa which are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.

Priority Four - Rare Plant Taxa

Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These plant taxa require monitoring every 5-10 years.

Currently, there is a single Priority 1 taxon, three Priority 2 plant taxa and eight Priority 4 plant taxa found in the Wongan-Ballidu Shire (see table 3 below). No Priority 3 plant taxa are known from this area.

Table 3: Plant taxa addressed in this Program that are listed in CALM's Priority Flora List as at 2005

Status	Taxon
Priority 1	*Dampiera glabrescens*
Priority 2	*Acacia congesta* subsp. *wonganensis*
	Grevillea kenneallyi
	Verticordia wonganensis
Priority 4	*Acacia botrydion*
	Acacia semicircinalis
	Daviesia spiralis
	Dryandra comosa
	Dryandra pulchella
	Dryandra wonganensis
	Hemigenia conferta
	Loxocarya albipes

6. Responsibilities within CALM

- Reviewing Departmental policy on Declared Rare Flora is the responsibility of CALM's Corporate Executive;

- Identification of Declared Rare Flora is primarily the responsibility of CALM Herbarium staff (Science Division), but is also a responsibility of other CALM staff including some within the Nature Conservation and Regional Services Divisions;

- Locating Declared Rare Flora is the responsibility of staff of the Science Division, Species and Communities Branch (Nature Conservation Division) and Regional Services Division;

- Determination of land status and preparation of material for notification to landowners is the responsibility of Species and Communities Branch;

- Hand-delivered notification to landowners of Declared Rare Flora populations is the responsibility of Regional staff and Species and Communities Branch;

- Maintenance of Declared Rare Flora information and database (CALM, 1990 onwards), and dissemination of this data is the responsibility of Species and Communities Branch;

- Maintenance of the flora ranking database is the responsibility of Species and Communities Branch;

- Advice on management prescriptions is the responsibility of District Managers, Regional and District Program Leaders Nature Conservation, Regional Ecologists and Conservation Officers (Regional Services Division), and staff of Species and Communities Branch and Science Division;

- Coordination of the writing and implementation of Recovery Plans and Interim Recovery Plans for threatened plant taxa is the responsibility of Species and Communities Branch;

- Management, protection and regular inspection of Declared Rare Flora populations is the responsibility of District staff (Regional Services Division);

- Enforcement matters relating to the provisions of the Wildlife Conservation Act are the responsibility of Nature Protection Branch (Nature Conservation Division);

- Implementation and revision of the Management Program is the responsibility of the Threatened Flora Recovery Team.

7. The Shire of Wongan-Ballidu

The Shire of Wongan-Ballidu is in the central wheatbelt of Western Australia in CALM's Merredin District. The Merredin District also contains the Shires of Dalwallinu, Mt Marshall, Koorda, Mukinbudin, Westonia, Goomalling, Dowerin, Wyalkatchem, Trayning, Nungarin, Merredin, Cunderdin, Tammin, Kellerberrin and part of the Shire of Yilgarn. The Merredin District has a total area of approximately 63,000 km^2, of which 3,350 km^2 (333,908 ha) lies within the Shire of Wongan-Ballidu.

The Shire of Wongan-Ballidu contains 21 nature reserves which are managed by CALM. These have a combined area of 4,179.4 hectares, which represents approximately 1.25% of the area of the Shire. For comparison, 5.2% of the Shire retains native vegetation cover (Shepherd, Beeston and Hopkins, 2002). Nineteen of these nature reserves are class A reserves (3,888 ha), and the remaining three are class C reserves (291.4 ha). The Shire also contains a class C water reserve (930.7 ha), a significant proportion of which is remnant natural vegetation. Much of the remaining land has been cleared for agriculture.

Climate

The climate of the Wongan-Ballidu area is Mediterranean, with hot, dry summers and cool, wet winters. January's mean maximum daily temperature is 34.4°C with a mean of 4.2 days being hotter than 40°C. July's mean maximum daily temperature is 17°C with a mean of 1.9 days reaching a minimum lower than 2°C. These means are derived from data collected for over 30 years. (Commonwealth of Australia, 2003).

The Western Australian wheatbelt has a mean annual rainfall of 280-580 mm. Wongan Hills receives a mean annual rainfall of 390 mm, with a mean of 250 mm of that falling within the months May to August. These means are derived from data collected for over 90 years. (Commonwealth of Australia, 2003).

Geology, Landforms and Soils

The Shire of Wongan-Ballidu lies within the Yilgarn Block, which is composed mainly of granites and gneisses, enclosing a number of 'greenstone belts' of metamorphosed layered rocks. The rocks of the metamorphic belts are harder and more resistant than gneiss and granite, so they form ranges of hills, with the granites and gneiss underlying sandplains. Those metamorphosed layered rocks within the Wongan-Ballidu Shire are distinct enough from the surrounding geology to have been provisionally named the Wongan Hills succession (Carter and Lipple, 1982). These are exposed in the north-south trending range of hills west of the townsite of Wongan Hills.

The Wongan Hills succession contains a large proportion of metamorphosed mafic igneous rocks such as metabasalt, metadolerite and metagabbro, smaller developments of metamorphosed felsic igneous rocks, and metasedimentary rocks such as banded iron-formation and chert. Minor occurrences of generally similar lithology crop out at a number of localities north of the hills, including Little Wongan Hill. (Carter and Lipple, 1982).

An earthquake in 1979 (magnitude 6.2 on Richter scale) produced surface faulting and tension gashes in a north-trending belt 14 km long which passed just east of Cadoux (Blight *et al.*, 1984).

The principal drainage through the Shire of Wongan-Ballidu is the seasonal Mortlock River. The region tends to drain into broad Mesozoic valleys, with most of the land within this shire draining south into the Avon palaeodrainage system. The remainder drains north into the Moore palaeodrainage system. However, very heavy rain would be required for these drainage systems to actually flow into the present Avon and Moore Rivers (Blight *et al.*, 1984).

In landform terms, the Wongan Hills are a series of flat-topped mesas, segmented by deep gullies often containing scree slopes. Surrounding the hills is the wider sandplain, broadly containing white and yellow sands with greater or lesser amounts of laterite or ironstone. Large salt lakes and salt flats occur within these sandplains, notably those associated with Mortlock Creek and Mortlock River, such as Lake Hinds to the east of Wongan Hills and Lake Ninan to their south.

Vegetation

The Shire of Wongan-Ballidu falls within the Avon Botanical District, and contains several defined vegetation systems – namely the Wongan Hills, Guangan and Victoria Plains systems (Beard 1979, 1980). The Victoria Plains system occurs in the western section of the Shire. It contains three main vegetation types. Woodlands of *Eucalyptus loxophleba* and *E. salmonophloia*, either singly or together, occupy red soils on the lower ground. A number of *Acacia* species are associated with the *E. loxophleba* woodland, but the smaller understorey herbs and grasses have mostly disappeared. *Allocasuarina campestris* thicket occurs on the few residual sandplains in the system, which are thought to be underlain with gneiss. Mosaics of woodland, teatree and samphire occur on the salt flats. It is likely that the vegetation of the salt flats is highly modified from pre-settlement condition through salinisation resulting from land clearing. Halophytes such as samphire, *Melaleuca uncinata* and other *Melaleuca* species are spreading, and dead vegetation is frequently seen at the lowest points of the salt flats. (Beard, 1979).

The Guangan (named by Drummond and spelling retained; also known as Kwongan) system surrounds the Wongan Hills system and occupies most of the Shire. This system is one of residual sandplain, thought to be underlain with granite. This can be seen as domed outcrops in many places, typically supporting *Allocasuarina huegeliana*, *Kunzea pulchella*, *Acacia acuminata*, *Melaleuca radula* and *Borya*

nitida. Threatened flora taxon *Verticordia staminosa* subsp. *staminosa* occurs on one such granite outcrop.

The dominant vegetation type on the sandplain is Mallee and *Allocasuarina* thicket, with a mosaic of different patches determined by soil variations. Threatened flora taxa *Conostylis wonganensis*, *Dampiera glabrescens*, *Daviesia euphorbioides*, *Gastrolobium glaucum*, *Gastrolobium hamulosum*, *Grevillea dryandroides* subsp. *dryandroides*, *Stylidium coroniforme* and *Verticordia wonganensis* occur on the Wongan-Ballidu sandplains, in shrublands with an *Ecdeiocolea* sedge component. On deeper sands, *Allocasuarina acutivalvis* and *Eucalyptus oldfieldii* dominate in association with *Acacia* and *Grevillea* species. *Eucalyptus recta* occurs on sandy laterite in mallee and *Allocasuarina* thicket and also in *Eucalyptus gardneri* and *E. oldfieldii* woodland with *Dryandra shanklandiorum*. On shallower sand over ironstone gravel *Allocasuarina campestris* and mallee eucalypts such as *E. foecunda*, *E. kochii* subsp. *plenissima*, *E. redunca*, *E. rigidula* and *E. transcontinentalis* dominate.

Yellow sand occurs on some areas of higher ground, and carries an alliance of *Banksia* and *Xylomelum*. A good example of this vegetation type can be seen within Reynoldson's Flora Reserve (Reserve No. 22289). A woodland of *Eucalyptus loxophleba*, *E. salmonophloia* and *E. salubris* occurs on patches of red loam. The uncleared lands of the Experimental Farm near the town of Wongan Hills is a substantial remnant of the Guangan system. (Beard, 1979; Beard, 1980).

The vegetation of the salt flats is dominated by samphire, including *Halosarcia doleiformis*, *H. indica* subsp. *bidens*, *H. halocnemoides*, *H. peltata* and *H. pergranulata* subsp. *pergranulata*. At the lowest points, they form the understorey to dead trees of *Melaleuca* spp. Slightly higher ground carries an open shrubland of *M. lateriflora* and *M. uncinata* over samphire ground cover. (Kenneally, 1977).

The Wongan Hills system occupies a relatively small area incorporating the Hills, and is highly specialised. An *Allocasuarina campestris* and *Dryandra* spp. thicket with scattered emergent mallee occupies the mesa plateaus. This contains threatened flora *Acacia pygmaea*, *Daviesia spiralis*, *Dryandra comosa*, *D. pulchella*, *D. wonganensis* and *Microcorys eremophiloides*. (*Microcorys eremophiloides* has also been found on granite outcrops in the Shires of Dowerin and Goomalling). On the slopes just below breakaways, the vegetation becomes a virtual monoculture of *Melaleuca undulata* low scrub. This gives way to *Allocasuarina campestris* and *Calothamnus asper* thicket on the scree slopes with surface ironstone rubble. Threatened plant taxa *Acacia botrydion*, *A. semicircinalis*, *A. congesta* subsp. *wonganensis*, *Grevillea kenneallyi* and *Melaleuca sciotostyla* occur here. *Acacia pharangites*, *Hemigenia conferta* and *Philotheca wonganensis* occur in this vegetation type in association with fractured or schistose greenstone.

Below this community woodlands occur, with species that vary with soil type. *Eucalyptus longicornis* and *E. salubris* occupy the heaviest red soils developed on metamorphic rocks, while the lighter red soils carry a more open woodland of *E. loxophleba* and *E. salmonophloia*. *Eremophila ternifolia* and *Rhagodia acicularis* occur in these woodlands on valley floors. A wide range of mallees are found on red soils with a surface layer of ironstone, including *E. drummondii*, *E. ebbanoensis*, *E. erythronema*, *E. eudesmioides*, *E. foecunda*, *E. ovularis*, *E. kochii* subsp. *plenissima*, *E. redunca*, *E. sheathiana*, *E. transcontinentalis*, although not all of these occur in one place. (Kenneally, 1977).

Beard and Sprenger (1984) calculated that the Avon Botanical District was 93% cleared, but this figure assumes that private land is fully cleared and does not recognise any areas of remnant vegetation on private lands. In the Shire of Wongan-Ballidu the percentage of land cleared is 94.8%. Vegetation remnants occur within nature reserves, shire and water reserves, road and rail verges and areas left uncleared on private land. This land is often left uncleared initially because of the difficulty of making that land productive (for example, rocky outcrops), heavily biasing the vegetation types that have been retained in remnants.

The severe fragmentation of many remnants affects their ability to sustain viable populations of flora and fauna species, therefore reducing their conservation value. The vegetation retained on and at the base of the Wongan Hills forms the largest single area of natural vegetation remaining in the northern wheatbelt (Kenneally, 1977). Some of this land is now nature reserve (Wongan Hills NR 33530, Mt Rupert NR 23313 and Fowlers Gully NR 42375), and the remainder is held by a number of landholders as private land.

Several features of the Wongan Hills flora are noteworthy in a regional context. *Acacia* and *Eremophila* species are unusually diverse and well represented. There is an unusual concentration of Myrtaceous species that occur elsewhere, but much more widely scattered. *Santalum spicatum* (Sandalwood) also occurs at Wongan Hills, which may become more important as it becomes rarer elsewhere. While the vegetation is not significantly richer in number of species per unit area than other wheatbelt reserves, it does contain an assemblage of species that doesn't occur anywhere else (Kenneally, 1977). Moreover, a number of those individual species are restricted to an ecological niche that occurs only within the Wongan Hills. This area of vegetation is less fragmented than any other in the northern wheatbelt (Kenneally, 1982a), although not all of this area is reserved for nature conservation, and is not necessarily secure.

Fire

The Wongan Hills have been largely unburnt for many decades. Kenneally reports *Calothamnus asper* plants with basal stem circumferences of 60 cm on the western slope of Mt Rupert (1977, p18), indicating a long absence of fire. Local records show that Mt Matilda and Mt Rupert were burnt in 1944, and part of Mt O'Brien was burnt around 1950 (personal communication, D. Holmes). As high points in the landscape, the Wongan Hills would attract lightning strikes to some extent and lightning char marks can be seen on rocks, but these tend not to burn much vegetation at once. This may be partly because the accompanying rain helps to put out the fire, partly due to the relatively rapid response of bush fire brigades due to the visual prominence of fire in the Hills and partly due to the rocky terrain in many areas. The eastern side of Fowler's Gully Nature Reserve was burnt after a lightning strike in 1993, affecting approximately five hectares. In the late 1960s the northern end of the Hills on the east side of Mt Rupert was burnt after a lightning strike, affecting about ten hectares. There was also a fire near Rogers Nature Reserve that escaped from a stubble burn in 2001 (personal communication, M. Fitzgerald). Aerial photos of the areas show fire-scars in the water reserve that may date from the 1960s.

The fire regime that may have existed before European settlement is very difficult to ascertain. The re-establishment of that regime may be undesirable even if it were possible, as the landscape changes under the influence of emerging patterns of climate change, with a trend of increasing temperatures and decreasing rainfall. This will inevitably influence the pattern of wildfires, and the management of threatened flora will need to be informed by a thorough scientific understanding of the response of these plant taxa and their communities to fire. This research will continue to be undertaken until this information is obtained for these plant taxa and for any others that may subsequently be added to the threatened flora listings.

8. Botanical history of the Shire of Wongan-Ballidu

The Wongan Hills formed the focal point of exploration in the area in early years, due to their prominence in the landscape and because explorers had been told of them by Aboriginal people. They were first visited by Europeans in 1836, as part of an expedition undertaken by G.F. Moore, Surveyor-General J.S. Roe, Surveyor G. Smythe and Policemen Heffron, Syred, Craigie and Hampshire. Roe named the Wongan Hills on November 3 1836, following the Aboriginal name for them (Wongan Catta). He also named the highest hill Mt. Matilda after his wife. He noted in his journal: "Here, very thick scrub among young gnardoruk [*Eucalyptus salubris*, Gimlet] trees commenced, and, together with a great quantity of fallen timber and young gnardoruk saplings growing very close together, almost defied our passage. Ironstone as we appeared as we advanced, and at E foot of "SI" peak there was a steep valley whose surface was covered in ironstone, which had also coloured the soil deep red." (cited in Kenneally, 1977, p41). At the same time Roe named Lake Hinds, commemorating R. Hinds, then a director of the Western Australian Bank. Further exploratory expeditions were undertaken in July 1846 by G. de Courcy Lefroy with Surveyor Hillman and in August 1846 by the Gregory brothers. (Kenneally, 1977).

J. Drummond and J. Gilbert set out for the Wongan Hills in September 1842 with the intention of collecting specimens. Drummond collected botanical specimens, and Gilbert was interested in collecting and learning more about the malleefowl that was reported to occur there by the 1836 expedition. Gilbert also collected botanical specimens, a number of which became type specimens for new species described by European botanists such as Bentham, Meisner and Turczaninov. (Kenneally, 1977).

A. Milligan, Honorary Ornithologist to the then Perth Museum, went to Wongan Hills in September 1903 to re-collect from there at the same time of year as Gilbert, and to observe any changes in the avifauna of the area. He noted the absence of malleefowl, and suggested that frequent burning of the bushland by farmers and/or the effect of drought conditions may explain this lack. Early pastoralists often ran their sheep in the care of a shepherd, who would burn off areas of bushland to encourage regrowth suitable for grazing (Kenneally, 1977).

Further major botanical collections were made from the Wongan Hills area by Government Botanist Dr. A. Morrison in October 1903, Dr. F. Stoward (Botanist and Vegetable Pathologist) in 1910, W.M. Carne (Botanist and Plant Pathologist) and C.A. Gardner (then Asst. Botanist and Plant Pathologist) in September 1924, E.H. Ising (botanist) and C.A. Gardner in August 1925, W.E. Blackall (botanist) and C.A. Gardner in September 1931, A.S. George (botanist) in August 1959, R. Erickson (naturalist) in 1963 and Kenneally extensively through the 1970s and 1980s. From many of these collections came type specimens for new species. (Kenneally, 1977; CALM, 1998 onwards).

J. Beard mapped the vegetation of the region for the Vegetation Survey of Western Australia, collecting widely in the Shire of Wongan-Ballidu in October 1976 (CALM, 2003). Land within the shire comprises part of the Moora and Hill River Areas map (Beard, 1979) and part of the Bencubbin Area map (Beard, 1980), both within the 1:250,000 series.

Pastoral grazing of cattle, sheep and horses was the main agricultural practice in the area until 1886, when the first crop of wheat was successfully grown in the Wongan Hills area. The land was cleared for cropping by ringbarking or felling trees and scrub, allowing grass to grow and dry off and then burning the lot. The railway line was extended from Northam to Goomalling in 1901, allowing those seeking agricultural land to move further north, and by 1906 a large number of people had settled in the Wongan Hills area. The township of Wongan Hills was declared in 1907, and the railway further extended from Goomalling to Wongan Hills in 1911. (Kenneally, 1977).

PART TWO: DECLARED RARE FLORA

Currently, 16 plant taxa listed as rare flora under Section 23F of the *Wildlife Conservation Act 1950* are known from the Wongan-Ballidu Shire. These comprise 7 Critically Endangered plant taxa, 5 Endangered plant taxa and 4 Vulnerable plant taxa and are listed below.

Critically Endangered plant taxa are:

Acacia cochlocarpa subsp. *velutinosa*
Acacia pharangites
Calothamnus accedens
Gastrolobium glaucum
Grevillea dryandroides subsp. *dryandroides*
Lysiosepalum abollatum
Verticordia staminosa subsp. *staminosa*

Endangered plant taxa are:

Acacia pygmaea
Conostylis wonganensis
Melaleuca sciotostyla
Philotheca wonganensis
Stylidium coroniforme

Vulnerable plant taxa are:

Eremophila ternifolia
Eucalyptus recta
Microcorys eremophiloides
Rhagodia acicularis

The following section contains information on each of the threatened plant taxa found in the Wongan-Ballidu Shire and includes a description, current status, distribution and habitat, and information on threats and recovery actions for each taxon.

Acacia cochlocarpa subsp. *velutinosa*

Common name: Velvety Spiral Pod Wattle

Family: Mimosaceae

Ranking: Critically Endangered
Flowering period: May to August
Information is accurate: 2004

Photo: Sue Patrick

BACKGROUND

Current status: *Acacia cochlocarpa* subsp. *velutinosa* currently meets World Conservation Union (IUCN) Red List Category Critical (CR) under criteria B1ab(v)+2ab(v) (IUCN 2000) as it is known from a single population, and there is a continuing decline in the number of mature individuals and the area and quality of its habitat, with over 90% of all mature plants occurring in one subpopulation.

Description: *Acacia cochlocarpa* subsp. *velutinosa* is a shrub 30-70 cm tall and up to 300 cm across. Bark is smooth or slightly stringy and reddish-grey. Branches are more or less straight, ribbed and pubescent. Phyllodes are erect, green, 2.5-4 cm long and 3-5 mm wide, flat and shallowly to strongly incurved, with 3-7 unequal nerves, usually hairy on nerves. Inflorescences are paired in axil of phyllode. Flower-heads are bright golden, sub-globular, axillary and 5-7 mm long when dry. Pods are tightly spirally or more or less irregularly coiled, smooth, brown, velvety, impressed around seeds, with broad yellow glabrous margins. Seeds are longitudinal in pod, up to 2.5 mm long and wide, glossy grey with brown speckling with a cream aril. The subspecies is named for its velvety branchlets, nerves and pods (Maslin and Chapman 1999; Mollemans *et al.* 1993).

Acacia cochlocarpa subsp. *cochlocarpa* differs from *A. cochlocarpa* subsp. *velutinosa* in its glabrous branchlets, pods and phyllodes, phyllodes generally longer than 4 cm and obloid to short-cylindrical flower-heads. *A. cochlocarpa* subsp. *velutinosa* also resembles *A. lirellata* subsp. *compressa* in their similar flat, curved, strongly multi-nerved phyllodes, and flower-head shapes, but *A. lirellata* subsp. *compressa* can be distinguished by its non-coiled glabrous pods, glabrous branchlets and glabrous narrower (usually 1-2 mm wide) phyllodes.

Distribution: *Acacia cochlocarpa* subsp. *velutinosa* is currently known from 3 populations in the Dowerin Shire, south-east of Wongan-Ballidu Shire. Population 1 is located on Vacant Crown Land (VCL), and both others occur in remnant vegetation on private property.

Habitat requirements

Soils: Hard white clay loam, possibly associated with the Cadoux fault line

Vegetation: In heath or in *Allocasuarina*, *Acacia* and mallee scrub
Associated Species: *Allocasuarina campestris*, *Ecdeiocolea monostachya*, *Melaleuca sclerophylla*, *Astroloma serratifolium*, *Leucopogon*, *Acacia* and *Borya* spp.

Biology

Fire: Effect on abundance unknown, but Population 3 regrew after a hot burn in December 1986. Fire is likely to be beneficial for inducing recruitment
Disturbance: Unknown
Propagation: Would need some sort of pre-treatment prior to sowing (personal communication, A. Shade)
Pollination: Unknown, but likely to be bee pollinated

Summary of population information for *Acacia cochlocarpa* subsp. *velutinosa*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01	Manmanning	Unallocated Crown Land	14/06/01	30+	Healthy
02	Manmanning	Private Property	23/07/01	5	Healthy
03	Manmanning	Private Property	23/07/01	50+	Healthy
			No. plants	**85**	
			No. popn's	**3**	

Threats

The threats to *Acacia cochlocarpa* subsp. *velutinosa* are:

Track maintenance: This is a threat to Population 1, which occurs on both sides of a vehicle track.

Illegal rubbish dumping: This occurs at Population 1, potentially affecting this taxon as well as its habitat through smothering and trampling.

Town development: (such as housing or recreation areas) in this area could remove or impact on the whole of Population 1 and its habitat.

Low recruitment: Population 3 is the younger population, and is approximately 15 years old.

RECOVERY ACTIONS

Existing Recovery Actions

- Seed was collected in November 1998. Approximately 4500 seeds are stored at the Threatened Flora Seed Centre (TFSC). Although initial germination was low (0-19%), germination after 12 months storage was over 75%, probably indicating better germination techniques as well as high seed viability.
- All known populations were surveyed in 2001, revealing 85 known plants. Despite extensive further survey (160 km of roadsides and 22 Reserves), no additional populations were found.
- The Department of Land Administration was notified of the population on VCL in 2001. The private property landowners guided staff to the populations on their land in the surveys conducted in 2001, and were notified of the Declared Rare status of this taxon in 2002.

Future Recovery Actions

Acacia cochlocarpa subsp. *velutinosa* populations occur on Unallocated (Vacant) Crown Land and private property. Permission will be sought from relevant land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four.

1. Install Declared Rare flora markers

These will alert road maintenance crews working near Population 1 to the presence of these plants, and enable them to minimise the threat by excluding operations from the area between the markers.

Action: Install markers
Populations: 1
Responsibility: CALM (Merredin District)
Cost (minus labour): $300

2. Conduct further surveys to determine conservation status

Although extensive survey has been undertaken in this area during 2001 and 2002, repeated and additional surveys are necessary to assess the conservation status of this taxon. It appears that *Acacia cochlocarpa* subsp. *velutinosa* is limited to a soil type unique to the local area (L. Polomka, unpublished file note). Surveys will be undertaken when the taxon is flowering (June-July).

Action: Conduct further surveys
Responsibility: CALM (Merredin) through MDTFRT
Cost (minus labour): $1,000

3. Investigate land management options

It may be possible to reserve some Unallocated Crown Land at Population 1, and this should be investigated. Strategies to improve the security of Populations 2 and 3 on private property should also be investigated, and may include covenants

Action: Investigate land management options
Populations: 1, 2 and 3
Responsibility: CALM (Merredin) through MDTFRT
Cost (minus labour): Subject to land management options pursued

In addition to the specific recovery actions detailed above, a range of common recovery actions are proposed that will reduce the threats facing the taxon. Those that are particularly relevant include:

- Community education
- Fire management
- Germplasm collection and storage
- Liaise with land managers
- Monitor populations

Acacia pharangites

Common name: Wongan Gully Wattle

Family: Mimosaceae

Ranking: Critically Endangered
Interim Recovery Plan: 20 (Evans & Brown, 1999)
Flowering period: August to September
Information is accurate: 2004

Photo: Nicole Willers

BACKGROUND

Current status: *Acacia pharangites* was declared as Rare Flora in September 1986 and is currently ranked as Critically Endangered under World Conservation Union (IUCN) Red List Criteria B1+2c; C2b; D (IUCN, 1994). The number of mature individual *Acacia pharangites* plants dropped from 329 in 1980 to 117 in 2001. *A. pharangites* is subject to a number of threatening processes and has a very restricted range.

Description: *Acacia pharangites* is a somewhat spindly, open, erect shrub to 4 m tall with main stems sparingly branched near base and phyllodes concentrated towards ends of branches. Bark is grey and slightly roughened. Phyllodes are smooth and rather rigid, linear-terete, slightly narrowed towards the base, 1.5-4 cm long and about 1 mm wide, with a sharp tip. Inflorescences are in axillary racemes of up to 2 flower-heads. Flower-heads golden, obloid, 7-10 mm long and 5-6 mm wide, with about 25 flowers. Legumes pendulous, narrowly oblong, up to 6.5 cm long and about 4 mm wide, slightly undulate, dark brown, glabrous, abruptly narrowed at both ends, prominently raised over the seeds and alternately more pronounced on one side of the legume than on the other. Seeds longitudinal in legume, 3-3.5 mm long, about 2.5 mm wide and about 2 mm thick, and shiny black with a more or less straight yellowish aril about 3 mm long. (Maslin, 1982).

Acacia pharangites has similar phyllode and legume morphology to the south coastal species *A. tetanophylla* but the two species are not closely related. *Acacia pharangites* differs in its taller habit, reduced inflorescences, obloid flower-heads and larger bracteoles. The lack of close relatives indicates that *A. pharangites* should be considered a relict species (Maslin, 1982).

Distribution: *Acacia pharangites* is known from a single population on two private property Locations within the Shire of Wongan-Ballidu. Population 1a contains just over 100 plants and Population 1b only 10. This species is probably naturally rare.

Habitat Requirements

Soils: Grows along sheltered gullies in rocky (greenstone) red-brown clay flanking seasonally dry creeks and also in the grey sand of the creek beds themselves

Vegetation: Scattered through dense scrub 3-4 m tall with sparse ground cover
Associated Species: *Calothamnus asper*, *Allocasuarina campestris*, *A. acutivalvis*, *Melaleuca radula*, *Acacia acuminata* and *A. collina*

Biology

Fire: Unknown, but thought to be necessary to germinate soil-stored seed (Evans & Brown, 1999)
Disturbance: Water erosion is the dominant, natural soil-disturbing process in the species' habitat. It is likely to have a positive effect on recruitment. However, disturbance that accelerates the current rate of erosion may have an adverse effect
Weed invasion: Preferred habitat is not prone to weed invasion, but it would be likely to reduce recruitment, which may lead to population senescence
Grazing: Habitat is not currently threatened by grazing but may be in the future. Grazing would cause adverse habitat modification and reduce chances of recruitment, leading to population senescence
Propagation: Propagated from seed, and can also be propagated from cuttings with moderate success. Need some sort of pre-treatment prior to sowing. Strike rates from Botanical Garden and Parks Authority are between 1 and 25% (personal communication, A. Shade)
Competition: Vulnerable to competition, particularly from native flora. This type of competition is likely to lead to a lack of recruitment, which can cause population senescence
Pollination: Presumed to be insect pollinated, as are many *Acacia* species (Rye, 1980)

Summary of population information for *Acacia pharangites*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01a	Mt O'Brien	Private Property	13/03/2001	107	Healthy
01b	Mt O'Brien	Private Property	8/08/2001	10	Healthy
			No. plants	**117**	
			No. popn's	**1**	

Threats

Acacia pharangites is threatened by a number of processes and interactions that may cause direct deaths, reduce rates of recruitment, and effect habitat changes that are detrimental to the long-term survival of the species. The threats to *Acacia pharangites* are:

Wildfire: Wildfire may represent a significant threat to the species. The population occurs in dense, highly flammable shrublands, located on steeply sloping terrain. Ignition sources, including lightning, stubble burns on nearby farmlands, and other human activities, are present most years. In the event of a wildfire, all known plants are expected to be destroyed. While Evans & Brown (1999) thought that fire may be necessary to germinate soil-stored seed, seedling survival may be adversely affected by a range of factors in the post-fire period. These include competition from other germinating native flora, selective grazing of seedlings by native fauna, and by accelerated erosion of the denuded steep slopes. If fire is not a key factor in germinating seed then wildfire is a serious threat.

Inadequate recruitment: Surveyors have expressed concern about the lack of recruitment seen in the population. It appears to be old, probably single stage. Without the correct recruitment conditions, this lack of recruitment will lead to a continuing decline in population numbers and ultimately, population senescence. Recruitment is likely to be linked to a disturbance event, such as fire, and favourable post-fire conditions.

Grazing by stock: Grazing is a serious threat that may affect the population in the near future. If stock were to move into the population area they would damage and destroy plants, cause soil compaction, accelerate erosion and encourage weed invasion, which will increase competition. All of these would lead to a decline in population numbers and condition and be detrimental to recruitment efforts.

Competition with native flora: Competition with native flora at Population 1b is high. The associated native flora compete with any *Acacia pharangites* seedlings for light, nutrients, pollinators and space to establish. Without successful recruitment the existing population will senesce.

Critically small population: Population 1b contains only 10 plants. A population this small is not as likely to be pollinated as plants in a larger population. This may lead to reduced seed production, smaller soil seed bank, less recruitment and ultimately population senescence. Small populations are also more vulnerable to extinction as they may be destroyed by a single event such as a disease or stochastic event.

RECOVERY ACTIONS

Existing Recovery Actions

- An Interim Recovery Plan has been prepared for this taxon (Evans & Brown, 1999).
- All appropriate land managers have been made aware of the threatened nature of this species and its location.
- CALM's Threatened Flora Seed Centre (TFSC) collected seed in November 1997 and November 1998. The 1997 collection of 50 seeds had excellent germination (80-100%), but the 1433 seeds collected in 1998 showed poor germination, which may be partly due to treatment used, but a high proportion appeared to be empty or unviable at the start of a test currently underway.
- Botanic Garden and Parks Authority (BGPA) collected seed in August and November 1996.
- BGPA hold 13 plants in its nursery frames.
- Staff from CALM's Merredin District office are monitoring the known population.

Future Recovery Actions

Acacia pharangites is found on private property. Permission will be sought from the land owner prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Reproduction and recruitment enhancement

Disturbance and smokewater trials will be conducted to ascertain their role in recruitment. This will be done with care to minimise any resulting soil erosion on the steep slopes. If these are found to be beneficial, recommendations will be made for future application of treatments at a time interval deemed appropriate to stimulate germination events periodically. The removal of competition by other plants, including adult *A. pharangites*, will also need to be investigated as part of any recruitment strategy. Fire will not be trialled at this time due to the high risk of escape to associated long unburnt vegetation and the probable post-fire threats of weed invasion, increased grazing by native fauna, competition from other regenerating native flora and increased erosion of bare slopes.

2. Action: Investigate and implement reproduction and recruitment enhancement

Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): $1,000

3. Develop and implement a fire management strategy

The response of *Acacia pharangites* to fire is not known, but it is likely that a wildfire would precipitate a number of threatening agencies, including weed invasion, increased grazing and erosion. The nature of the terrain would make fighting a wildfire impossible in many areas, suggesting that relatively large areas would be likely to be affected by such an event. Fire should therefore be prevented from occurring in the *A. pharangites* habitat area where possible. Research will be conducted to develop a fire management strategy, which will outline fire control measures and fire frequency.

Action: Develop and implement a fire management strategy

Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): $1,500

4. Fence key habitat area

Populations 1a and 1b are threatened by grazing, and fencing is required to ensure protection of the species. Grazing is likely to result in plant casualties and a range of adverse habitat changes. CALM will provide practical assistance and, when available, materials to ensure the adequacy of fences.

Action: Fence key habitat area
Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): $3,000

5. Collect and store seed or cutting material

Preservation of germplasm is essential to guard against extinction if the wild population is lost. This is urgent as there is only a small amount of viable seed in storage, and many existing plants appear old. Seed will be collected for storage, and cuttings will be taken to enhance a living collection at BGPA.

Action: Collect and store seed or cutting material
Populations: 1a and 1b
Responsibility: CALM (Merredin District, TFSC), BGPA, through MDTFRT
Cost (minus labour): $800

6. Obtain biological and ecological information

Research is required to increase knowledge of the biology and ecology of *Acacia pharangites.* Investigations will include:
– Soil seed bank dynamics and the role of various factors including disturbance, and post-disturbance competition, rainfall and grazing on recruitment and seedling survival
– Determination of reproductive strategies, phenology and seasonal growth
– Key soil conditions, pH, permeability and nutrient composition of the soil

Action: Obtain biological and ecological information
Populations: 1a and 1b
Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): $15,900 per annum

7. Undertake a translocation

As there are only 117 known plants in a single population, it may be essential to undertake a translocation into appropriate habitat once the factors limiting in-situ recruitment are better understood. This will require the development and approval of a translocation proposal, and propagation of translocates. Once planting has occurred, extensive monitoring will be required. Information on the translocation of threatened animals and plants in the wild is provided in CALM's Policy Statement No. 29 *Translocation of Threatened Flora and Fauna.* All translocation proposals require endorsement by the Director of Nature Conservation.

Action: Undertake a translocation
Responsibility: CALM (Merredin District) through the MDTFRT
Cost (minus labour): $13,200 in the first year and $5,800 in subsequent years

8. Land management options

Seek to purchase Melbourne Location 3457 and 2221 from the current private land owner. This property would be an ideal acquisition as a nature reserve, as it contains the only known *Acacia pharangites*

population and a plethora of other Declared Rare and Priority Flora. Nature reserve tenure would guarantee long-term protection for the area.

Action:	Seek to purchase land / investigate future management options
Populations:	1a and 1b
Responsibility:	CALM (Merredin District) through the MDTFRT
Cost (minus labour):	Subject to agreed management option

In addition to the specific recovery actions detailed above, a range of common recovery actions are proposed that will reduce the threats facing *A. pharangites*. Those that are particularly relevant include:

- Community education
- Liaison with land manager
- Population monitoring
- Surveys to locate new populations

Acacia pygmaea

Common name: Dwarf Rock Wattle

Family: Mimosaceae

Ranking: Endangered
Interim Recovery Plan: 9 (Holland, Kershaw & Brown, 1997)
Flowering period: November-March
Information is accurate: 2004

Photo: Nicole Willers

BACKGROUND

Current status: *Acacia pygmaea* was declared as Rare Flora in May 1991 and ranked as Critically Endangered in September 1995. It no longer meets criteria for Critically Endangered and is currently ranked as Endangered (EN) under World Conservation Union (IUCN) Red List criterion D (IUCN, 2000).

Description: *Acacia pygmaea* is a dwarf, erect shrub to 70 cm tall with prominently ribbed branchlets. Bark is grey at base of stems, light brown at ends of branchlets. The green phyllodes are elliptic to obovate, 20-30 mm long and 9-13 mm wide with yellow marginal nerves (pale red when young). The inflorescences are globular with white filaments, which turn orange with age. Seed pods are narrowly oblong to 30 mm long (Holland *et al.*, unpublished).

Acacia pygmaea has similar phyllodes to *A. disticha* and is closely allied to that species. It also appears closely related to *A. obovata,* which is also a dwarf shrub with phyllodes similar to those of *A. pygmaea.* However, *A. obovata* is distinguished from *A. pygmaea* by its multi-stemmed growth habit and frequently hairy branchlets and phyllodes (Maslin, 1995). *A. disticha* and *A. pygmaea* have affiliations with *A. myrtifolia,* and belong to the "*Acacia myrtifolia*" group. The name of the species is derived from the Latin *pygmaeus*, meaning dwarf, and refers to the diminutive height of the mature plant.

Distribution: *Acacia pygmaea* is known from 5 populations comprised of 14 tenure or location based subpopulations, all in the Shire of Wongan-Ballidu. Eight of these subpopulations occur on nature reserves, and these account for 70% of known plants. The remainder of the subpopulations are on private property.

Habitat requirements

Soils:	Confined to the ridges of lateritic breakaways, growing in rock crevices with the roots presumably reaching into underlying clay
Vegetation:	Open mallee over an open heath
Associated Species:	*Eucalyptus ebbanoensis*, *Allocasuarina campestris*, *Dryandra comosa*, *D. wonganensis*, *D. pulchella* and *Persoonia divergens*

Biology

Fire:	Unknown, but may require fire to germinate soil-stored seed
Disturbance:	This species probably responds positively to disturbance associated with natural erosion. No data is available on effects of other forms of disturbance
Disease:	Unknown
Weed invasion:	The species' preferred habitat is not prone to weed invasion
Grazing:	Survey results suggest the species is vulnerable to grazing by sheep. With two exceptions the species has never been found on grazed sites, even though it occurs on identical ungrazed habitat only a short distance away
Propagation:	Propagated from seed, but can also be propagated from cuttings with some success. Need some sort of pre-treatment prior to sowing. Strike rates between 1 and 25% (personal communication, A. Shade)
Competition:	No evidence of vulnerability to competition
Pollination:	Probably by insects (Rye, 1980), such as honey bees, flies and wasps, although the process is poorly understood
Other:	The species is vulnerable to loss of overstorey shade, especially when associated with severe summer droughts

Summary of population information for *Acacia pygmaea*

Pop'n	Locality	Land Type	Survey date	Mature	Seedlings	Condition
01a	Mt Matilda	Nature Reserve	4/04/2001	45	6	Healthy
01b	Mt Matilda	Private Property	4/04/2001	45	6	Healthy
01c	Mt Matilda	Private Property	4/04/2001	6	0	Healthy
02a	Mt Matilda	Private Property	3/04/2001	4	2	Moderate
02b	Mt Matilda	Nature Reserve	3/04/2001	4	0	Healthy
02c	Mt Matilda	Private Property	3/04/2001	9	9	Healthy
02d	Mt Matilda	Nature Reserve	4/04/2001	5	0	Moderate
02e	Mt Matilda	Private Property	4/04/2001	17	1	Healthy
03a	Mt O'Brien	Private Property	30/09/2000	3	2	Healthy
03b	Mt O'Brien	Private Property	3/04/2001	11	5	Healthy
04-	Rogers	Nature Reserve	3/04/2001	36	16	Moderate
05a	Mt Matilda	Nature Reserve	6/08/2000	36	6	Healthy
05b	Mt Matilda	Nature Reserve	6/08/2000	26	0	Healthy
05c	Mt Matilda	Nature Reserve	18/09/2000	59	17	Healthy
			No. plants	**306**	**70**	
			No. popn's	**5**		

Threats

Acacia pygmaea is threatened by activities and processes that cause direct casualties to populations or effect habitat changes that are detrimental to the long-term survival of the species. The threats to *Acacia pygmaea* are:

Didgeridoo cutting: *Eucalyptus ebbanoensis* stems were illegally removed from one population, close to an access road between 1994 and 1996. While *Acacia pygmaea* plants were not directly impacted during the removal of the didgeridoos, subsequent monitoring revealed a significant drop in plant numbers and in the health of surviving plants. These changes have been attributed to a reduction in shade provided by the overstorey vegetation, mainly *Eucalyptus ebbanoensis,* which protects plants from the worst effects of summer drought. Recent monitoring of populations has indicated that didgeridoo cutting is a current threat, with the potential to affect up to 80% of some populations.

Stock grazing: Between 1999 and 2001, most areas of the Wongan Hills that contained suitable habitat for *Acacia pygmaea* were surveyed. While new populations were discovered, no plants were discovered at any of the sites that bore evidence of summer grazing. Two healthy populations have been found at sites that are accessed by stock only during the late autumn and winter months. Rye Grass Toxicity

prohibits spring and summer grazing at these sites. It is unclear whether the absence of plants from the summer grazed areas was the result of direct plant losses from grazing, or the changes grazing wrought on the species' habitat, such as loss of shade.

Pedestrian Traffic: One population occurs astride a section of the Mount Matilda Walk Track. Some plants within this population are threatened by direct damage from pedestrian traffic.

Wildfire: No information exists on the effects of fire on *Acacia pygmaea*. However, population surveyors have expressed concern about the potential deleterious effects fire may have on post-fire recruitment through critical changes to the population habitat.

RECOVERY ACTIONS

Existing Recovery Actions

- A single Declared Rare Flora (DRF) marker has been placed at Population 2a, approximately three metres east of the walk trail.
- The owners of the private property containing Populations 1a and 2a were notified of the presence of this species on their land in June 1991 and January 1992 respectively.
- Staff from Botanic Garden and Parks Authority (BGPA) collected seed, cuttings and graft material from Population 1 in December 1991 and 1993. Results from cuttings gave a 0.3 % success rate and one plant has been grown on and potted. A total of 148 seeds are in storage at -20°C.
- Approximately 2,000 seeds are in storage at CALM's Threatened Flora Seed Centre (TFSC) in 2003, with a germination rate of approximately 50%.

Future Recovery Actions

Acacia pygmaea populations occur on private property and on nature reserves managed by CALM. Permission will be sought from land managers, where appropriate, prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Exclude stock from key habitat areas

To protect *Acacia pygmaea* populations from the effects of grazing, CALM will:

- ensure that Populations 3a and 3b are securely fenced
- routinely check on fence condition when monitoring populations
- provide practical assistance, and when available, materials, to ensure the adequacy of fences

Action:	Exclude stock from key habitat areas
Populations:	3a and 3b
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$2,000

2. Biological and ecological research

Increased knowledge of the biology and ecology of the species will provide a scientific basis for management of *Acacia pygmaea* in the wild. *Acacia pygmaea* grows in very particular habitats. However, there are many areas containing this habitat type where *Acacia pygmaea* does not grow. At this stage it is unclear whether this is due to past grazing or other factors. Investigations will determine:

- Key soil conditions, pH, permeability and nutrient composition of the soil.
- Soil seed bank dynamics and the role of various factors (including disturbance, competition, rainfall and grazing) in germination and recruitment.
- Determination of reproductive strategies, phenology and seasonal growth.

- The effects of fire on *Acacia pygmaea* and its habitat.
- Potential for reintroduction of *Acacia pygmaea* to previously grazed sites.

Action: Conduct biological and ecological resaerch
Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): $15,900 per annum

3. Walk trail management

The Mt Matilda Walk Track bisects Population 2d. To protect this population from physical damage caused by pedestrian traffic:

- Information panels and walk trail brochures will be provided to explain the significance and sensitivity of the habitats through which the walk trail passes
- CALM will assess the options for diverting the walk trail around the population site

Action: Walk trail management
Populations: 2d
Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): $500

In addition to the specific recovery actions detailed above, a range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Fire management strategies
- Liaison with land managers
- Manage harvesting of mallees for didgeridoo industry
- Monitor populations
- Surveys

Calothamnus accedens

Common name: Piawaning clawflower

Family: Myrtaceae

Ranking: Critically Endangered
Flowering period: January to February
Information is accurate: 2005

Photo: Rosemarie Rees

BACKGROUND

Current status: *Calothamnus accedens* was discovered in 1980 and at that time was known from one population of 14 plants on a narrow road verge near Piawaning. This population has since disappeared, possibly destroyed during vegetation slashing to control weeds. In 2004, it was rediscovered south of Moora in CALM's Moora District by Botanist Alex George. It currently meets World Conservation Union (IUCN) Red List category Critically Endangered under criteria B1ab(ii,iii,v)+2ab(ii,iii,v) (IUCN, 2000).

Description: *Calothamnus accedens* is a slender erect shrub, up to 1.8 m tall, with many branches. The leaves are densely crowded at the ends of its branches, which have prominent leaf and bud scars lower down. The leaves, 10 to 15 mm long and 0.8 to 1 mm wide, are stalkless, stiff and linear, with long, spreading, whitish hairs which are shed on the older leaves. There are short clusters of 4 to 10 flowers on the lower parts of the stem, usually on one side but sometimes almost encircling the stem. The bell-shaped calyx tube is densely hairy at the base, with shorter and sparser hairs higher up. Flowers have 5 narrow, orange to brown petals, up to 7 mm long, and 5 equal staminal claws, 20 to 25 mm long, which are pinkish-red to dark crimson. There are 15 to 19 filaments on each claw, with anthers 1 to 1.5 mm long. The fruits are a depressed globe shape or cylindrical, and have 5 short lobes which wear away with age. They are 5 to 6 mm long and 6.2 to 8 mm wide, and are densely hairy at first. The dark chocolate brown seeds are 1.5 to 2 mm long (Brown *et al.*, 1998).

Calothamnus accedens is very closely related to *C. brevifolius*, with which it overlaps in range in the Piawaning-Wongan Hills area. *Calothamnus accedens* is also very closely related to *C. hirsutus* in gross morphology and these three species may be regarded as a species-group. There is marked variation between the plant taxa in plant height (*C. brevifolius* grows to 50 cm and *C. hirsutus* to 1 m). The leaves of all three species are similar morphologically with those of *C. hirsutus* being distinctively longer than the leaves of the other two. There is little difference between the leaves of *C. brevifolius* and *C. accedens*, although those of the latter species are usually slightly thicker and often more pilose. The flowers of *C. accedens* are usually on portions of stems from which the leaves have fallen, while those of the other two species are usually amongst leaves (Hawkeswood, 1984).

Distribution: *Calothamnus accedens* was previously known from a single population on a highly degraded shire road verge in the Shire of Wongan-Ballidu. This population has been searched for a number of times without success, and both verges have been cleared by slashing in an attempt to control

the weeds. In 2004 the species was rediscovered south of Moora and currently consists of two populations on road reserve and private property in the Shire of Moora.

Habitat requirements

Soils:	Pale sandy soil over laterite
Vegetation:	Grows in remnant heathland vegetation
Associated Species:	Melaleuca scabra and Acacia spp.

Biology

Fire:	Unknown
Disturbance:	Unknown, survives on a weed infested road verge
Propagation:	Unknown
Pollination:	Unknown

Summary of population information for *Calothamnus accedens* in the Merredin District

Pop'n	Locality	Land Type	Survey date	Mature	Condition
50X	Wongan Hills	Rd Verge SHIRE	16/02/85	0	Extinct
			No. of plants	**0**	
			No. of pop'ns	**0**	

RECOVERY ACTIONS

Existing Recovery Actions

- *Calothamnus accedens* was formally described in 1984.
- The previously known population was searched for in 1986 without success, but this surveyor suggested another search at the end of summer as the verge was a 'dense jungle of wild oats and wild turnip'. In 1988 another survey revealed that the vegetation on both sides of the road had been slashed to clear wild oats, and no *Calothamnus accedens* could be seen.

Future Recovery Actions

Further information on many of these actions can be found in Part Four: Management Strategies.

1. Community education

Promote awareness of this species to the community through production and distribution of a glossy information sheet. This could be distributed through the Wongan Boomer, a well-read local newspaper. This may locate new populations on private land.

Action:	Promote awareness of this species
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$500

In addition to the specific recovery actions detailed above, a range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Population monitoring - monitor vicinity of old population site for regeneration
- Surveys

Conostylis wonganensis

Common name: Wongan Conostylis

Family: Haemodoraceae

Ranking: Endangered
Flowering period: late July to early September
Information is accurate: 2004

Photo: Steve Hopper

BACKGROUND

Current status: *Conostylis wonganensis* was declared as Rare Flora in September 1987 and is currently ranked as Endangered under World Conservation Union (IUCN) Red List criterion B1+3d (IUCN, 1994).

Description: *Conostylis wonganensis* is a small, perennial herb to 20 cm tall with a 10 cm basal diameter, growing in dense tufts. Its rhizome and stems are short, bearing numerous crowded leaves and wiry roots 30 cm or more long. Leaves to 17 cm long and 0.9 mm in diameter, erect, thin, terete, sulcate, pale green except for their yellow-brown bases, and glabrous except for small densely pubescent spines evenly spaced along the margins. The scape is covered with a dense mesh of hairs, 1-3 cm high and 0.5-1 mm in diameter, bearing less than 10 flowers. Flowers are creamy yellow and covered with a dense mesh of hairs on all surfaces. The flower tube is 5-8 mm long, and the lobes another 3-6 mm long and held at right angles to the tube when fresh. (Hopper, 1982).

Conostylis wonganensis is most closely related to *C. teretiuscula* and *C. dielsii. C. wonganensis* differs from *C. teretiuscula* in that the leaves are glabrous except for small densely pubescent marginal spines and in the few ovules per locule that are attached on the lower side of the placenta. It differs from *C. dielsii* in that it has glabrous leaf bases and the flowering stems are less than a third the length of the leaves. Also, *C. wonganensis* has noticeably smaller leaves than those of its closest relatives (Hopper, 1982).

Distribution: *Conostylis wonganensis* is known from five populations. Three populations are located in the Shire of Wongan-Ballidu, on a water reserve, a nature reserve, and a Department of Agriculture Experimental Farm Reserve. The remaining two populations are located in the Shire of Dowerin, on nature reserve and rail reserve. A third population previously known from private property in the Shire of Dowerin is now extinct.

Habitat requirements

Soils: Yellow sand over clay or laterite on gradual slopes high in the landscape
Vegetation: Scattered through species-rich heath with emergent mallees
Associated Species: *Eucalyptus pyriformis*, *Ecdeiocolea monostachya*, *Hakea scoparia*, *Casuarina campestris*, *Conospermum brownii*, *Grevillea paniculata*, *G. armigera*, *G. eryngioides* and *Stylidium coroniforme*

Biology

Fire: Unknown
Disturbance: Unknown, but thought to be unfavourable
Propagation: Most likely to be propagated by either division or cuttings. Some small plants were grown through tissue culture in the Botanical Garden and Parks Authority's Laboratory (personal communication, A. Shade)
Pollination: Unknown

Summary of population information for *Conostylis wonganensis*

Pop'n	Locality	LGA	Land Type	Survey date	Mature	Seedlings	Condition
01a	Wongan Hills	Wongan-Ballidu	Water Reserve	30/09/01	330	0	Healthy
01c	Elphin	Wongan-Ballidu	Nature Reserve	2/10/00	180	0	Healthy
01d	Elphin	Wongan-Ballidu	Nature Reserve	3/05/01	3100	0	Healthy
01e	Elphin	Wongan-Ballidu	Nature Reserve	30/09/01	500	0	Healthy
02-		Dowerin	Private Property	30/7/93	0	0	Extinct
03a	Wongan Hills	Wongan-Ballidu	Water Reserve	30/09/01	20000	0	Healthy
03b	Wongan Hills	Wongan-Ballidu	Water Reserve	30/09/01	1000	0	Healthy
04a	Wongan Hills	Wongan-Ballidu	Experimental Farm Res	22/08/01	50	0	Healthy
04b	Wongan Hills	Wongan-Ballidu	Experimental Farm Res	10/11/00	0	0	Extinct
04c	Wongan Hills	Wongan-Ballidu	Experimental Farm Res	22/08/01	74	0	Healthy
04d	Wongan Hills	Wongan-Ballidu	Experimental Farm Res	30/09/01	625	0	Healthy
05-		Dowerin	Nature Reserve	13/10/94	6	0	Healthy
06-		Dowerin	Railway Reserve	12/09/93	8	0	Healthy
				No. of plants	**25873**		
				No. of pop'ns	**6**		

Threats

Conostylis wonganensis is threatened by a number of interactions, activities and processes that cause direct deaths to plants or effect habitat changes that are detrimental to the long-term survival of the species. The threats to *Conostylis wonganensis* are:

Wildfire: No information exists on the effects of fire on *C. wonganensis*. However, population surveyors have expressed concern on the potential deleterious effects fire may have indirectly on post-fire recruitment through critical changes to the population habitat. Until the fire response of *C. wonganensis* has been determined, fire should be excluded from the populations if possible.

Grazing by stock: This is a threat to Population 4d, where the fence is in a state of disrepair. Stock on the adjoining property may gain access to Population 4d and graze the habitat area. Any grazing is likely to cause adverse habitat modifications, such as erosion, increased weed invasion and a reduction in the local biodiversity. Grazing may also result in plant deaths and a lack of recruitment.

Competition by weeds: Weeds are a threat to Population 4d, mainly along the existing firebreak which is the northern boundary of the population. The weeds threaten to further encroach on the population and out-compete mature and juvenile *Conostylis wonganensis* plants for light, nutrients and pollinators, which

is likely to result in reduced recruitment. They also degrade habitat, exacerbate grazing pressure and increase the risk and severity of fire.

Maintenance activities: A range of tenure specific activities such as rail, firebreak and powerline maintenance threaten the species. These activities are likely to cause physical damage or destruction of plants, as well as adverse habitat modifications such as soil compaction. Maintenance events also typically encourage weed invasion.

Grazing by other fauna: Affects two subpopulations and is most likely to be kangaroos and/or rabbits. Reduced plant vigour or plant deaths are likely results of grazing by fauna. Rabbit droppings add nutrients and weed seeds, and this combined with rabbit diggings for warren construction exacerbates the threat from weeds as well as the direct damage caused. Rabbit and kangaroo grazing are likely to result in a decline in recruitment as they often selectively graze younger plants.

Salinisation: Salinity is threatening Population 4d, with the adjacent community already showing the impact of salinity. The exact effects of salinity on *Conostylis wonganensis* are unknown but they will almost certainly be detrimental. When salinisation of the population site occurs, it will cause adverse habitat changes which will likely result in the loss of this population.

Mining: Mining for gravel or sand is a potential threat to Population 3b. If mining were to commence it would cause damage to many plants and many others would be destroyed. It would also create a range of adverse habitat modifications.

RECOVERY ACTIONS

Future Recovery Actions

Conostylis wonganensis populations exist on a range of land tenures. Permission will be sought from relevant land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Undertake weed control

Effective weed control is required to reduce the impact of weed invasion at Population 4d. This will be by hand weeding or localised application of herbicide during the appropriate season to minimise the effect of herbicide on the species and the surrounding native vegetation. All applications of weed control will be followed by a brief report on the method, timing and success of the treatment against weeds, and the effect on *C. wonganensis* and associated native plant species.

Action:	Undertake weed control
Populations:	4d
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$800

In addition to the specific recovery actions detailed above, a range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Fence key habitat areas – essential to protect Population 4d from stock grazing.
- Fire management strategies
- Germplasm collection and storage
- Install markers at Population 6.

- Land management options
- Liaison with land managers
- Monitor populations
- Surveys

Eremophila ternifolia

Common name: Wongan Eremophila
Family: Myoporaceae
Ranking: Vulnerable
Flowering period: September to November
Information is accurate: 2004


Photo: Nicole Willers

BACKGROUND

Current status: *Eremophila ternifolia* was declared as Rare Flora in September 1987 and is currently ranked as Vulnerable under World Conservation Union (IUCN) Red List criterion D2 (IUCN, 1994).

Description: *Eremophila ternifolia* is a low spreading shrub 30-50 x 50-70 cm. Leaves are sessile, in whorls of 3, the whorls alternate. They are green above, often reddish-brown below and on the margins, lanceolate to elliptic, 6-11 x 2.7-4 mm and glabrous. Flowers are solitary, sessile to 10 mm long, lilac, white below and spotted purple inside, pubescent outside, prominently bearded on the lowermost lobe inside extending down the tube. Fruits are dry, indehiscent, prominently beaked, 2.3-3.2 x 2.2-2.8 mm, hirsute. Seed are small, pale yellowish-white, 1.8 x 0.6 mm. (Chinnock, 1982).

Eremophila veronica is allied to *E. ternifolia* but differs in having small, densely spiral, linear subterete leaves which are flattened on the upper side and an ovoid fruit which is not split in the upper part (Chinnock, 1982).

Distribution: *Eremophila ternifolia* is known from three populations, all in the Shire of Wongan-Ballidu. These are located on private property and in the relative safety of a nature reserve.

Habitat requirements

Soils:	Red clays between breakaways
Vegetation:	Grows in mallee or morrel and gimlet woodlands with scattered mallee, under a shrub layer of sandalwood, *Acacia* and *Melaleuca*
Associated Species:	*Eucalyptus erythronema*, *E. longicornis*, *E. salubris*, *E. gracilis*, *Santalum acuminatum*, *Melaleuca adnata* and *Acacia orbifolia*

Biology

Fire:	Unknown
Disturbance:	Unknown, but may benefit from some natural disturbance, such as erosion
Propagation:	Can be propagated from cuttings or grafts; BGPA prefer grafts using *Myoporum acuminatum* or *M. insulare* as rootstock. Their records show one record of an 8%

strike rate from cuttings, and a 41% success rate from grafting (personal communication, A. Shade)

Competition: Weed competition is thought to have an adverse effect on recruitment

Pollination: Unknown

Summary of population information for *Eremophila ternifolia*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01a	Mt Matilda	Private Property	24/09/99	500	Disturbed
01b	Mt Matilda	Nature Reserve	24/09/99	500	Disturbed
02-	Mt O'Brien	Private Property	9/08/01	81	Healthy
03-	Mt Matilda	Nature Reserve	4/04/01	300	Healthy
			No. plants	**1381**	
			No. popn's	**4**	

Threats

Eremophila ternifolia is threatened by processes and interactions that cause direct casualties, reduce rates of recruitment, and effect habitat changes that are detrimental to the long-term survival of the species. However, most of the threats are low level ones that at this stage do not affect large percentages of the populations. The threats to *Eremophila ternifolia* are:

Wildfire: No information exists on the effects of fire on *Eremophila ternifolia*. Wildfire may represent a serious threat to the species, as ignition sources such as lightning, stubble burns on nearby farms and other human activities are present most years. A wildfire would destroy adult plants, but it is unknown if fire is required to germinate soil-stored seed. Even if it is, a range of factors may adversely affect seedling survival in the post-fire period. These include competition from other germinating native flora, selective grazing of seedlings by native fauna and possibly accelerated erosion of denuded steep slopes or gully floors.

Competition by weeds: Weeds are a threat to Populations 1a, 1b and 3 and appear to originate from galah droppings, as they occur mainly at the base of nesting trees. At these sites weeds threaten to out-compete *Eremophila ternifolia* juveniles for light, nutrients and pollinators, resulting in reduced recruitment and ultimately population senescence. They also degrade habitat, exacerbate grazing pressure and increase the risk and severity of fire.

Vehicle traffic: This threat has the potential to damage or destroy plants at Subpopulations 1a and 1b, where vehicles travel along a maintenance track in Mt Matilda Nature Reserve and on adjoining private property. Vehicle traffic may also result in adverse habitat changes such as soil compaction, and could cause gullying by creating soil instability and channelling run-off.

Water runoff / gullying: This represents a threat to Populations 1a and 1b, where the flow of excess water is causing soil erosion and gullying. The movement of topsoil after heavy rains may result in adverse habitat changes, creating unfavourable conditions for plant growth and recruitment.

RECOVERY ACTIONS

Future Recovery Actions

Eremophila ternifolia populations occur on private property and on nature reserves managed by CALM. Permission will be sought from relevant land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Surface water management

The impacts of soil erosion and gullying from a newly constructed maintenance track need to be reduced at two population sites. Different options for this will need to be investigated.

Action:	Surface water management
Populations:	1a and 1b
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	Subject to solution determined

2. Undertake weed control

Weeds are not densely present in the general habitat, but have a patchy distribution under trees. Effective weed control is required to reduce the presence of weeds at Populations 1a, 1b and 3. This will be by hand weeding or localised application of herbicide during the appropriate season to minimise the effect of herbicide on the species and the surrounding native vegetation. All applications of weed control will be followed by a brief report on the method, timing and success of the treatment against weeds, and the effect on *E. ternifolia* and associated native plant species.

Action:	Undertake weed control
Populations:	1a, 1b and 3
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$700

3. Access management

Vehicle traffic on the new maintenance track will be limited, with the track being closed during wet periods. Most damage to this track occurs after heavy rains, as vehicles tend to veer off the track, which results in the track gradually becoming wider. Vehicle movement can also create soil instability, particularly in saturated soils, and further rains can cause erosion.

Action:	Limit vehicle traffic
Populations:	1a and 1b
Responsibility:	CALM (Merredin District) through WBTFMP
Cost (minus labour):	$300

In addition to the specific recovery actions detailed above, a range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Liaison with land managers
- Monitor populations
- Surveys

Eucalyptus recta

Common name: Wongan Mallet

Family: Myrtaceae

Ranking: Vulnerable
Flowering period: May
Information is accurate: 2004

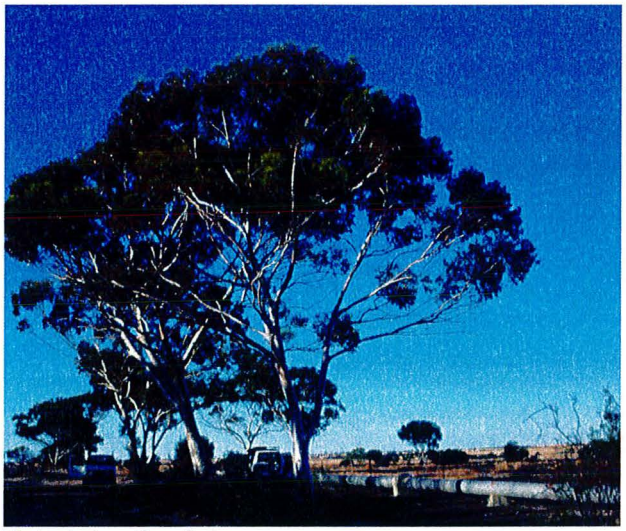


Photo: Andrew Crawford

BACKGROUND

Current status: *Eucalyptus recta* was declared as Rare Flora in April 2003, and is currently ranked as Vulnerable under World Conservation Union (IUCN) Red List Criterion D2 (IUCN, 2000). The species is restricted to a small number of locations which are prone to the effects of human activities and stochastic events and could become Critically Endangered within a very short time period.

Description: *Eucalyptus recta* is a mallet to 15 m, trunk straight to about 5 m. Bark smooth, shining pale silver-grey or white. Juvenile leaves opposite for many nodes; adult leaves disjunct, lanceolate. Seeds glossy dark grey, shallowly reticulate (Hill & Johnson, 1992).

Eucalyptus recta is closest to *E. ornata* from which it differs in the larger buds. It is distinguished in the Subseries Rugatae by its mallet habit, the white bark, the large buds, which are broadly shallowly ribbed, the long, acute calyptra (operculum) and the large fruits. Pedicels and peduncles are relatively long (Hill & Johnson, 1992).

Distribution: *Eucalyptus recta* is known from one population occurring over three land tenures in the Shire of Wongan-Ballidu, and three populations occurring over six tenures in the Shire of Dowerin, an adjoining Shire to the south-east of Wongan-Ballidu. In the Shire of Wongan-Ballidu, Population 1a is located on shire road verge and Populations 1b and 1c are on private property. In the Shire of Dowerin populations occur on nature reserve, a number of private property Locations and shire road verge.

Habitat requirements

Soils: Lateritic slopes; white or pale yellow gravelly sand
Vegetation: Found in blue mallet woodlands
Associated Species: *Eucalyptus gardneri*, *E. oldfieldii*, *E. subangusta*, *E. tenera*, *Dryandra shanklandiorum*

Biology

Fire: The response of this species to fire is unknown, but moderate to intense fire will generally kill a mallet as they lack a lignotuber or strong system of epicormic buds. Mallets regenerate exclusively from canopy stored seed that is released en masse following a disturbance, such as fire, that kills the adult population.

Disturbance: The response of this species to disturbance is unknown, however mallets generally regenerate prolifically after fire. Moderate to intense fire will kill mallets due to the lack of a lignotuber and relatively thin bark. Some populations occur in areas that were previously disturbed.

Propagation: Unknown, although most species of mallet readily germinate from seed

Pollination: Unknown

Summary of population information for *Eucalyptus recta*

Pop'n	Locality	LGA	Land Type	Survey date	Mature	Condition
01a	Cadoux	Wongan-Ballidu	Rd Verge SHIRE	4/05/01	60	Healthy
01b	Cadoux	Wongan-Ballidu	Private Property	4/05/01	50	Healthy
01c	Cadoux	Wongan-Ballidu	Private Property	4/5/01	100	Healthy
02-	Cadoux	Dowerin	Private property	4/5/01	100	Healthy
03a	Moonjin	Dowerin	Nature Reserve	4/05/01	200	Healthy
03b	Moonjin	Dowerin	Nature Reserve	23/05/00	250	Healthy
03c	Moonjin	Dowerin	Private Property	23/05/00	20	Healthy
04a	Manmanning	Dowerin	Private Property	4/05/01	500	Healthy
04b	Manmanning	Dowerin	Rd Verge SHIRE	4/05/01	60	Healthy
04c	Manmanning	Dowerin	Private Property	4/05/01	40	Disturbed
				No. of plants	**1380**	
				No. of pop'ns	**4**	

Threats

Eucalyptus recta is threatened by a number of processes, activities and interactions that cause direct deaths to plants or effect habitat changes that are detrimental to the long-term survival of the species. The threats to *Eucalyptus recta* are:

Inadequate recruitment: Favourable conditions for recruitment do not appear to exist at any of the *E. recta* populations, as highlighted by the absence of young plants. It is unlikely that recruitment can occur in the absence of a disturbance event that kills the adult trees and causes mass seed release from canopy-stored seed. Without an appropriate disturbance event, such as a fire and suitable post-disturbance conditions, populations are unlikely to persist in the long-term as mature trees naturally senesce.

Stock grazing: Half of the known *Eucalyptus recta* sites are located on private property, as small pockets of remnant vegetation. As none of the sites are fenced, stock are able to move through the sites and graze around the trees. This grazing is likely to cause adverse habitat modification, as it removes the understorey and remnant fringing communities, decreasing the local biodiversity. The grazing may also result in a lack of recruitment as stock will find tender young growth an attractive food source. Stock grazing is a serious threat to the long-term survival of the species.

Chemical drift: Over half the population sites are threatened by drift of chemicals such as fertilisers and herbicides, as they exist in small pockets in the middle of agricultural lands. The impact of chemical drift on *E. recta* populations is largely unknown, although it is anticipated to include damage to plants (particularly juveniles) in the form of burning. There are also likely to be adverse habitat modifications through possible damage to associated vegetation and an increase in weed presence.

Wildfire: No information exists on the effects of fire on *E. recta,* although there is plenty of ecological knowledge available on the response of many other mallet species to fire. However, population surveyors have expressed concern about the potential deleterious effects fire may have indirectly on post-fire recruitment through critical changes to the population habitat. Until the fire response of *Eucalyptus recta* has been determined, fire should be prevented from occurring in the populations if possible.

Road and firebreak maintenance: Maintenance activities are likely to cause physical damage or destruction of plants, as well as adverse habitat modifications such as soil compaction. However soil disturbance may also promote recruitment. Maintenance events also typically encourage weed invasion, which would create competition with juveniles.

Lack of habitat: Most of the *E. recta* populations are small, fragmented and generally surrounded by farmland, and as a result they do not have access to the same ecological resources as the nature reserve population. It is predicted that over time this will result in a decline in recruitment, which will ultimately lead to population senescence.

Competition – weeds: Weeds are prevalent at many of the population sites and compete for resources, particularly affecting juveniles. They also degrade habitat, exacerbate grazing pressure and increase the risk and severity of fire.

Grazing – insect: A herbivorous insect is grazing on *E. recta* plants at two population sites. This is likely to be reducing plant health and reproductive capacity.

RECOVERY ACTIONS

Existing Recovery Actions

- Surveys were undertaken, locating new populations in addition to monitoring known populations.
- Approximately 14,000 seeds were collected by the Threatened Flora Seed Centre in November 2001. These had a germination rate of 100%. Half of this seed was sent to the Millennium Seed Bank at Kew Gardens in March 2002.

Future Recovery Actions

Eucalyptus recta populations exist mainly on private property but also on Shire road verges and a nature reserve. Permission will be sought from relevant land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Reproduction and recruitment enhancement

Trials will be conducted to identify conditions favouring recruitment. Factors such as canopy seed bank dynamics and the predation seeds by terrestrial invertebrates, and the role of disturbance, fire, competition, rainfall and grazing in recruitment and seedling survival will be investigated. When the key factors are determined they will be incorporated into improve recruitment.

Action:	Conduct reproduction and recruitment enhancement
Populations:	All
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$2,200

2. Undertake weed control

Effective weed control is required to reduce the impact of weed invasion at the population sites. This will be by hand weeding or localised application of herbicide during the appropriate season to minimise the effect of herbicide on the species and the surrounding native vegetation. All applications of weed control

will be followed by a brief report on the method, timing and success of the treatment against weeds, and the effect on *E. recta* and associated native plant species.

Action:	Undertake weed control
Populations:	4c
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$800

3. Habitat restoration and rehabilitation

Community function will be investigated to determine the factors the species requires to maintain healthy, functioning populations. When the key factors are determined these will be incorporated into rehabilitation and restoration works where existing populations are currently degraded and appear to be lacking ecological resources, or are affected by insect grazing.

Action:	Habitat restoration and rehabilitation
Populations:	1a, 1b, 1c, 2, 4b and 4c
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$10,000 per annum

4. Plant vegetation buffers

Vegetation buffers will be planted to help protect those *E. recta* populations threatened by chemical drift. Buffers will reduce the incidence of foliage damage from herbicide drift.

Action:	Plant vegetation buffers
Populations:	1a, 1b, 1c, 2, 4b and 4c
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$15,000

In addition to the specific recovery actions detailed above, a range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Fencing of key habitat areas – essential to protect Populations 1b, 1c, 2, 3c, 4a and 4c from stock grazing
- Fire management strategies
- Germplasm collection and storage
- Land management options
- Liaison with land managers
- Markers for maintenance risk zones - required at Populations 1a, 3a, 3b, 3c and 4b.
- Monitor populations
- Surveys

Gastrolobium glaucum

Common name: Spike Poison

Family: Papilionaceae

Ranking: Critically Endangered
Flowering period: August to September
Information is accurate: 2004

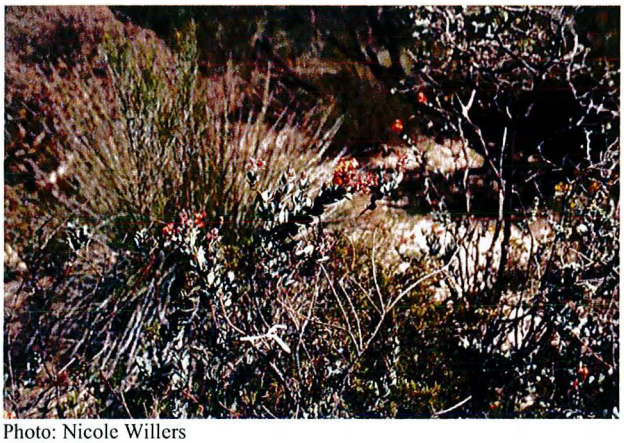


Photo: Nicole Willers

BACKGROUND

Current status: *Gastrolobium glaucum* was declared as Rare Flora in November 1980 and is currently ranked as Critically Endangered under World Conservation Union (IUCN) Red List criterion C1 (IUCN, 2000).

Description: *Gastrolobium glaucum* is a dense, erect shrub with many stems up to 90 cm high arising from a woody stock. The leaves are arranged in whorls of three and held erect, up to 1.7 cm long and 1.3 cm wide. They are blue-green or almost grey in colour, varying in shape from almost circular to elliptic or obovate, flat, rather thick and rigid with a very blunt tip bearing a hard prickly point. The flowers are orange and red, well under 1 cm long, in closely clustered whorls of three, borne above the leaves. The sepals and flowers stalks are densely hairy (Sampson and Hopper, 1990).

Gastrolobium glaucum is distinguished from other species by the leaves and small, black stipules.

Distribution: *Gastrolobium glaucum* is known from 4 populations and 5 sites, all within 15 km of the Wongan Hills township. The populations occupy a range of tenures including water reserve (2 sites), road verge (2 sites) and experimental farm reserve (1 site). Although CALM has proposed that the water reserve and parts of the experimental farm reserve be made nature reserves, no populations are currently recorded from CALM lands.

Habitat requirements

Soils: Mixed soils that contain sand, gravel, loam and clay
Vegetation: Low shrubland communities on sandplains and rises
Associated Species: *Melaleuca* sp., *Hakea scoparia*, *Hakea incrassata*, *Casuarina campestris* and *Gastrolobium hamulosum*.

Biology

Fire: Recent field observations suggest that the species resprouts from rootstock, indicating that mature plants may survive fire. Seed of *Gastrolobium* spp. germinate prolifically from the soil seed bank following fire.

Disturbance:	Although the largest population is in undisturbed vegetation, all other populations are at disturbed sites suggesting the species may be a coloniser
Propagation:	Would need some sort of pre-treatment prior to sowing (personal communication, A. Shade)
Pollination:	Probably insect (bee) pollinated
Other:	Evidence suggests that this species is clonal (personal communication, M. Fitzgerald)

Summary of population information for *Gastrolobium glaucum*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01a	Wongan Hills	Experimental Farm res	22/08/01	153	Healthy
01b	Craig Road	Rd Verge SHIRE	22/08/01	12	Healthy
02-	Wongan Hills	Water Reserve	3/05/01	6	Healthy
03-	Manmanning Road	Rd Verge SHIRE	30/08/01	6	Healthy
04-	Wongan Hills	Water Reserve	30/09/01	1	Healthy
			No. of plants	**178**	
			No. of pop'ns	**4**	

Threats

Gastrolobium glaucum is threatened by a number of processes, activities and interactions that cause direct casualties, reduce rates of recruitment, and effect habitat changes that are detrimental to the long-term survival of the species. The threats to *G. glaucum* are:

Inadequate recruitment: Favourable conditions for recruitment do not appear to exist at any of the *Gastrolobium glaucum* populations, as highlighted by the absence of young plants. The species may require fire to germinate soil-stored seed, or may need a disturbance regime to induce recruitment. Without the right conditions for recruitment, the populations are less likely to sustain themselves in the long-term. This is likely to result in a decline in population numbers and condition over time, which will ultimately result in population senescence.

Wildfire: Wildfire could destroy adult plants, but may be required to germinate soil-stored seed. However, post-fire effects, including competition from other germinating native flora and weeds, and accelerated erosion as a result of water runoff, may represent more significant threat.

Water runoff: The threat of water runoff currently affects Populations 1a and 1b. It is causing an increase in weed invasion, and is likely to result in habitat modification and a decline in population numbers and condition over time. These effects, particularly weed invasion, will result in reduced recruitment in the population sites. The physical process of water runoff can also cause death and injury in plants.

Competition by weeds: Competition by weeds may cause a decline in population numbers and condition, and over time reduced recruitment. Weeds compete with *Gastrolobium glaucum* germinants for lights, nutrients and space to establish.

Tenure specific maintenance activities: Drain, power line and road maintenance threatens the species. These maintenance activities are likely to result in the physical damage or destruction of plants, and adverse habitat modifications such as soil compaction. Maintenance events often encourage weed invasion, which will create competition with any germinants.

Critically small populations: Small populations are not as likely to be pollinated, and are highly vulnerable to disease or stochastic events. This may lead to a decline in population health, reduced recruitment and eventually population senescence.

Weed control: Direct applications of herbicides to control weeds on the road verge, and spray drift from herbicide application in adjoining farmlands cause damage to plants. This can result in a decline in

population health and recruitment. Furthermore, weed control efforts may damage other species that grow with *G. glaucum*, therefore causing overall habitat modification.

Lack of ecological resources: There appears to be a lack of ecological resources at Population 3. Most of the surrounding vegetation is agricultural crops and weeds. Without adequate ecological resources the population is likely to fail to recruit and to decline in numbers and condition, leading ultimately to population senescence.

Grazing: The effects of stock being moved along the road threaten Population 3. Impacts include direct grazing and trampling of the plants, and habitat modifications from grazing and trampling of other vegetation, and from soil compaction.

Vehicle traffic: Vehicles travelling along a maintenance track threaten Population 2. Impacts include physical damage to plants from direct contact with vehicles, and habitat modifications from soil compaction and erosion.

Mining: Mining for gravel or sand is a potential threat to Population 4. If mining commenced it is likely the population would be damaged or destroyed, also adverse habitat modifications are likely.

RECOVERY ACTIONS

Existing Recovery Actions

- Approximately 70 seeds were collected by the Threatened Flora Seed Centre in November 1999.

Future Recovery Actions

Gastrolobium glaucum populations are found on a range of land tenures. Permission will be sought from relevant land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Reproduction and recruitment enhancement

Trials will be conducted to identify conditions favouring recruitment. Factors such as soil seed bank dynamics and the role of disturbance, fire, competition, rainfall and grazing in germination and recruitment will be investigated. When the correct conditions are determined, they will be implemented to encourage recruitment.

Action:	Investigate and implement favourable recruitment conditions
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	To be determined

2. Surface water management

The impacts of water runoff need to be reduced at two population sites. The best option for alleviating this will need to be investigated.

Action:	Surface water management
Populations:	1a and 1b
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	Subject to solution determined

3. Undertake weed control

Effective weed control is required to reduce the impact of weed invasion at Populations 1a, 1b and 3. This will be by hand weeding or localised application of herbicide during the appropriate season to minimise the effect of herbicide on the species and the surrounding native vegetation. All applications of weed

control will be followed by a brief report on the method, timing and success of the treatment against weeds, and the effect on *G. glaucum* and associated native plant species.

Action:	Undertake weed control
Populations:	1a, 1b and 3
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$1,000

In addition to the specific recovery actions detailed above, a range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Fire management strategy
- Germplasm collection and storage
- Land management options – this is particularly applicable to Population 1a located on the Agriculture Department Experimental Farm
- Liaison with land managers
- Monitor populations
- Surveys

Grevillea dryandroides subsp. *dryandroides*

Common name: Phalanx Grevillea

Family: Proteaceae

Ranking: Critically Endangered
Interim Recovery Plan: 64 (Phillimore & Brown, 2000)
Flowering period: September to March
Information is accurate: 2004

Photo: Leonie Monks

BACKGROUND

Current status: *Grevillea dryandroides* subsp. *dryandroides* was declared as Rare Flora in October 1996 and is currently ranked as Critically Endangered under World Conservation Union (IUCN) Red List criteria B1+2b,c,d,e and C1 (IUCN 1994). The five small populations are highly fragmented, there is a decline in the area of occupancy and the quality of its habitat (mainly on disturbed road and rail reserves), and a continuing decline in the number of individual plants. The main threats include weeds, accidental destruction through road and rail maintenance and recreational activities, fire and competition from associated native plant species (Phillimore & Brown, 2000).

Description: *Grevillea dryandroides* subsp. *dryandroides* is a root-suckering shrub to 50 cms tall. It usually forms colonies of less than five plants or is scattered singly amongst associated vegetation. The leaves are dull, yellow-green, each with leaf lobes 5 to 15 mm long, glabrescent (Olde and Marriott, 1995). The inflorescence is 3 to 4 cm long, and pedicels are 1 to 1.5 mm long. Individual flowers are pink to orange-pink with a grey-green limb. The style is red or pink with a green tip. The perianth is 6 to7 mm long, pink to orange-pink with a grey-green limb; pistil 17 to 18 mms long (Olde and Marriott, 1993; Phillimore and Brown, 2000). Fruits posteriorly oblique on curved pedicels; surface striped with several narrow longitudinal stripes from the suture to the dorsal side, texture firmly crustaceous. Seeds are obliquely and narrowly oblong-elliptical, with a firmly waxy texture (McGillivray, 1993).

Distribution: *Grevillea dryandroides* is known from 5 populations, all in the Shire of Wongan-Ballidu. Only 71 plants are known. Populations occur on Main Roads Department road verges, railway reserves, a shire reserve and a shire road verge. No populations exist within nature reserve.

Habitat requirements

Soils: Grey sandy loam and yellow gravelly sand
Vegetation: Found in open heathlands with shrubs of Allocasuarina and Melaleuca
Associated Species: *Acacia resinimarginea*, *A. yorkrakinensis* subsp. *acrita*, *A. sessilispica*, *Dampiera lavandulacea*, *Calytrix breviseta* subsp. *stipulosa*, *Chorizema rhynchotropis*, *Opercularia spermacocea*, *Melaleuca cordata*, *M. conothamnoides*, *M. uncinata*, *M.*

orbicularis, *Waitzia acuminata*, *Hakea scoparia*, *H. meisneriana*, *Allocasuarina campestris*, *Conospermum stoechadis* subsp. *?sclerophyllum*, *Synaphea* sp.., *Glischrocaryon aureum* var. *aureum*, *Verticordia chrysantha*, *Petrophile incurvata*, *Hibbertia huegelii*

Biology

Fire:	Probably causes germination. However, fire may rapidly deplete the soil seed bank if it recurs before plants have reached maturity. It could also deplete nutrients stored in the roots and thus affect the capacity to resprout (Phillimore and Brown, 2000)
Disturbance:	Regenerates from seed or sucker (Olde and Marriott, 1995)
Weed invasion:	Is a threat, but species typically grows in weedy sites
Grazing:	Unknown, but would probably be detrimental to plant health. Only one site is threatened by grazing
Propagation:	Sets few seeds and as a result there has been little experience with this method of cultivation. From cuttings, firm young growth gives a fairly good strike rate in spring or early autumn. BGPA records show a strike rate for cuttings between 10% and 65%, and 61% for grafting. They use several species for rootstock when grafting, including *G. robusta* and 'Poorinda Constance' (personal communication, A. Shade). Excellent drainage is required (Wrigley, 1989). Can be grown in hot-dry and cool-wet climates (Olde & Marriott, 1995)
Competition:	Is thought to be vulnerable to competition, particularly from weeds and native flora
Pollination:	Pollinated by birds (Olde and Marriott, 1995)

Summary of population information for *Grevillea dryandroides* subsp. *dryandroides*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01a	Northam – Pithara Road	Rd Verge MRD	20/09/00	4	Healthy
01b	Avon – Mullewa Rail Line	Railway Reserve	20/09/00	10	Moderate
02-	Ballidu	Rd Verge SHIRE	13/03/01	3	Moderate
03a	Northam - Pithara Road	Rd Verge MRD	13/03/01	8	Moderate
03b	Ballidu	Shire Reserve	13/03/01	5	Healthy
03c	Avon - Mullewa Rail Line	Railway Reserve	20/09/00	10	Healthy
04a	Lake Ninan	Shire Reserve	20/09/00	1	Healthy
04b	Lake Ninan	Shire Reserve	20/09/00	3	Healthy
05a	Northam – Pithara Road	Rd Verge MRD	29/09/00	11	Moderate
05b	Avon – Mullewa Rail Line	Railway Reserve	29/09/00	16	Moderate
			No. plants	**71**	
			No. popn's	**5**	

Threats

Grevillea dryandroides subsp. *dryandroides* is threatened by a number of processes, activities and interactions that cause direct casualties, reduce rates of recruitment, and effect habitat changes that are detrimental to the long-term survival of the subspecies. The threats to *Grevillea dryandroides* subsp. *dryandroides* are:

Competition by weeds: The species is a disturbance opportunist and therefore typically grows in disturbed areas such as road verges and maintenance tracks, which are also typically weedy. This threat is likely to result in the greatest number of plant casualties, as it currently affects 7 population sites. Weeds threaten to out-compete *Grevillea dryandroides* subsp. *dryandroides* seedlings by competing for nutrients, light, pollinators, and space to establish, all of which would result in reduced recruitment, and ultimately population senescence. The lack of seedlings at many sites may be partially due to this threat.

Tenure specific maintenance activities: A range of site and tenure specific activities, including maintenance of roads, rail facilities, drains, golf course, cemetery and Telstra cables threaten the taxon. These maintenance activities are likely to result in the physical damage or destruction of plants, and

possibly adverse habitat changes such as soil compaction. Maintenance activities such as the above often encourage weed invasion, which will create competition with any germinants.

Vehicle traffic: This threat has the potential to damage or destroy plants at four population sites, where vehicles travel along firebreaks and rail maintenance tracks. Vehicle traffic may also result in adverse habitat changes such as soil compaction, or changes to water flow.

Inadequate recruitment: It seems that favourable conditions for recruitment do not exist at 3 population sites, indicated by the absence of young plants. Fire or disturbance is often necessary to promote recruitment, but there may also be other conditions required. Research suggests that disturbance is particularly important for inducing recruitment in this species. Without the correct recruitment conditions this lack of recruitment will lead to a continuing decline in population numbers and ultimately, population senescence.

Salinisation: Salinity is affecting one population site. The exact effects of salinity on *Grevillea dryandroides* subsp. *dryandroides* are unknown but they will almost certainly be detrimental. If and when salinisation of the population site occurs, it will cause adverse habitat changes which will likely result in the loss of this population.

Competition by native flora: Four population sites are affected by competition from native flora. Native flora can physically restrict the growth of *Grevillea dryandroides* subsp. *dryandroides* and can compete with it for light, nutrients and possible pollinators. This competition can make it difficult for seedlings to establish and without new plants the populations are at risk of senescence.

Waterlogging and soil deposition: Both threats affect one population site, with the soil deposition a result of water moving soil to the population site. Population 2 is a low-lying area and can stay waterlogged for some time after heavy rains. This may drown the plants, resulting in deaths or cause a decline in plant health, depending on the length of waterlogging. Soil deposition and waterlogging may also result in adverse habitat changes, creating unfavourable conditions for plant growth.

Critically small populations: The largest population has 16 plants, with some populations as low as 1 or 3 plants. Small populations are not as likely to be pollinated, they may lack ecological resources and are highly vulnerable to disease or stochastic events. This may lead to a lack of population health and reduced recruitment, and ultimately population senescence.

Recreational activities: The two population sites that exist on the golf course are impacted upon by recreational activities. These activities may result in physical damage or the destruction of plants. Adverse habitat changes are also probable.

Grazing by rabbits: Grazing impacts one population and causes physical damage to plants, and may cause destruction. In addition, disturbance of soil by rabbit warren construction and increased nutrient levels from their droppings can encourage weeds.

RECOVERY ACTIONS

Existing Recovery Actions

- An Interim Recovery Plan has been prepared for this taxon (Phillimore & Brown, 2000).
- Appropriate land managers have been informed of the taxon's location and their legal obligations.
- Declared Rare Flora (DRF) markers have been installed at Populations 1a, 1b, 2, 3a, 4 and 5a.
- Dashboard stickers and posters that illustrate DRF markers and describing their purpose have been produced and distributed.
- A poster that provides a description of the taxon and information about threats and recovery actions has been produced.
- A reply-paid postal drop describing the taxon and its habitat has also been developed and distributed to local farmers and residents in the Wongan-Ballidu Shire.
- Populations 1b and 3b have been fenced.

- Seed was collected every year from 1996 to 2000 inclusive by CALM's Threatened Flora Seed Centre. A combined total of approximately 1000 seeds were collected with germination rates of up to 100%.
- Cuttings have been propagated by Botanic Gardens and Parks Authority.
- Smoke trials were undertaken by BGPA in 1995.
- Staff from CALM's Merredin District office regularly monitor the populations.
- Translocation proposal completed and endorsed March 2000. Translocation undertaken June 2000. Proponents were R. Phillimore (S&CB), P. Roberts and Shire of Wongan-Ballidu, represented by N. Goode. None of the 135 seedlings survived, probably due to initial drought.
- Received endorsement from Director of Western Australian Threatened Species and Communities Unit (now amalgamated within Species and Communities Branch) to continue the translocation in 2002 using the existing site. Seed will be collected in November/December 2001, then propagated at BGPA. Seedlings will need to be thoroughly watered in and provided with a drip irrigation system for the first few months following translocation.
- Surveys were conducted for new populations throughout Ballidu in September 2000 and 2001, including large areas of remnant vegetation at the local airstrip. Although these areas contained similar vegetation and soil types, no *Grevillea dryandroides* subsp. *dryandroides* were found.
- Population 3 was fenced with Westrail in May 2001. This helps to identify the population boundaries and prevent accidental damage during rail operations.

Future Recovery Actions

As *Grevillea dryandroides* subsp. *dryandroides* populations are found on a range of land tenures, permission will be sought from relevant land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Undertake weed control

Effective weed control is required to reduce the impact of weed invasion at Populations 1a, 1b, 2, 3a, 3c, 5a and 5b. This will be by hand weeding or localised application of herbicide during the appropriate season to minimise the effect of herbicide on the species and the surrounding native vegetation. All applications of weed control will be followed by a brief report on the method, timing and success of the treatment against weeds, and the effect on *G. dryandroides* subsp. *dryandroides* and associated native plant species. Follow up monitoring will be necessary to achieve this.

Action:	Undertake weed control
Populations:	1a, 1b, 2, 3a, 3c, 5a and 5b
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$1,100

2. Install Declared Rare Flora markers

Declared Rare Flora (DRF) markers are required at Populations 3c and 5b to ensure railway staff know where the plants are when they maintain rail-lines.

Action:	Install DRF markers
Populations:	3c and 5b
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$400

3. Obtain biological and ecological information

Research is required to increase knowledge of the biology and ecology of *Grevillea dryandroides* subsp. *dryandroides*. Investigations will include:

- Key soil conditions, pH, permeability and nutrient composition of the soil

- Soil seed bank dynamics and the role of various factors including disturbance, competition, rainfall and grazing in recruitment and seedling survival
- Determination of reproductive strategies, phenology and seasonal growth
- The effects of fire on recruitment and detrimental habitat changes
- The effects of salinity

Action: Obtain biological and ecological information
Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): $15,900 per annum for 5 years

4. Translocation

A translocation is already planned for 2002 at the same site as the unsuccessful 2001 translocation, but this time will involve more provision of water to translocates. Information on the translocation of threatened animals and plants in the wild is provided in CALM's Policy Statement No. 29 *Translocation of Threatened Flora and Fauna.* If any further development of the translocation project is necessary, that work will be completed.

Action: Implement translocation
Responsibility: CALM (Merredin District) through the MDTFRT
Cost (minus labour): $12,400 in first year, and $5,600 in subsequent years

5. Fence population

Golf course maintenance and recreational activities threaten Populations 4a and 4b. By fencing these population sites the plants would be afforded a greater amount of protection. The plants at site 4a are in a small area that would be convenient to fence, and the plants at site 4b are in a strip of remnant vegetation. CALM will provide practical assistance and, when available, materials to ensure the adequacy of fences.

Action: Fence population
Populations: 4a and 4b
Responsibility: CALM (Merredin District) through the MDTFRT
Cost (minus labour): $3,000

In addition to the above specific actions, some common management actions are detailed in Part Four: Management Strategies. The most relevant of these include:

- Community education
- Fire management
- Fire response research
- Germplasm collection and storage
- Liaison with land managers
- Monitor populations
- Reproduction and recruitment enhancement
- Surface water management – diverting water flow upstream of the low-lying area of Population 2 may significantly decrease the threat of waterlogging and soil deposition.
- Surveys to locate new populations

Lysiosepalum abollatum

Common name: Woolly Lysiosepalum

Family: Sterculiaceae

Ranking: Critically Endangered
Flowering period: August to October
Information is accurate: 2004

Photo: Anne Cochrane

BACKGROUND

Current status: *Lysiosepalum abollatum* was declared as Rare Flora in April 2002 and currently meets World Conservation Union (IUCN) Red List Category Critically Endangered under criteria B1ab(iii,iv,v)+B2ab(iii,iv,v) and C2a(ii) (IUCN 2000). The species is known from a single population, and there is a continuing decline in the number of mature individuals and the area and quality of its habitat, with over 90% of all mature plants occurring in one subpopulation.

Description: *Lysiosepalum abollatum* is a dense, erect shrub to 1.5 m x 1.5 m; young growth and inflorescences have a white woolly appearance from large stellate hairs. Leaves are erect or spreading, mid-green, narrowly ovate, 10-16 x 2-3 mm with stellate hairs on both surfaces and moderately recurved margins. Inflorescence is 40-90 mm long with up to 8 flowers, and on a peduncle 10-35 mm long. Calyx lobes are ovate to elliptic, 6.5-11.5 x 3.2-3.5 mm with acute apex. Petals are usually present, usually horizontal (rarely erect), flat, dark red 0.8-1.5 x 0.8-1.3 mm (Wilkins and Chappill, 2001).

Lysiosepalum abollatum is similar to *L. rugosum* in having a long inflorescence with up to eight flowers and leaves with rugose surfaces and recurved margins. It differs in having short petioles, epicalyx bracts with an acuminate rather than acute apex and a woolly appearance from long-stalked, large, stellate hairs rather than a close tomentum of sessile, small, stellate hairs (Wilkins and Chappill, 2001).

Distribution: *Lysiosepalum abollatum* is only known from one population, located in the Shire of Wongan-Ballidu. Population 1a contains a single plant located on private property. Population 1b is also on private property, and contains 99 mature plants and 9 juveniles.

Habitat requirements

Soils: Red clay and orange-brown sandy clay with laterite
Vegetation: Open mallee woodland to about 5 m
Associated Species: Found in the shade of *Eucalyptus* trees

Biology

Fire:	No knowledge of this species' response, but Sterculiaceae species generally respond well to fire, regenerating from soil-stored seed
Disturbance:	Scarification of seed produced good germination results under laboratory conditions, so disturbance likely to be beneficial to germination of seed
Pollination:	No knowledge of vector, but seed viability has been found to be high, so can be assumed to be occurring
Propagation:	Unknown

Summary of population information for *Lysiosepalum abollatum*

Pop'n	Locality	Land Type	Survey date	Mature	Juveniles	Condition
01a	Mt O'Brien	Private Property	25/08/2001	130	9	Healthy
01b	Mt O'Brien	Private Property	29/08/200	1	0	Healthy
			No. plants	**131**	**9**	
			No. popn's	**1**		

Threats

Lysiosepalum abollatum is threatened by several processes, activities and interactions that may cause direct casualties, reduce rates of recruitment, and effect habitat changes that are detrimental to the long-term survival of the species. The threats to *Lysiosepalum abollatum* are:

Water runoff: This population occurs on a slope and is affected by water-borne soil movement. This affects some plants by soil movement away from the root zone, and others by soil deposition.

Inadequate recruitment: It seems that favourable conditions for recruitment may not exist at this population, indicated by the absence of young plants. Fire or disturbance is often necessary to promote recruitment, but there may also be other conditions required. The limited area of shaded habitat may be an important factor for *Lysiosepalum abollatum*. Without the correct recruitment conditions this lack of recruitment will lead to a continuing decline in population numbers and ultimately, population senescence.

Grazing by stock: This population occurs on private property, and access to this area by stock would cause damage to the habitat through trampling and grazing as well as to the *Lysiosepalum abollatum* plants.

Critically small populations: Small populations are not as likely to be pollinated, they may lack ecological resources and they are highly vulnerable to disease or stochastic events. This may lead to a lack of population health and reduced recruitment, and ultimately population senescence.

RECOVERY ACTIONS

Existing Recovery Actions

- The owners of the private property containing Populations 1a and 1b were notified of the presence of this declared rare species on their land in May 2002.
- The population is fully fenced to protect it from grazing.
- Seed was collected from Population 1a in November 2000, and some 3700 seeds are now stored at the Threatened Flora Seed Centre. This seed had an initial germination rate of 96%.
- Extensive surveys were undertaken, which failed to locate any new populations. The known population was also monitored.

Future Recovery Actions

Lysiosepalum abollatum populations occur on private property. Permission will be sought from land managers, where appropriate, prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Reproduction and recruitment enhancement

The high viability of seed collected in 2000 suggests that germination rather than pollination may be a factor currently limiting recruitment in this species. There is no specific information about the response of this species to fire or disturbance, but other species in the Sterculiaceae family tend to respond well to fire, germinating in large numbers from soil-stored seed. This species occurs near long unburnt remnant vegetation at Mt O'Brien which would be likely to suffer major impacts if a trial fire were to get out of control, so trials will be limited to disturbance and smokewater. Trial areas will be monitored for recruitment for several years to allow for delayed germination.

Action:	Investigate reproduction and recruitment enhancement
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$750

2. Undertake a translocation

As there are only 131 known plants in a single population, it is essential to undertake a translocation into appropriate habitat. This will require the development and approval of a translocation proposal, and propagation of translocates. Once planting has occurred, extensive monitoring will be required. Information on the translocation of threatened animals and plants in the wild is provided in CALM's Policy Statement No. 29 *Translocation of Threatened Flora and Fauna.* All translocation proposals require endorsement by the Director of Nature Conservation.

Action:	Undertake a translocation
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$12,500 in first year, and $5,600 in subsequent years

In addition to the specific recovery actions detailed above, a range of common recovery actions are proposed that will reduce the threats facing the taxon. Those that are particularly relevant include:

- Germplasm collections
- Liaise with land managers
- Rehabilitate habitat
- Surveys

Melaleuca sciotostyla

Common name: Wongan Melaleuca

Family: Myrtaceae

Ranking: Endangered
Flowering period: August
Information is accurate: 2004

Photo: Nicole Willers

BACKGROUND

Current status: *Melaleuca sciotostyla* was declared as Rare Flora in July 1989 and is currently ranked as Endangered under World Conservation Union (IUCN) Red List criteria C2a and D (IUCN, 1994).

Description: *Melaleuca sciotostyla* is a shrub up to 1.5 m tall, glabrous except for the young shoots. Flat to almost terete leaves, 5-8 mm long. The inflorescence occurs at the tips of branches, and usually consists of 4 flowers with involucral bracts in four series of 6-8. The fruit is barrel-shaped and papery or somewhat corky (Barlow and Cowley, 1988).

Melaleuca sciotostyla differs from its apparent near relatives *M. cuticularis* and *M. haplantha* in having more than one flower in the inflorescence and in the reddish pink colouration of the bracts and especially the distal part of the style and the stigma. It further differs from *M. cuticularis* in the narrower leaves, the fewer stamens per bundle and the generally smaller fruits. It further varies from *M. haplantha* in the non-pungent leaves and the very long sepals (Barlow and Cowley, 1988).

Distribution: *Melaleuca sciotostyla* is known from 2 populations located within 1 km of each other. The largest population is located on a pistol range reserve and on an adjoining nature reserve. The second population occurs on a nearby water reserve

Habitat requirements

Soils:	Orange clayey sand with lateritic pebbles, scree slopes
Vegetation:	Dense shrubland
Associated Species:	*Eucalyptus erythronema*, *E. obtusiflora*, *E. sheathiana*, *E. transcontinentalis* and *Melaleuca coronicarpa*

Biology

Fire:	Unknown
Disturbance:	Commonly found on eroded scree slopes suggesting the species benefits from natural disturbance
Propagation:	BPGA have tried to propagate this from cuttings with no success so far (personal communication, A. Shade)

Pollination: Unknown

Summary of population information for *Melaleuca sciotostyla*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01a	Elphin	Nature Reserve	23/08/01	114	Healthy
01b	Elphin	Shire Reserve	23/08/01	362	Healthy
02-	Elphin	Water Reserve	No details		
			No. of plants	**476**	
			No. of pop'ns	**2**	

Threats

Melaleuca sciotostyla is threatened by a number of processes, activities and interactions that cause direct casualties, reduce rates of recruitment, and effect habitat changes that are detrimental to the long-term survival of the species. The threats to *M. sciotostyla* are:

Wildfire: The effect of wildfire on *Melaleuca sciotostyla* is unknown, but may represent a significant threat to the species. The population sites occur in dense, highly flammable shrublands, located on sloping terrain. Ignition sources such as lightning and prescribed burning on nearby lands are present most years, and adjoining pistol range activities are present on a regular basis. As many species of *Melaleuca* are bradysporous, fire may be required to release sufficient canopy-stored seed for recruitment to occur. Fire may cause detrimental habitat changes, such as accelerated erosion of the denuded slopes that are the species' preferred habitat.

Narrow geographical range: *Melaleuca sciotostyla* is only known from two populations within 1km of each other, and is therefore vulnerable to stochastic events such as disease.

Water run-off and soil deposition: Water run-off and soil deposition are significant threats to Population 1b. While the species appears to be adapted to life on erosive slopes, accelerated water run-off from cleared areas of the adjoining pistol club facilities causes increased deposition of soil and organic matter in parts of the population area. This may have an adverse effect on the species through habitat modification and possibly stem rot.

Pistol range maintenance: Maintenance activities around the pistol club will impact on Population 1b, and to a lesser extent Population 1a. These activities are likely to result in the physical damage or destruction of plants, and possibly some adverse habitat changes, such as soil compaction. The disturbance created by maintenance works often encourages weed invasion, which will create competition with any *Melaleuca sciotostyla* juveniles.
Gunfire. Populations 1a and 1b are threatened directly by gunfire, which causes physical damage to plants, reducing their overall health.

Firebreak maintenance: Firebreak maintenance around Population 1b may result in some physical damage to plants as well as adverse habitat changes such as soil compaction and weed invasion.

RECOVERY ACTIONS

Existing Recovery Actions

- Approximately 90,000 seeds were collected by the Threatened Flora Seed Centre in October 1995. These had a germination rate of up to 96%.

Future Recovery Actions

Melaleuca sciotostyla occurs on a nature reserve, a shire reserve and a water reserve. Permission will be sought from land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Manage surface water flow

Areas such as the pistol club carpark, nearby firebreaks and some scree slopes need to be stabilised to prevent water run-off resulting in soil deposition downhill. The best method of stabilising these areas needs to be investigated but some options are brushing, matting, buffering or installing culverts.

Action: Manage surface water flow
Populations: 1a and 1b
Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): (Subject to solution determined)

2. Conduct further surveys

One of the major threats to the species is its narrow geographical range. Recent surveys have located a new population. Information collected from the new site suggests that other undiscovered populations may occur in other areas. Consequently, further surveys will be conducted, particularly around breakaways and scree slopes, during the species' flowering season (August) when the plants are easiest to find.

Action: Conduct further surveys
Responsibility: The Department (Merredin District) through MDTFRT
Cost (minus labour): $700

In addition to the specific recovery actions detailed above, a range of common recovery actions would reduce the threats facing *M. sciotostyla*. Those that are particularly relevant include:

- Community education
- Fire management
- Germplasm collection and storage
- Land management options is particularly applicable to the population recently found on the water reserve.
- Liaison with land managers will address threats arising from pistol club activities and maintenance
- Monitor populations

Microcorys eremophiloides

Common name: Wongan Microcorys

Family: Lamiaceae

Ranking: Vulnerable (Proposed Priority 4).
Flowering period: Early September to early November
Information is accurate: 2004

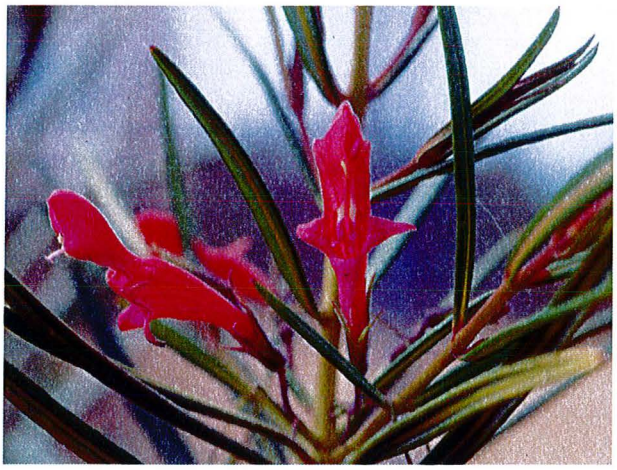


Photo: Andrew Brown

BACKGROUND

Current status: *Microcorys eremophiloides* was declared as Rare Flora in September 1987 and is currently ranked as Vulnerable under World Conservation Union (IUCN) Red List criterion C2a (IUCN, 1994). As a large number of plants are now known, many secure from threats in nature reserves, it is recommended that the species be nominated for Priority 4 listing.

Description: *Microcorys eremophiloides* is an erect, openly branched shrub to 2 m high. Stems with slightly fissured bark when young, becoming deeply fissured and corky with age. Leaves are opposite, often crowded towards the ends of the terminal branchlets, linear, 30-60 x 1-3 mm. Flowers are axillary, pedicels are slender with a pair of bracteoles below the calyx. The calyx is narrow-cylindrical and about 10-15 mm long, with a mixture of glandular and simple hairs. The corolla is 4 cms long, deep pink to red and slightly glandular-pubescent. The upper lip is narrow, concave, somewhat shorter than the tube, while the lower lip is much shorter than the upper lip, spreading with 3 acute entire lobes. Nutlets are dry, cylindrical, 3-4 mm long, irregularly ribbed, dark brown and remain attached, surrounded by the calyx, until late February (Kenneally, 1982b).

Microcorys eremophiloides superficially resembles its close relative *M. longifolia* and was formerly incorrectly referred to this species. However, M. eremophiloides can be distinguished by its flowers, which are twice as large, and by the upper lip of the corolla being much longer than the lower lip. The 3 lobes of the lower lip of the corolla are acute in M. eremophiloides and obtuse in M. longifolia. The leaves of M. eremophiloides tend to be crowded towards the ends of the terminal branchlets whereas young branches of M. longifolia are leafy throughout. (Kenneally, 1982b).

Distribution: *Microcorys eremophiloides* is known from 17 populations, two of which are located in the Shire of Dowerin, south-east of the Shire of Wongan-Ballidu. The populations located in Wongan-Ballidu Shire occur on a range of land tenures, including private property, Shire road verges, a Telstra site and the relative safety of Nature Reserves.

Habitat requirements

Soils: Shallow soil over massive laterite

Vegetation: Occurs as scattered plants in closed heath with emergent mallees
Associated Species: *Allocasuarina campestris*, *Dryandra* spp., *Eucalyptus drummondii* and *E. ebbanoensis*

Biology

Fire: Unknown
Disturbance: Unknown
Propagation: Can be propagated using cuttings or grafted onto *Westringia dampieri*. BGPA found that grafting gives slightly better results (25-50%) than cuttings (2-22%) (personal communication, A. Shade).
Pollination: Unknown

Summary of population information for *Microcorys eremophiloides*

Pop'n	Locality	LGA	Land Type	Survey date	Mature	Seedling	Condition
01a	Mt Matilda	Wongan-Ballidu	Nature Reserve	30/09/2000	500	50	Healthy
01b	Mt Matilda	Wongan-Ballidu	Nature Reserve	18/09/2000	200	0	Healthy
01c	Mt Matilda	Wongan-Ballidu	Nature Reserve	30/09/2000	260	0	Healthy
01d	Mt Matilda	Wongan-Ballidu	Private Property	30/09/2000	140	0	Healthy
01e	Mt Matilda	Wongan-Ballidu	Rd Verge SHIRE	18/09/2000	5	1	Healthy
01f	Mt Matilda	Wongan-Ballidu	Nature Reserve	30/09/2000	100	0	Healthy
01g	Mt Matilda	Wongan-Ballidu	Nature Reserve	29/09/2001	35	0	Healthy
01h	Mt Matilda	Wongan-Ballidu	Nature Reserve	24/08/2001	80	0	Healthy
01i	Mt Matilda	Wongan-Ballidu	Nature Reserve	24/08/2001	17	1	Healthy
01j	Mt Matilda	Wongan-Ballidu	Private Property	20/08/2001	1	0	Healthy
02a	Fowler's Gully	Wongan-Ballidu	Nature Reserve	9/08/2001	30	0	Healthy
02b	Fowler's Gully	Wongan-Ballidu	Nature Reserve	1/10/2000	62	19	Healthy
03-	Rogers	Wongan-Ballidu	Nature Reserve	1/09/1992	5	0	Healthy
04a	Mount O'Brien	Wongan-Ballidu	Private Property	9/08/2001	178	10	Healthy
04b	Mt O'Brien	Wongan-Ballidu	Private Property	20/09/2000	250	0	Healthy
04c	Mt O'Brien	Wongan-Ballidu	Telstra Site	9/08/2001	9	0	Healthy
04d	Mt O'Brien	Wongan-Ballidu	Private Property	29/08/2001	20	10	Healthy
05-	Elphin	Wongan-Ballidu	Nature Reserve	23/08/2001	12	2	Healthy
06a	Mt Rupert	Wongan-Ballidu	Private Property	24/08/2001	19	3	Healthy
06b	Mt Rupert	Wongan-Ballidu	Private Property	24/08/2001	53	4	Healthy
07-	Fowler's Gully	Wongan-Ballidu	Nature Reserve	27/09/1992	42	0	Healthy
08-		Dowerin	Private Property	12/09/1993	100	100	Healthy
09a	Unknown	Unknown	Unknown	30/10/1991	2	0	
09b	Wattengutten	Dowerin	Private Property	12/09/1993	500	0	Healthy
09c		Dowerin	Private Property	12/09/1993	21	0	Healthy
10-	Rogers	Wongan-Ballidu	Nature Reserve	15/11/1988	1	0	Healthy
12a	Rogers	Wongan-Ballidu	Nature Reserve	9/07/2001	50	0	Healthy
12b	Rogers	Wongan-Ballidu	Nature Reserve	8/08/2001	50	0	Healthy
13-	Rogers	Wongan-Ballidu	Nature Reserve	9/07/2001	40	0	Healthy
14a	Gathercole	Wongan-Ballidu	Nature Reserve	19/10/2001	8	0	Healthy
14b	Gathercole	Wongan-Ballidu	Nature Reserve	5/08/2000	2	0	Healthy
15-	Rogers	Wongan-Ballidu	Nature Reserve	9/07/2001	120	0	Healthy
16a	Elphin Hills	Wongan-Ballidu	Private Property	26/08/2001	5	0	Healthy
16b	Rogers	Wongan-Ballidu	Private Property	26/08/2001	100	0	Healthy
16c	Rogers	Wongan-Ballidu	Private Property	26/08/2001	29	0	Healthy
17-	Elphin	Wongan-Ballidu	Private Property	1/10/2001	100	0	Healthy
				No of plants	**3146**	**200**	
				No of pop'ns	**36**		

RECOVERY ACTIONS

Existing Recovery Actions

- All appropriate land managers have been made aware of the threatened nature of this species and its location.
- Extensive surveys were undertaken, locating new populations in addition to monitoring known populations.
- CALM's Threatened Flora Seed Centre (TFSC) collected seed in November 1995 and again in 1996. Approximately 500 seeds are in storage with a germination rate of up to 60%.

Future Recovery Actions

1. Change conservation status

It has been suggested that this species may warrant downlisting from Declared Rare Flora to Priority 4 now that a substantial number of plants occur within nature reserves. This will need to be assessed, and if appropriate, CALM procedures followed to achieve a change in recognised conservation status.

Action:	Change conservation status
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	Nil

As this species is proposed for Priority 4 conservation status, the change to its conservation status is the only specific recovery action recommended. There are only a small number of threats facing the species, and their overall impact is low. Some recovery actions that may maintain the low level of threat to this species include:

- Community education
- Liaison with land managers
- Monitor populations

Philotheca wonganensis

Common name: Wongan Philotheca

Family: Rutaceae

Ranking: Endangered
Flowering period: August to October
Information is accurate: 2004

Photo: Nicole Willers

BACKGROUND

Current status: *Philotheca wonganensis* (previously *Eriostemon wonganensis*) was declared as Rare Flora in September 1987 and is currently ranked as Endangered under World Conservation Union (IUCN) Red List criterion C2a (IUCN, 1994).

Description: *Philotheca wonganensis* is an erect, glabrous shrub to 1 m high, with a number of erect branches arising from the base. Branches are slender. Leaves are scattered, erect, slender, 5-10 mm long and somewhat flattened above. Flowers are solitary, axillary and glabrous on pedicels about 5 mm long. Petals are oblong-elliptic, about 5 mm long and white except for pink outer medial strip. Seeds black, oblong-kidney-shaped, about 2.5 mm long and 1.8 mm wide (Wilson, 1982a).

Philotheca (then *Eriostemon*) *wonganensis* belonged to the section *Nigrostipulae* as determined by the flower and seed structure, but unlike all other members of that section, is completely glabrous (Wilson 1982a). *Eriostemon* sect. *Nigrostipulae* has since been moved to *Philotheca* Sect. *Philotheca* (Wilson, 1998).

Distribution: *Philotheca wonganensis* is known from 4 populations and 5 sites, all in the Shire of Wongan-Ballidu. Three populations, including the largest, are located entirely on private property. Population 2 contains two sites, one of which is located on a Nature Reserve while the other is on private property.

Habitat requirements

Soils:	Red soil over fractured or schistose greenstone
Vegetation:	Occurs in dense shrubland 3-5 m tall with sparse ground cover and open woodland with shrubland understorey
Associated Species:	*Eucalyptus ebbanoensis*, *E. loxophleba*, *Allocasuarina acutivalvis*, *A. campestris*, *Baeckea crispiflora*, *Acacia orbifolia*, *A. congesta* subsp. *wonganensis*, *A. pulchella*, *Grevillea petrophylloides*, *Comersonia pulchella*, *Hemigenia conferta* and *Calothamnus asper*

Biology

Fire:	Unknown
Disturbance:	Water erosion is the dominant, natural soil-disturbing process in the species' habitat. It is likely to have a positive effect on recruitment
Propagation:	Unknown
Pollination:	Unknown

Summary of population information for *Philotheca wonganensis*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01-	Mt O'Brien	Private Property	25/08/01	1000	Healthy
02a	Mt Matilda	Nature Reserve	6/08/00	500	Healthy
02b	Mt Matilda	Private Property	6/08/00	50	Healthy
03-	Mt O'Brien	Private Property	8/08/01	600	Healthy
04-	Mt Matilda	Private Property	29/09/01	200	Healthy
			No. plants	**2350**	
			No. popn's	**4**	

Threats

Interactions and a physical process threaten *Philotheca wonganensis* that may cause direct casualties, reduce rates of recruitment, and effect habitat changes that are detrimental to the long-term survival of the species. The threats to *Philotheca wonganensis* are:

Wildfire: No information exists regarding the effects of fire on *Philotheca wonganensis*. However, fire may represent a significant threat to species as all populations occur in dense, highly flammable shrublands, located on steeply sloping terrain. Ignition sources such as lightning, stubble burns on nearby farmlands and other human activities are present most years. A wildfire would destroy adult plants, but it is unknown if fire is required to germinate soil-stored seed. In the post-fire period, recovering populations would be subject to competition from other germinating native flora and weeds; selective grazing of seedlings by native fauna and possibly accelerated erosion of denuded steep slopes and gully floors.

Inadequate recruitment: Most populations of *Philotheca wonganensis* appear to be old, possibly single stage. Surveyors have noted a lack of recruitment across populations and this raises concern for the long-term survival of the species. Without suitable conditions for recruitment, population numbers are likely to decline, leading ultimately to population senescence.

Grazing by stock: Grazing is a serious threat that may affect the species in the near future. If stock were to move into the population areas they would damage and destroy plants, adversely affect the habitat by accelerating erosion, encouraging weed invasion and causing soil compaction. These impacts are likely to lead to a decline in population numbers and condition and be detrimental to recruitment.

RECOVERY ACTIONS

Future Recovery Actions

Philotheca wonganensis populations occur on nature reserve and private property. Permission will be sought from land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Reproduction and recruitment enhancement

Trials will be conducted to identify conditions favouring recruitment. Factors such as soil seed bank dynamics and the role of disturbance, fire, competition, rainfall and grazing in germination and

recruitment will be investigated. When the key factors are determined they will be incorporated into prescriptive recruitment enhancement strategies. These will be implemented to encourage recruitment.

Action: Investigate and implement reproduction and recruitment enhancement strategies
Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): $1,000

In addition to the specific recovery actions detailed above, a range of common recovery actions is proposed that will reduce the threats facing *P. wonganensis*. Those that are particularly relevant include:

- Community education
- Fence installation in key habitat areas – essential to protect Populations 1, 2b and 3 from stock grazing
- Fire management
- Germplasm collection and storage
- Land management options
- Liaison with land managers
- Population monitoring
- Surveys

Rhagodia acicularis

Common name: Wongan Rhagodia

Family: Chenopodiaceae

Ranking: Vulnerable
Flowering period: October to May
Information is accurate: 2004

Photo: Nicole Willers

BACKGROUND

Current status: *Rhagodia acicularis* was declared as Rare Flora in September 1987 and is currently ranked as Vulnerable under World Conservation Union (IUCN) Red List criteria C2a and D2 (IUCN, 1994). A total of 3,420 plants are known from six populations, some 830 plants occur on a nature reserve.

Description: Compact, intricately branched, rounded, dioecious shrub to about 50 cm high, scurfy due to a close covering of minute vesicular hairs which although collapsing, retain their circular shape with age. Branchlets spinescent. Leaves alternate, small, somewhat fleshy, narrowly elliptic, 2-5 mm long, glabrescent above, closely vesicular puberulous below. Flowers few, sessile, subtended by a minute bract. Male flowers broadly turbinate, about 1 mm long. Female flowers spheroidal, about 1.2 mm diameter. Terminal flower on female inflorescence sterile, densely filled with woolly hairs. Fruit baccate, depressed spherical, about 3 mm diameter, pale red, clasped around sides by tepals but exposed at the top and between tepals. Seed lenticular with rounded margin, 1.5 mm diameter, radially verruculose, black. (Wilson, 1982b).

Rhagodia acicularis closely resembles its close relative *R. ulicina*, but differs in the following characters: the terminal flower of female inflorescence is sterile not large and fertile; the seed is radially verruculose not smooth or minutely granular; and the male flower has woolly stamens united into a cup-shaped disc not glabrous and without a disc. (Wilson, 1982b).

Distribution: *Rhagodia acicularis* is known from 6 populations, all in the Shire of Wongan-Ballidu. Two populations are located on a nature reserve and all the remaining populations occur on private property.

Habitat requirements

Soils:	Red soil on gravelly lateritic slopes
Vegetation:	Occurs in 10-12 m tall woodlands dominated by gimlet and morrel, with low mixed shrubland
Associated Species:	*Eucalyptus salubris*, *E. longicornis*, *Acacia eminosa*, *Eremophila ternifolia*, *Melaleuca sp.*

Biology

Fire: Unknown
Disturbance: Unknown
Propagation: Can be propagated from cuttings. BGPA have recorded results of 28 and 66% in the past (personal communication, A. Shade)
Pollination: Unknown

Summary of population information for *Rhagodia acicularis*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01a	Mt Rupert	Private Property	2/05/01	1340	Undisturbed
01b	Mt Rupert	Private Property	9/08/01	1000	Healthy
02-	Mt Matilda	Nature Reserve	29/09/01	30	Healthy
04-	Mt Matilda	Nature Reserve	24/08/01	800	Healthy
05-	Mt Rupert	Private Property	5/08/00	50	Healthy
07-	Ninan	Private Property	2/05/01	100	Healthy
08-	Mt Matilda	Private Property	29/09/01	100	Healthy
			No. of plants	**3420**	
			No. of pop'ns	**6**	

Threats

Rhagodia acicularis is threatened by a number of interactions that effect habitat changes, which are detrimental to the long-term survival of the species. The threats to *Rhagodia acicularis* are:

Grazing by stock: Over half of the known *Rhagodia acicularis* sites are threatened by stock grazing. The threatened sites are either not fenced, or the fencing is in bad condition, which is currently, or may allow stock access to population sites for grazing. Any grazing is likely to cause adverse habitat modifications, such as erosion, increased weed invasion and a reduction in the local biodiversity. Grazing may also result in plant deaths and a lack of recruitment.

Competition from weeds: Weeds are a threat to Population 1a and appear to be concentrated around old stock routes. At this site weeds threaten to out-compete *Rhagodia acicularis* juveniles for light, nutrients and pollinators, which may result in reduced recruitment. They also degrade habitat, exacerbate grazing pressure and increase the risk and severity of fire.

Lack of habitat: Population 7 exists in a degraded remnant, most likely as a result of past grazing pressures. Therefore this population does not have access to the same ecological resources as other populations located in better quality bushland. It is predicted that over time this will result in a decline in recruitment, which will ultimately lead to population senescence.

Grazing by other fauna: Affects Population 7 and is most likely to be kangaroo and rabbit grazing. Plant deaths and damage to plants are likely results of grazing by these animals. Added nutrient and weed seeds from droppings combine with rabbit diggings to exacerbate weed invasion. Rabbit and kangaroo grazing are likely to result in a decline in recruitment as they often selectively graze younger plants.

RECOVERY ACTIONS

Future Recovery Actions

Most *Rhagodia acicularis* populations exist on private property, and two are located on a nature reserve. Permission will be sought from relevant land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Undertake weed control

Effective weed control is required to reduce the impact of weed invasion at Population 1a. This will be by hand weeding or localised application of herbicide during the appropriate season to minimise the effect of herbicide on the species and the surrounding native vegetation. All applications of weed control will be followed by a brief report on the method, timing and success of the treatment against weeds, and the effect on *R. acicularis* and associated native plant species.

Action:	Undertake weed control
Population:	1a
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$800

2. Undertake Habitat restoration and rehabilitation

Community restoration and rehabilitation works will be carried out at Population 7 to rehabilitate the degraded associated vegetation. By improving the quality of the remnant, more ecological resources will be available to the current plants, and this may increase recruitment and thus population numbers.

Action:	Undertake habitat restoration and rehabilitation
Population:	7
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$9,900

In addition to the specific recovery actions detailed above, a range of common recovery actions is proposed that will reduce the threats facing the species. Those that are particularly relevant include:

- Community education
- Fence installation in key habitat areas – essential to protect Populations 1a, 5, 7 and 8 from stock grazing, and where possible, other fauna grazing.
- Fire management
- Germplasm collection and storage
- Land management options
- Liaison with land managers
- Population monitoring
- Surveys

Stylidium coroniforme

Common name: Wongan Hills Triggerplant

Family: Stylidiaceae

Ranking: Endangered
Flowering period: September to November
Information is accurate: 2004

Photo: Nicole Willers

BACKGROUND

Current status: *Stylidium coroniforme* was declared as Rare Flora on 14th April 1980 and is currently ranked as Endangered under World Conservation Union (IUCN) Red List criteria C2a and D (IUCN, 1994).

Description: *Stylidium coroniforme* is a perennial, stocky, closely branching plant, with several loose rosettes of leaves. Leaves are 3-4 cm long, grey-green, linear, becoming wider in the upper third and ending in a white point at the apex. Corolla is creamy pink with red spots at the throat and dark red lines on the outer surface of the petals (Erickson and Willis, 1966).

Stylidium coroniforme is closely related to short fruited *S. limbatum* as they share the same long ovary, racemose scape and marginate leaves. The corolla resembles that of *S. dichotomum,* which has a bare throat and cushion-like stigma. The name of the species is in reference to the attractively crown-like arrangement of inflorescences, encircling each cluster of rosettes (Erickson and Willis, 1966).

Distribution: *Stylidium coroniforme* is known from 8 populations, two of which are located in the Perenjori Shire in the Mid-West Region. The remaining six populations are located in the Wongan-Ballidu Shire, where four exist on a water reserve, one is on private property and one is on a nature reserve.

Habitat requirements

Soils:	Favours sites with laterite (sheet or gravel) that may be overlaid with shallow sand (Stace and Coates, 1995)

Biology

Fire:	Unknown
Disturbance:	Is a disturbance opportunist species
Propagation:	By seed, division or cuttings. BGPA have found both division and cuttings to have quite good success (personal communication, A. Shade)

Pollination: A range of native bees, and bombyllid and syrphid flies have been reported to be pollen vectors for the plant taxa. They are attracted by colourful petals. Nectar guides are present and there is a copious nectar flow at the throat of the flower (Stace & Coates, 1995)

Other: Seeds persist in the soil for some years. The minute seeds germinate readily on a moist medium in autumn (Stace & Coates, 1995)

Summary of population information for *Stylidium coroniforme*

Pop'n	Locality	LGA	Land Type	Survey date	Mature	Condition
01-	Rogers	Wongan-Ballidu	Private Property	1/10/01	25	Moderate
02-	Wongan Hills	Wongan-Ballidu	Water Reserve	1/10/00	5	Poor
03-	Maya	Perenjori	Railway Reserve	15/11/95	14	Moderate
04-	Maya	Perenjori	Railway Reserve	15/11/95	75	Healthy
05-	Wongan Hills	Wongan-Ballidu	Water Reserve	6/02/02	20	Poor
06a	Elphin	Wongan-Ballidu	Nature Reserve	27/09/99	65	Healthy
06b	Elphin	Wongan-Ballidu	Nature Reserve	29/09/00	1	Healthy
06c	Elphin	Wongan-Ballidu	Nature Reserve	29/09/00	1	Healthy
06d	Elphin	Wongan-Ballidu	Nature Reserve	1/10/00	70	Healthy
07-	Wongan Hills	Wongan-Ballidu	Water Reserve	30/09/01	2	Healthy
08a	Wongan Hills	Wongan-Ballidu	Water Reserve	2/10/00	1	Healthy
08b	Wongan Hills	Wongan-Ballidu	Water Reserve	30/09/01	1700	Healthy
09-	Wongan Hills	Wongan-Ballidu	Experimental Farm Res	30/09/01	800	Healthy
10-	Elphin	Wongan-Ballidu	Private Property	1/10/01	50	Healthy
			No of plants	**2829**		
			No of pop'ns	**10**		

Threats

Stylidium coroniforme is threatened by a number of interactions, activities and processes that cause direct deaths to plants or effect habitat changes that are detrimental to the long-term survival of the species. The threats to *Stylidium coroniforme* are:

Wildfire: No information exists on the effects of fire on *S. coroniforme*. However, population surveyors have expressed concern on the potential deleterious effects fire may have indirectly on post-fire recruitment through critical changes to the population habitat. Until the fire response of *S. coroniforme* has been determined, fire should be excluded from the populations if possible.

Grazing by stock: This is a threat to Populations 1 and 9, where the fences are in a state of disrepair. Stock may gain access to the populations and graze the habitat areas. Any grazing is likely to cause adverse habitat modifications such as erosion, increased weed invasion and a reduction in the local biodiversity, resulting in plant deaths and reduced recruitment.

Salinisation: Salinity is threatening Population 9, with the adjacent community already showing the impact of salinity. The exact effects of salinity on *Stylidium coroniforme* are unknown but they will almost certainly be detrimental. When salinisation of the population site occurs, it will cause adverse habitat changes which will likely result in the loss of this population.

Maintenance activities: Tenure specific activities such as powerline and water pipe maintenance threaten the species. These activities are likely to cause physical damage or destruction of existing plants, although the soil disturbance created by maintenance activities has previously stimulated recruitment. Maintenance events also typically encourage weed invasion, which may compete with seedlings.

Inadequate recruitment: Affects at least 3 populations – 3, 5 and 7. Favourable conditions for recruitment do not appear to exist at these *S. coroniforme* populations, as highlighted by the absence of young plants. The species may require fire or physical disturbance to germinate soil-stored seed, or possibly an opening of the canopy cover. Without the right conditions for recruitment, the populations are

less likely to sustain themselves in the long-term. This is likely to result in a decline in population numbers and condition over time, which will ultimately result in population senescence.

Competition from weeds: Weeds are a threat to Population 9, mainly along the existing firebreak which is the northern boundary of the population. The weeds threaten to further encroach on the population site and out-compete mature and juvenile *S. coroniforme* plants for light, nutrients and pollinators, which may result in reduced recruitment. They also degrade habitat, exacerbate grazing pressure and increase the risk and severity of fire.

Grazing by other fauna: This affects Population 9 and is most likely to be kangaroo and rabbit grazing. Damage to plants or plant deaths are likely results of grazing by these animals. Added nutrient and weed seeds from droppings combine with rabbit diggings to exacerbate weed invasion. Rabbit and kangaroo grazing are likely to result in a decline in recruitment as they often selectively graze younger plants.

Vehicle traffic: Vehicles travelling along maintenance tracks threaten Populations 2 and 5. Impacts include physical damage to plants from direct contact with vehicles and habitat modifications from soil compaction and erosion.

Mining: Mining for gravel or sand is a potential threat to Populations 2 and 7. If mining were to commence it would damage or destroy the existing populations. However, the disturbance effected as a result of the mining is likely to cause recruitment at the site.

RECOVERY ACTIONS

Existing Recovery Actions

- A total of approximately 28,000 seeds were collected by the Threatened Flora Seed Centre in December 1992 and 1993. These collections had germination rates ranging from 67% to 87%.

Future Recovery Actions

Stylidium coroniforme populations exist on a range of land tenures. Permission will be sought from relevant land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Reproduction and recruitment enhancement

Trials will be conducted to identify conditions favouring recruitment. Factors such as soil seed bank dynamics and the role of disturbance, fire, competition, rainfall and grazing in germination and recruitment will be investigated. When the correct conditions are determined, they will be implemented where possible to encourage recruitment.

Action:	Investigate and implement favourable recruitment conditions
Populations:	All, but especially 2, 5 and 7
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$1,250

2. Undertake weed control

Effective weed control is required to reduce the impact of weed invasion at Population 9. This will be by hand weeding or localised application of herbicide during the appropriate season to minimise the effect of herbicide on the species and the surrounding native vegetation. All applications of weed control will be followed by a brief report on the method, timing and success of the treatment against weeds, and the effect on *S. coroniforme* and associated native plant species.

Action:	Undertake weed control
Population:	9

Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): $900

In addition to the specific recovery actions detailed above, a range of common recovery actions is proposed that will reduce the threats facing the species. Those that are particularly relevant include:

- Community education
- Fence installation in key habitat areas – essential to protect Populations 1 and 9 from stock grazing
- Fire management
- Germplasm collection and storage
- Land management options
- Liaison with land managers
- Population monitoring
- Surveys

Verticordia staminosa subsp. *staminosa*

Common name: Wongan Featherflower

Family: Myrtaceae

Ranking: Critically Endangered
Interim Recovery Plan: IRP 90 (Evans & Brown, 2001)
Flowering period: June to October
Information is accurate: 2004

Photo: Andrew Brown

BACKGROUND

Current status: *Verticordia staminosa* subsp. *staminosa* was declared as Rare Flora in October 1996 and is currently ranked as Critically Endangered under World Conservation Union (IUCN) Red List criterion B1+2c (IUCN 1994). The subspecies is known from a single population of 1165 mature individuals in a restricted habitat, with continuing habitat degradation.

Description: *Verticordia staminosa* subsp. *staminosa* is a small spreading, much branched shrub. Its branchlets are hairy, with very narrow, more or less stalkless leaves, up to 1.5 cm long and crowded at their tips. The flowers are about 5 mm long. Sterile stamens do not protrude from the flower and the style is not hairy. Its 10 very long protruding stamens that are bright red with yellow tips distinguish *V. staminosa* subsp. *staminosa*. Below these are yellow, very feathery sepals and two bright red persistent bracts (Evans and Brown, 2000).

Verticordia staminosa subsp. *staminosa* differs from *V. staminosa* subsp. *cylindracea* in having larger flowers, a shorter staminal tube, longer stamens, and staminodes that are outside the staminal tube, rather than inserted between the staminal filaments (Gardner & George, 1963).

Distribution: *Verticordia staminosa* subsp. *staminosa* is known from one population, divided by land tenure into four subpopulations. These are located on a water reserve and private property.

Habitat requirements

Soils: Sandy loam over granite complex
Vegetation: Found in crevices or soil pockets of granite outcrops that are still well vegetated
Associated Species: *Kunzea pulchella*, *Wurmbea* sp., *Borya nitida*, *Hakea petiolaris*, *Cheilanthes* sp., *Drosera* sp., *Gastrolobium callistachys*, mosses, liverworts and lichens

Biology

Fire:	Mature plants are thought to be killed by fire. Seeds appear unlikely to require fire to effect germination as it would not be a frequent occurrence on the granite outcrop (personal communication, C. Yates)
Disturbance:	Unknown, but thought to be killed by disturbance (Evans and Brown, 2000)
Propagation:	BGPA have found the species to be generally consistent in having good results from cuttings (personal communication, A. Shade)
Pollination:	Insect pollinated (Yates *et al.*, 2000)

Summary of population information for *Verticordia staminosa* subsp. *staminosa*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01a	Wongan Hills	Water Reserve	3/03/99	1117	Healthy
01b	Wongan Hills	Private Property	3/03/99	22	Healthy
01c	Wongan Hills	Private Property	3/03/99	13	Healthy
01d	Wongan Hills	Private Property	3/03/99	13	Healthy
			No. of plants	**1165**	
			No. of pop'ns	**1**	

Threats

Verticordia staminosa subsp. *staminosa* is threatened by processes and interactions that cause direct casualties to the population or effect habitat changes that are detrimental to the long-term survival of the species. The threats to *V. staminosa* subsp. *staminosa* are:

Wildfire: Wildfire may represent a significant threat to the species. Ignition sources, including lightning, stubble burns on nearby farmlands, and other human activities, are present most years. In the event of a wildfire, all known plants are expected to be destroyed. As the species does not appear to require fire to stimulate germination, a range of factors may adversely affect the survival of those seedlings that emerge in the post fire period. These include competition from other germinating native flora, selective grazing of seedlings by fauna, and accelerated erosion.

Narrow geographical range: *Verticordia staminosa* subsp. *staminosa* is only known from one population, and is therefore vulnerable to stochastic events such as wildfire or disease.

Grazing by rabbits: Affects all population sites causing physical damage or destruction of plants. Added nutrient and weed seeds from droppings exacerbate weed invasion. Rabbit grazing is likely to result in a decline in recruitment as they often selectively graze younger plants.

Competition from weeds: Weeds appear to compete with *Verticordia staminosa* subsp. *staminosa* within the fissures of the granite outcrop in which they grow. Weeds compete for nutrients, light, water and are detrimental to recruitment. They also degrade habitat and exacerbate grazing pressure.

Grazing by stock: Some parts of the remnant vegetation the population is found in, are not adequately fenced. If stock were to graze the population sites they would cause physical damage to the plants. Stock are also likely to inflict a range of adverse habitat modifications on the sites such as erosion and increased weed invasion.

Pedestrian and vehicle traffic: Population 1a is traversed by a vehicle track. Plants have been damaged by direct contact with vehicles using this track. The track also provides access to sites with potential for a low level of recreation. Consequently, there is an associated risk of pedestrians walking through the population and inadvertently trampling plants. Both of these threats are likely to result in the physical damage or destruction of plants, and adverse habitat modifications.

RECOVERY ACTIONS

Existing Recovery Actions

- An Interim Recovery Plan has been prepared for this taxon (Evans & Brown, 2001).
- All appropriate people have been made aware of the existence of the taxon and its location.
- Staff from the Threatened Flora Seed Centre have collected and stored approximately 3,000 seeds of the taxon, with germination rates ranging from 2% to 100%.
- The fence around the reserve which contains *Verticordia staminosa* subsp. *staminosa* was repaired and partly replaced in 1999 to prevent stock grazing on the plants.
- An information sheet has been produced for the taxon which provides photos and a description of the taxon, threats and recovery actions.
- Research investigating the conservation biology of this taxon has been conducted (Yates *et al.* 2000).
- Staff from CALM's Merredin District regularly monitor the population of *Verticordia staminosa* subsp. *staminosa.*

Future Recovery Actions

As *Verticordia staminosa* subsp. *staminosa* is known from private property and water reserve, permission will be sought from relevant land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Undertake a translocation

As there is only one known population it is important to develop a translocation proposal to establish a second population. This will require the development and approval of a translocation proposal, and propagation of translocates. Once planting has occurred, extensive monitoring will be required. Information on the translocation of threatened animals and plants in the wild is provided in CALM's Policy Statement No. 29 *Translocation of Threatened Flora and Fauna.* All translocation proposals require endorsement by the Director of Nature Conservation.

Action:	Undertake a translocation
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$12,400 in the first year, $5,600 in subsequent years

2. Develop and implement a rabbit control strategy

Population 1a is located on a water reserve, which is used for water harvesting. Therefore the use of 1080 to control rabbits would be inappropriate. In consultation with the Water Corporation, the Shire and the adjacent landowners, CALM will develop and implement a rabbit control strategy for all the population sites.

Action:	Develop and implement a rabbit control strategy
Populations:	1
Responsibility:	CALM (Merredin District) in consultation with Water Corporation, Shire of Wongan-Ballidu and adjacent landowners through MDTFRT
Cost (minus labour):	Subject to discussions with Water Corporation

3. Undertake weed control

Effective weed control is required to reduce the impact of weed invasion at the population. This will be by hand weeding or localised application of herbicide during the appropriate season to minimise the effect of herbicide on the species and the surrounding native vegetation. The control of weeds in a water catchment area will need to be discussed with the Water Corporation to ascertain whether suitable methods can be found. All applications of weed control will be followed by a brief report on the method,

timing and success of the treatment against weeds, and the effect on *V. staminosa* subsp. *staminosa* and associated native plant species.

Action:	Undertake weed control
Population:	1
Responsibility:	CALM (Merredin District) in consultation with Water Corporation through MDTFRT
Cost (minus labour):	Subject to discussions with Water Corporation

4. Erect barriers and signs along access track

Due to damage from vehicles, secure barriers will be erected along the access track to ensure vehicles do not deviate from the track onto the granite outcrop where *Verticordia staminosa* subsp. *staminosa* plants are found. Signs informing pedestrians of the environmental sensitivity of the area will also be erected along those parts of the access track where pedestrians are most likely to deviate.

Action:	Erect barriers and signs along access track
Population:	1a
Responsibility:	CALM (Merredin District) in consultation with Water Corporation, through MDTFRT
Cost (minus labour):	$6,500

In addition to the specific recovery actions detailed above, a range of common recovery actions is proposed that will reduce the threats facing the species. Those that are particularly relevant include:

- Community education
- Fence installation in key habitat areas – essential to protect Populations 1b, 1c and 1d from stock grazing
- Fire management
- Germplasm collection and storage
- Land management options
- Liaison with land managers
- Monitor populations
- Surveys

PART THREE: PRIORITY FLORA

CALM maintains a Priority Flora List to determine priorities for survey of plants of uncertain conservation status. In 2005 the List comprised 2,138 plant taxa (Atkins, 2003) that are poorly known and in need of high priority survey or are adequately surveyed but in need of monitoring. Only those plants considered to be threatened or presumed extinct on the basis of thorough survey can be included on the Declared Rare Flora Schedule.

Currently, there is a single Priority 1 taxon, three Priority 2 plant taxa and eight Priority 4 plant taxa found in the Wongan-Ballidu Shire. No Priority 3 plant taxa are known from this area.

Priority One plant taxa

These are plant taxa that are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include plant taxa with threatened populations on protected lands. Such plant taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

Currently, there is a single Priority 1 taxon found in the Wongan-Ballidu Shire. That species is:

Dampiera glabrescens

Dampiera glabrescens

Common name: Wongan Dampiera
Family: Goodeniaceae
Priority: 1
Flowering period: September
Information is accurate: 2004

Photo: Anne Cochrane

BACKGROUND

Current status: *Dampiera glabrescens* is currently listed as a Priority 1 taxon. This category includes those taxa that are known from one or a few populations which are under threat, either due to small population size, or being on lands under immediate threat. Such plant taxa are under consideration for declaration as 'rare flora' but are in urgent need of further survey.

Description: *Dampiera glabrescens* is an erect perennial to 20 cm tall, hairy in patches to glabrescent, hairs whitish; stem triangular. Leaves sessile, oblong to lanceolate, entire, pubescent in patches or glabrescent. Flowers in panicles; inflorescence branches 1-3 together, 1-3 flowered, purple-blue (Flora of Australia, 1992).

Distribution: *Dampiera glabrescens* is known from only one population on three land tenures in the Shire of Wongan-Ballidu. Population 1a is located on a railway reserve, Population 1b is on a Main Roads Western Australia road verge and Population 1c, the largest, is on a shire reserve.

Habitat requirements

Soils:	Gravelly, white or grey/yellow sandy soil
Vegetation:	Grows in gravel pits, roadsides, rail reserves – all highly disturbed habitats
Associated Species:	*Acacia* sp., *Borya sp.*, *Allocasuarina* sp., *Grevillea sp.* and *Gastrolobium* sp.

Biology

Fire:	Unknown
Disturbance:	Responds well, is a disturbance opportunist
Propagation:	BGPA have propagated this once from cuttings, with a 65% strike rate (personal communication, A. Shade)
Pollination:	Unknown

Summary of population information for *Dampiera glabrescens*

Pop'n	Locality	LGA	Land Type	Survey date	Mature	Condition
01a	Avon - Mullewa Rail Line	Wongan-Ballidu	Railway Reserve	20/09/00	120	Healthy
01b	Northam - Pithara Road	Wongan-Ballidu	Rd Verge MRD	20/09/00	50	Healthy
01c	Ballidu	Wongan-Ballidu	Shire Reserve	29/09/00	300	Healthy
				No. of plants	**470**	
				No. of pop'ns	**1**	

Threats

Dampiera glabrescens is threatened by activities and processes that cause direct deaths to plants or effect habitat changes that are detrimental to the long-term survival of the species. The threats to *Dampiera glabrescens* are:

Maintenance activities: A range of tenure-specific activities such as rail, firebreak and road maintenance threaten the species. These activities are likely to cause physical damage or destruction of plants, as well as adverse habitat modifications such as soil compaction. Maintenance events also typically encourage weed invasion, which would create competition with seedlings. However as this species is a disturbance opportunist, soil disturbance may also promote recruitment.

Clearing: May be a threat to Population 1c. This area is currently being used as a catchment for town water, and the Shire may wish to further clear the area in future. Whilst this would remove the plants that occur there, the soil disturbance associated with the clearing has caused considerable recruitment in the past.

Vehicle traffic: Vehicles travelling along a rail reserve maintenance track threaten Population 1a. Impacts include physical damage to plants from direct contact with vehicles, and habitat modifications from soil compaction and erosion.

RECOVERY ACTIONS

Future Recovery Actions

Dampiera glabrescens populations exist on several different land tenures. Permission will be sought from the land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Install Declared Rare Flora markers

Declared Rare Flora (DRF) markers are required at Populations 1a, 1b and 1c to ensure appropriate operational staff know where the plants are when they maintain rail-lines.

Action: Install DRF markers
Populations: 1a, 1b and 1c
Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): $600

A range of common recovery actions is proposed that will reduce the threats facing the species. Those that are particularly relevant to this species include:

- Community education
- Fire management
- Germplasm collection and storage
- Land management options
- Liaise with land managers – particularly to reduce threat of maintenance activities (1a, 1b and 1c), vehicle traffic (1a) and clearing (1c)
- Surveys – high priority to locate more populations
- Population monitoring

Priority Two plant taxa

These are plant taxa that are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

Currently, there are three Priority 2 taxa known from the Wongan-Ballidu Shire. These are:

Acacia congesta subsp. *wonganensis*
Grevillea kenneallyi
Verticordia wonganensis

Acacia congesta subsp. *wonganensis*

Common name: Wongan Wonky Wattle
Family: Mimosaceae
Priority: 2
Flowering period: August to September
Information is accurate: 2004

Photo: Nicole Willers

BACKGROUND

Current status: *Acacia congesta* subsp. *wonganensis* is currently listed as a Priority 2 taxon pending further survey to clarify its conservation status.

Description: *Acacia congesta* subsp. w*onganensis* is a shrub, 1-2 m tall. Bark dark grey. Phyllodes glabrous, sometimes margins sparsely hairy; heads 50-70 flowered, racemosely arranged. Legumes to 6 cm, glabrous, brown to yellow. Seeds longitudinal, dark brown.

Distribution: *Acacia congesta* subsp. *wonganensis* is known from 6 populations and 8 sites in the Shire of Wongan-Ballidu. Five sites are located on private property and three are on nature reserves.

Habitat requirements

Soils: Grows in rocky or lateritic clay or loam (Maslin, 1999)
Vegetation: Mallee communities
Associated Species: *Grevillea kenneallyi*, *Verticordia* sp. and *Calothamnus asper*

Biology

Fire: Unknown, although many wattles recruit prolifically after fire from soil-stored seed.
Disturbance: Observation following clearing suggest that physical soil disturbance (and therefore mechanical damage to the seed testa) promotes prolific germination of the soil seed bank.
Propagation: Would need some sort of pre-treatment prior to sowing (personal communication, A. Shade)
Pollination: Unknown, but most likely bee pollinated

Summary of population information for *Acacia congesta* subsp. *wonganensis*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01-	Mt Rupert	Private Property	5/08/00	1000	Healthy
02-	Mt Matilda	Nature Reserve	18/09/00	100	Healthy
03a	Mt O'Brien	Private Property	25/08/01	600	Healthy
03b	Mt O'Brien	Private Property	8/08/01	20	Healthy
04-	Fowler's Gully	Nature Reserve	29/09/00	50	Healthy
05-	Mt O'Brien	Private Property	30/09/00	2	Healthy
06a	Fowler's Gully	Nature Reserve	9/08/01	20	Healthy
06b	Mt Matilda	Private Property	9/08/01	20	Healthy
			No. of plants	**1812**	
			No. of pop'ns	**6**	

Threats

Acacia congesta subsp. *wonganensis* is threatened by processes and interactions that cause direct deaths to plants or effect habitat changes that are detrimental to the long-term survival of the species. The threats to *Acacia congesta* subsp. *wonganensis* are:

Stock grazing: Grazing is a serious threat that may affect two subpopulations in the near future. If stock were to move into the population area they would damage and destroy plants, adversely affect the habitat by causing soil compaction, accelerating erosion and encouraging weed invasion. All of these would lead to a decline in population numbers and condition and be detrimental to recruitment.

Wildfire: No information exists on the effects of fire on *Acacia congesta* subsp. *wonganensis*. Until a fire management plan has been developed for *A. congesta* subsp. *wonganensis*, fire should be excluded from the populations if possible.

Competition – weeds: Weeds are prevalent at two population sites and compete for resources, particularly affecting juveniles. They also degrade habitat, exacerbate grazing pressure and increase the risk and severity of fire.

RECOVERY ACTIONS

Existing Recovery Actions

- Approximately 2130 seeds were collected by the Threatened Flora Seed Centre in December 2000. These had a germination rate of 84%. Half of this seed was sent to the Millennium Seed Bank at Kew Gardens in May 2001

Future Recovery Actions

Acacia congesta subsp. *wonganensis* populations exist on private property as well as on nature reserves. Permission will be sought from landowners prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Undertake weed control

Effective weed control is required to reduce the impact of weed invasion at Population 6. This will be by hand weeding or localised application of herbicide during the appropriate season to minimise the effect of herbicide on the species and the surrounding native vegetation. All applications of weed control will be followed by a brief report on the method, timing and success of the treatment against weeds, and the effect on *A. congesta* subsp. *wonganensis* and associated native plant species.

Action: Undertake weed control
Populations: 6a and 6b
Responsibility: CALM (Merredin District) through MDTFRT

Cost (minus labour): $900

In addition to the specific recovery actions detailed above, a range of common recovery actions is proposed that will reduce the threats facing the species. Those that are particularly relevant include:

- Community education
- Conduct further surveys
- Fence installation in key habitat areas – essential to protect Populations 3a and 3b from stock grazing
- Fire management
- Germplasm collection and storage
- Land management options
- Liaise with land managers
- Monitor populations

Grevillea kenneallyi

Common name: Kenneally's Grevillea

Family: Proteaceae

Priority: 2
Flowering period: July to September
Information is accurate: 2004

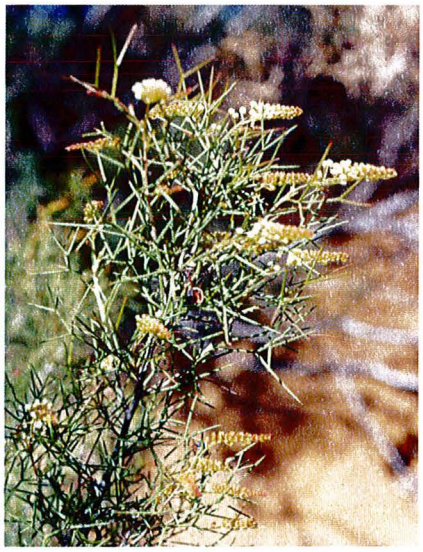


Photo: Sue Patrick

BACKGROUND

Current status: *Grevillea kenneallyi* is currently listed as a Priority 2 taxon pending further survey to clarify its conservation status.

Description: *Grevillea kenneallyi* is a dense, spreading shrub to about 3 m high and 3 m wide. Branchlets are terete, silky; leaves 4-8 cm long, ascending; upper surface glabrous or almost so; lower surface consisting entirely of the raised midvein. Flowers- perianth and style are white, with a pink tinge on young buds. Fruit erect on curved pedicels, glabrous, pericarp about 1 mm thick; seed not seen (Olde and Marriott, 1995).

Grevillea kenneallyi is related to *G. teretifolia*, from which it differs in its densely silky branchlets and flowers with a smaller pistil and villous hairs only on the lower half of the perianth (CALM file 1998F003305, f 2). It can be confused with *G. subtiliflora*, which has cylindrical unit conflorescences with floral rachises 30-60 mm long (Flora of Australia, 2000).

Distribution: *Grevillea kenneallyi* is known from ten populations over a range of approximately 10 km in the Shire of Wongan-Ballidu. A total of approximately 4700 plants are known from Shire road verges, the edges of a carpark, Nature Reserves and private property. Almost 70% of those occur in a single population on private property (Population 9).

Habitat requirements

Soils: Lateritic, clayey loams, often just below breakaways
Vegetation: Mallee woodland over shrubs
Associated Species: *Acacia* sp., *Grevillea petrophiloides*, *Micromyrtus racemosa*, *Allocasuarina campestris*, *Petrophile shuttleworthiana*

Biology

Fire: Regenerates from seed after fire (Olde and Marriott, 1995)
Pollination: Probably pollinated by insects (Olde and Marriott, 1995)
Propagation: Seed untested but likely to be successful if pre-treated by nicking or peeling. Firm, young growth taken in spring has been struck. Material from cultivated plants should prove easier (Olde and Marriott, 1995). BGPA had only moderate success from cuttings (25-39%), although this may be attributable to the quality of propagative material (personal communication, A. Shade). Can be difficult to establish and maintain.

Summary of population information for *Grevillea kenneallyi*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01-	Wongan Hills	Rd Verge SHIRE	8/11/95	50	Healthy
03-	Mt O'Brien	Private Property	25/08/01	3200	Healthy
06a	Fowlers Gully	Private Property	9/08/01	100	Healthy
06b	Fowlers Gully	Nature Reserve	9/08/01	100	Healthy
07-	Fowlers Gully	Nature Reserve	10/09/79	0	Healthy
08-	Wongan Hills	Private Property	26/08/01	50	Healthy
10-	Wonga Valley	Nature Reserve	3/05/01	1000	Healthy
			No. of plants	**4500**	
			No. of pop'ns	**6**	

Threats

Grevillea kenneallyi is threatened by a number of interactions, activities and processes that can cause direct deaths to plants or effect habitat changes that are detrimental to the long-term survival of the species. The threats to *G. kenneallyi* are:

Competition from weeds: Weeds are a threat to Population 6a and 6b. The weeds threaten to encroach on the population and may out-compete juvenile *Grevillea kenneallyi* plants for light, nutrients and pollinators, which is likely to result in reduced recruitment. They also degrade habitat, exacerbate grazing pressure and increase the risk and severity of fire.

Grazing by stock: Stock have access to Populations 5 in winter. Direct grazing is negligible but stock also cause soil compaction and erosion, as well as degrading associated habitat.

Gravel mining: This may be a threat at Population 1.

RECOVERY ACTIONS

Future Recovery Actions

Permission will be sought from relevant land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Conduct further surveys to determine conservation status

Extensive survey is required to assess the conservation status of this taxon. Surveys will be undertaken when the taxon is flowering (July - September).

Action: Conduct further surveys
Responsibility: CALM (Merredin) through MDTFRT
Cost (minus labour): $1,000

2. Undertake weed control

Effective weed control is required to reduce the impact of weed invasion at the population. This will be by hand weeding or localised application of herbicide during the appropriate season to minimise the effect of herbicide on the species and the surrounding native vegetation. The control of weeds in a water catchment area will need to be discussed with the Water Corporation to ascertain whether suitable methods can be found. All applications of weed control will be followed by a brief report on the method, timing and success of the treatment against weeds, and the effect on *G. kenneallyi* and associated native plant species.

Action:	Undertake weed control
Populations:	6a and 6b
Responsibility:	CALM (Merredin District) through MDTFRT
Cost (minus labour):	$900

In addition to the specific recovery actions detailed above, a range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Fence installation in key habitat areas
- Fire management
- Fire response research
- Germplasm collection and storage
- Liaise with land managers
- Monitor populations

Verticordia wonganensis

Common name: Wongan Sandplain Featherflower

Family: Myrtaceae

Priority: 2 (proposed P1)
Flowering period: November to December
Information is accurate: 2004

Photo: Gillian Stack

BACKGROUND

Current status: *Verticordia wonganensis* was listed as Priority 2 in August 2001. However, on current information it meets Priority 1 and further survey is required to clarify its conservation status.

Description: *Verticordia wonganensis* is a shrub, 0.2-0.6 m high. Flowers pink.

Closely related to *Verticordia drummondii*, from which it differs especially in the larger pale pink flowers with shorter style, and the earlier flowering period (George, 1991).

Distribution: *Verticordia wonganensis* is known from 4 populations and 6 sites, all in the Shire of Wongan-Ballidu. Population 3 is located on a water reserve and Population 4 exists on a railway reserve. The other two populations contain two sites each, one on water reserve and one on rail reserve.

Habitat requirements

Soils: Deep yellow or white sand
Vegetation: Shrubland
Associated Species: *Verticordia* spp.

Biology

Fire: Unknown
Disturbance: Unknown
Propagation: Cuttings with quite high strike rates (personal communication, A. Shade)
Pollination: Unknown

Summary of population information for *Verticordia wonganensis*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01a	Wongan Hills	Water Reserve	10/11/2000	7	Moderate
01b	Avon - Mullewa Rail Line	Railway Reserve	10/11/2000	2	Healthy
02a	Wongan Hills	Water Reserve	10/11/2000	4 (148 seedlings)	Healthy
02b	Avon - Mullewa Rail Line	Railway Reserve	10/11/2000	18	Healthy
03-	Wongan Hills	Water Reserve	10/11/2000	6	Poor
04-	Avon - Mullewa Rail Line	Railway Reserve	29/11/2001	100	Healthy
50x	Unknown	Unknown		1	
51x	Unknown	Unknown		1	
			No. of plants	**137**	
			No. of pop'ns	**8**	

RECOVERY ACTIONS

Future Recovery Actions

Verticordia wonganensis populations occur on water reserve and railway reserve. Permission will be sought from relevant land managers prior to any recovery actions being undertaken. Further information on many of these actions can be found in Part Four: Management Strategies.

1. Monitor all populations

All populations need to be monitored to ascertain the number and health of plants in each. This will require careful preparation, as a number of similar Verticordia species flower at similar times in the habitat (November to December). The possibility of a Verticordia specialist participating in these surveys should be investigated.

Action: Monitor all populations
Populations: All
Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): $800

2. Conduct further surveys

At the same time as the known populations are surveyed, appropriate habitat should be searched for new populations.

Action: Conduct further surveys
Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): $500

3. Reassess conservation status

When both previous actions have been completed, the conservation status of *Verticordia wonganensis* should be reassessed, so that it can be afforded an appropriate level of protection. If this species seems to meet criteria, it should be nominated to be Declared as Rare Flora.

Action: Reassess conservation status
Responsibility: CALM (Merredin District) through MDTFRT
Cost (minus labour): Nil

In addition to the specific recovery actions detailed above, a range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Fencing is essential to protect Populations 1b, 1c, 2, 3c, 4a and 4c from stock grazing.
- Fire management
- Germplasm collection and storage
- Installation of markers is required at Populations 1a, 3a, 3b, 3c and 4b.
- Land management options
- Liaise with land managers

Priority Three plant taxa

These are plant taxa that are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such plant taxa are under consideration for declaration as 'rare flora' but are in need of further survey.

Currently, there are no Priority 3 plant taxa known from the Wongan-Ballidu Shire.

Priority Four plant taxa

These are plant taxa that are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These plant taxa require monitoring every 5-10 years.

Currently, there are eight Priority 4 plant taxa known from the Wongan-Ballidu Shire. These are:

Acacia botrydion
Acacia semicircinalis
Daviesia spiralis
Dryandra comosa
Dryandra pulchella
Dryandra wonganensis
Hemigenia conferta
Loxocarya albipes

Acacia botrydion

Common name: Wongan Grapebunch Wattle
Family: Mimosaceae
Priority: 4
Flowering period: July to September
Information is accurate: 2004

Photo: Bruce Maslin

BACKGROUND

Current status: *Acacia botrydion* was listed as Priority 1 but in 2001 was downgraded to Priority 4 as it was found to be less threatened than previously thought. Priority 4 listing includes plant taxa which are considered to have been adequately surveyed and which, whilst being rare, are not currently threatened by any identifiable factors.

Description: *Acacia botrydion* is a harsh, craggy, diffuse, intricately branched shrub 0.5-1.3 m tall, domed and spreading to about 3 m diameter in exposed areas, main stems sparingly branched near base. Bark is light grey and smooth. Phyllodes are dark green with yellowish to orange-red margins, asymmetrically elliptic with a very sharp tip, 9-15mm long and 4-12 mm wide, and somewhat undulate. Inflorescences are dense, showy, 1-2 per node, racemose or sometimes appearing paniculate towards the ends of the branchlets due to phyllode reduction. Flower-heads are globular and light golden, with ca. 40 flowers. Flowers are 5-merous, 2.5mm long, glabrous. Legumes circinate, to 4 cm long when uncoiled, about 4 mm wide, slightly resinous, red-brown, glabrous, very finely longitudinally wrinkled when dry, margins barely thickened. Seeds longitudinal in legume, 3.5-4.5 mm long x 2.5-3 mm wide and dull black with a large fleshy yellowish aril folded once on top of the seed (Maslin, 1982).

Acacia botrydion appears to be most closely allied to *A. semicircinalis*. *Acacia botrydion*, however, is readily distinguished from *A. semicircinalis* in the following ways. It is a harsher, more craggy and intricately branched shrub which forms bushes to 1.3 m tall. It has light grey bark and numerous short, coarsely spinescent lateral branches which are frequently devoid of phyllodes. *A. semicircinalis* on the other hand is a more wiry, sprawling, diffuse, open shrub often with long prostrate branches which are sparsely divided and which lack the short, coarsely spinescent branchlets of *A. botrydion*, its bark is reddish brown. Additionally *A. botrydion* has terminal clusters of racemes or panicles which form brilliant bright golden floral aggregates (which look similar to bunches of grapes) at flowering whereas *A. semicircinalis* has inflorescences which are less conspicuous and more scattered along the branches. *A. botrydion* has distinctly circinate legumes while those of *A. semicircinalis* are broader and only gently curved. (Maslin, 1982).

Distribution: *Acacia botrydion* is known from nine populations, all located in the Shire of Wongan-Ballidu. Populations 2b, 5 and 6 occur in the relative safety of Nature Reserves. Populations 1a and 2a

exist in the threatened environment of a shire road verge. All other populations occur within private property.

Habitat requirements

Soils: Gravelly lateritic soils on hill slopes
Associated Species: *Eucalyptus ebbanoensis*, *Melaleuca undulata* and *Phebalium brachycalyx*

Biology

Fire: Unknown, but fire is likely to be beneficial for inducing recruitment
Disturbance: Although the largest populations occur in relatively undisturbed remnant vegetation, all other populations exist in disturbed sites, suggesting the species may be a coloniser
Propagation: Seed has been sown once, but no germination was recorded. Would need some sort of pre-treatment prior to sowing (personal communication, A. Shade)
Pollination: Unknown, but likely to be bee pollinated

Summary of population information for *Acacia botrydion*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01a	Wongan Hills	Rd Verge SHIRE	1/03/01	79	Healthy
01b	Mt O'Brien	Private Property	18/09/00	50	Healthy
02a	Wongan Hills	Rd Verge SHIRE	28/09/91	2	Healthy
02b	Rogers	Nature Reserve	9/07/01	3	Healthy
03-	Mt Matilda	Private Property	23/06/00	50	Healthy
04-	Ningan	Private Property	1/08/00	1000	Healthy
05a	Mt Matilda	Nature Reserve	30/09/00	150	Healthy
05b	Mt Matilda	Nature Reserve	30/09/00	100	Healthy
05c	Mt Matilda	Nature Reserve	30/09/00	400	Healthy
06a	Fowler's Gully	Nature Reserve	1/10/00	674	Healthy
06b	Fowler's Gully	Nature Reserve	9/08/01	100	Healthy
06c	Fowler's Gully	Nature Reserve	9/08/01	200	Healthy
07a	Mt O'Brien	Private Property	1/10/00	108	Healthy
07b	Mt O'Brien	Private Property	1/10/00	57	Healthy
07c	Mt O'Brien	Private Property	9/08/01	340	Healthy
07d	Mt O'Brien	Telstra Site	9/08/01	27	Healthy
08a	Mt Rupert	Private Property	24/08/01	2000	Healthy
09-	Elphin Hills	Private Property	26/08/01	200	Healthy
			No. of plants	**5540**	
			No. of pop'ns	**9**	

RECOVERY ACTIONS

Existing Recovery Actions

- Approximately 1220 seeds were collected by the Threatened Flora Seed Centre in December 2001. These had a germination rate of 85%. Half of this seed was sent to the Millennium Seed Bank at Kew Gardens in March 2002.

Future Recovery Actions

As this species has a Priority 4 conservation status, specific recovery actions have not been recommended. There are only a small number of threats facing the species, and their overall impact is low. A range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Germplasm collection and storage
- Liaison with land managers
- Monitor populations

Acacia semicircinalis

Common name: Wongan Sprawling Wattle
Family: Mimosaceae
Priority: 4
Flowering period: Mainly September to November
Information is accurate: 2004

Photo: Nicole Willers

BACKGROUND

Current status: *Acacia semicircinalis* was declared as Rare Flora in September 1987 at which time it was ranked as Vulnerable under World Conservation Union (IUCN) Red List criterion C2a (IUCN, 1994). However, during a recent review, it was found that the taxon no longer met DRF criteria and it was downgraded to Priority 4 status. Priority 4 listing includes plant taxa which are considered to have been adequately surveyed and which, whilst being rare, are not believed to be currently threatened.

Description: *Acacia semicircinalis* is a wiry, open, diffuse shrub to about 1 m tall, often with sprawling prostrate branches. Branches are more or less straight, reddish brown to light brown and slightly shiny. Phyllodes asymmetrically oblong, 10-20 mm long and 5-9 mm wide with a sharp tip, slightly to obviously undulate, light olive green to subglaucous with yellowish margins and midrib. Inflorescences are scattered, up to 2 per node, within the axils of phyllodes. Flower-heads globular, bright golden with about 25 flowers. Legumes are gently curved, raised over but not constricted between seeds, to 6 cm long and 6 mm wide, reddish-brown, glabrous. Seeds longitudinal in legume, about 6 mm long and 3.5-4 mm wide, with a large white to yellowish fleshy aril with a short fold on top of the seed. (Maslin, 1982).

Acacia semicircinalis is most closely related to *A. botrydion*, from which it can be readily distinguished by the former's reddish-brown stems, and more wiry, sprawling, diffuse and open habit with long prostrate branches. (Maslin, 1982).

Distribution: *Acacia semicircinalis* is known from 15 populations and 32 tenure or location based subpopulations, all in the Shire of Wongan-Ballidu. Of the 32 subpopulations, 10 are located on nature reserves, 9 on Shire road verges, 7 on private property and 6 on a water reserve.

Habitat requirements

Soils:	Grows on lateritic hills
Vegetation:	Occurs in mallee woodlands, various heath and shrubland types, degraded road verges
Associated Species:	*Microcorys eremophiloides*, *Dryandra wonganensis*, *Allocasuarina campestris*, *Grevillea* sp., *Westringia* sp., *Petrophile shuttleworthiana*, *Eucalyptus ebbanoensis*, *E. drummondii* and *Daviesia spiralis*

Biology

Fire:	Largest population exists within the boundaries of a 1970's fire scar, which suggests fire may beneficial in the long term by inducing recruitment
Disturbance:	Disturbance opportunist; appears to recruit following disturbance
Propagation:	Would need some sort of pre-treatment prior to sowing (personal communication, A. Shade)
Pollination:	Unknown, but likely to be bee pollinated

Summary of population information for *Acacia semicircinalis*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01a	Wongan Hills	Rd Verge SHIRE	29/09/91	60	Disturbed
01b	Wongan Hills	Rd Verge SHIRE	29/09/91	42	Disturbed
01c	Wongan Hills	Rd Verge SHIRE	29/09/91	208	Disturbed
01d	Wongan Hills	Rd Verge SHIRE	29/09/91	5	Disturbed
01e	Mt Matilda	Rd Verge SHIRE	18/09/00	94	Healthy
01f	Mt Matilda	Private Property	18/09/00	100	Healthy
01g	Mt Matilda	Rd Verge SHIRE	18/09/00	12	Moderate
01h	Mt Matilda	Private Property	30/09/00	250	Healthy
02a	Mt Matilda	Nature Reserve	30/09/00	25	Healthy
02b	Mt Matilda	Nature Reserve	30/09/00	100	Healthy
02c	Mt Matilda	Nature Reserve	30/09/00	25	Healthy
02d	Mt Matilda	Nature Reserve	30/09/00	300	Healthy
02e	Mt Matilda	Nature Reserve	30/09/00	50	Healthy
03a	Fowler's Gully	Nature Reserve	27/09/92	100	Healthy
03b	Fowler's Gully	Nature Reserve	1/10/00	2	Healthy
04-	Mt O'Brien	Telstra Site	9/08/01	8	Healthy
05-	Mt O'Brien	Private Property	9/08/01	15	Healthy
06a	Wongan Hills	Water Reserve	2/10/00	3000	Healthy
06b	Wongan Hills	Water Reserve	10/11/00	3900	Healthy
06c	Wongan Hills	Water Reserve	26/09/92	50	Healthy
06d	Wongan Hills	Water Reserve	6/02/02	0	Unknown
06e	Wongan Hills	Water Reserve	2/10/00	110	Moderate
07-	Wongan Hills	Rd Verge SHIRE	29/09/91	11	Disturbed
08-	Rogers	Nature Reserve	9/07/01	101	Healthy
09-	Rogers	Nature Reserve	9/07/01	200	Healthy
10-	Wongan Hills	Rd Verge SHIRE	28/09/91	59	Disturbed
11-	Wongan Hills	Water Reserve	1/10/00	166	Moderate
12-	Damboring	Rd Verge SHIRE	13/06/95	10	Disturbed
13-	Elphin	Nature Reserve	29/09/00	20	Healthy
14-	Ninan	Private Property	18/09/00	30	Healthy
15a	Elphin Hills	Private Property	26/08/01	50	Healthy
15b	Rogers	Private Property	26/08/01	1200	Healthy
			No. of plants	**10303**	
			No. of pop'ns	**15**	

RECOVERY ACTIONS

Future Recovery Actions

As this species has a Priority 4 conservation status, specific recovery actions have not been recommended. There are only a small number of threats facing the species, and their overall impact is low. A range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Germplasm collection and storage
- Liaison with land managers
- Monitor populations

Daviesia spiralis

Common name: Spiral-leaved Daviesia
Family: Papilionaceae
Priority: 4
Flowering period: August to January
Information is accurate: 2004

Photo: Nicole Willers

BACKGROUND

Current status: *Daviesia spiralis* was declared as Rare Flora in September 1987 at which time it was ranked as Vulnerable under IUCN criteria (IUCN, 1994). However, following the discovery of further secure populations in 2001 the species was downgraded to Priority 4 status. Priority 4 listing includes plant taxa which are considered to have been adequately surveyed and which, whilst being rare, are not currently believed to be threatened.

Description: *Daviesia spiralis* is an intricate, rounded shrub to 1.5 m tall and broad. Phyllodes are alternate, ascending, linear and twisted into a right-handed spiral, with the leaf-base extending down the plant stem. Standard petal is broad and elliptic, 6.5-7.5 mm x 8-10 mm, yellow, the centre with a rich yellow, bilobed marking bordered with a red infusion, the wings are reddish and the keel is reddish grading to maroon at the apex. The pod is compressed, obliquely half ovate, 10-13 mm x 4.5-5 mm. Seed is compressed, 3-4 mm x 2-2.5 mm, pale brown speckled with black with a conspicuous aril about 1.5 mm long. (Crisp, 1982).

Daviesia spiralis is a most distinctive species, apparently without close relatives within the genus. Apart from the twisting of the leaves, it is vegetatively similar to *D. elongata* and *D. costata,* but is quite different in floral morphology and inflorescence. The flowers, fruits, seed and to some extent, the inflorescence of *D. lancifolia* resembles those of *D. spiralis*, but there is no similarity in vegetative morphology. Taken together, the spiral leaves, the presence of stipules and the 1-2 flowered racemes readily distinguish *D. spiralis* from all other *Daviesia* species (Crisp, 1982).

Distribution: *Daviesia spiralis* is known from 13 populations all of which occur in the Shire of Wongan-Ballidu. Populations occur on nature reserve (including the largest population), private property and in the threatened environment of a road verge.

Habitat requirements

Soils:	Laterite-derived clay and gravel
Vegetation:	Mallee shrubland, although most numerous in openings in the vegetation

Associated Species: *Eucalyptus eudesmioides*, *E. ebbanoensis*, *E. drummondii*, *Allocasuarina campestris*, *Dryandra comosa* and *D. pulchella*

Biology

Fire: Unknown
Disturbance: Responds well, is a disturbance opportunist
Propagation: Would need some sort of pre-treatment prior to sowing (personal communication, A. Shade)
Pollination: Most likely insect pollinated, probably flies (Diptera) or butterflies (Lepidoptera)

Summary of population information for *Daviesia spiralis*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01A	Wongan Hills	Rd Verge SHIRE	28/09/91	30	
01B	Rogers	Nature Reserve	9/07/01	200	Healthy
02-	Mt Matilda	Nature Reserve	1/10/99	2	Healthy
03-	Mt O'Brien	Private Property	30/09/00	85	Healthy
04-	Rogers	Nature Reserve	11/09/93	100	Healthy
06-	Rogers NR	Private Property	11/01/89	400	
07-	Rogers	Nature Reserve	11/01/89	3000	Disturbed
08-	Wongan Hills	Rd Verge SHIRE	29/09/91	65	Disturbed
09-	Mt Matilda	Nature Reserve	29/09/01	3	Healthy
11-	Rogers	Nature Reserve	11/09/93	2	Healthy
13-	Rogers	Nature Reserve	11/09/93	3	Healthy
14-	Rogers	Nature Reserve	11/09/93	15	Healthy
15-	Elphin	Private Property	15/11/88	0	
16a	Elphin Hills	Private Property	26/08/01	50	Healthy
16b	Rogers	Private Property	26/08/01	2000	Healthy
			No. of plants	**5955**	
			No. of pop'ns	**13**	

RECOVERY ACTIONS

Existing Recovery Actions

- Approximately 170 seeds were collected by staff of the Threatened Flora Seed Centre in December 1993. These had a germination rate of up to 92%.

Future Recovery Actions

As this species has a Priority 4 conservation status, specific recovery actions have not been recommended. There are only a small number of threats facing the species, and their overall impact is low. A range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Germplasm collection and storage
- Liaise with land managers
- Monitor populations

Dryandra comosa

Common name: Shaggy Wongan Dryandra
Family: Proteaceae
Priority: 4
Flowering period: August to October
Information is accurate: 2004

Photo: Margaret Pieroni

BACKGROUND

Current status: *Dryandra comosa* is currently listed as Priority 4. This listing includes plant taxa which are considered to have been adequately surveyed and which, whilst being rare, are not currently believed to be threatened.

Description: *Dryandra comosa* is a compact shrub to about 1.7 m in height. It is rather prickly with the flower heads hidden amongst a tangled mass of very long leaves (15 to 30 cm). They are very narrow, rigid and bordered by small, pungent-pointed, distant teeth or lobes to 3 mm long and 2 cm apart. The under-surface of the leaf is white in colour; the upper-surface has a very prominent midrib and revolute margins. A few, long floral leaves surround yellow flower heads, which are usually hidden in the foliage (Wrigley & Fagg, 1989); brown bracts (Sainsbury, 1985).

D. comosa is distinguished from *D. pulchella* and *D. wonganensis* by its long, narrow leaves with few short curved teeth, and the small but many flowered inflorescence with broad brown involucral bracts (Flora of Australia, 1999).

Distribution: *Dryandra comosa* is known from 7 populations, all in the Wongan-Ballidu Shire. Three are located in nature reserves, including the largest population; three occur on private property and one in the threatened environment of a shire road verge.

Habitat requirements

Soils:	Orange-brown gravelly clay or shallow gravelly soil over laterite conglomerate. On the summits of mesas, their upper slopes and sometimes their lower slopes.
Vegetation:	Open woodlands of various mallee species and varied smaller shrubs.
Associated Species:	*Eucalyptus ebbanoensis*, *E. drummondii*, *Casuarina campestris*, *Hakea scoparia*, *Melaleuca sp.* and *Microcorys eremophiloides*.

Biology

Fire:	Unknown.
Disturbance:	Appears to be a successful coloniser in some situations, but occupies a greater range of undisturbed habitats than disturbed.
Propagation:	Is only propagated from seed and once germinated is considered very difficult to keep growing. Cutting-grown specimens may provide the answer once the usual fungal problems have been overcome (Sainsbury, 1985).
Pollination:	Thought to be by birds (Rye, 1980).

Summary of population information for *Dryandra comosa*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01-	Wongan Hills	Rd Verge SHIRE	21/08/80	36	Healthy
02-	Elphin	Private Property	21/08/80	4	Poor
02b	Rogers	Private Property	26/08/01	500	Healthy
02c	Elphin Hills	Private Property	26/08/01	300	Healthy
02d	Rogers	Private Property	26/08/01	60	Healthy
03-	Rogers	Private Property	26/09/91	35	Healthy
04-	Mt Matilda	Nature Reserve	27/10/80	250	Healthy
05-	Mt O'Brien	Private Property	9/08/01	92	Healthy
06a	Rogers	Nature Reserve	8/08/01	2000	Healthy
06b	Rogers	Nature Reserve	8/08/01	3000	Healthy
07-	Elphin	Nature Reserve	23/08/01	300	Healthy
			No. of plants	**6577**	
			No. of pop'ns	**7**	

RECOVERY ACTIONS

Future Recovery Actions

As this species has a Priority 4 conservation status, specific recovery actions have not been recommended. There are only a small number of threats facing the species, and their overall impact is low. A range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Germplasm collection and storage
- Liaise with land managers
- Monitor populations

Dryandra pulchella

Common name: Silver Wongan Dryandra
Family: Proteaceae
Priority: 4
Flowering period: October
Information is accurate: 2004

Photo: Nicole Willers

BACKGROUND

Current status: *Dryandra pulchella* is currently listed as Priority 4. This listing includes plant taxa which are considered to have been adequately surveyed and which, whilst being rare, are not currently believed to be threatened.

Description: *Dryandra pulchella* is a bushy shrub, to 3 m. Stems curled-pubescent, glabrescent. Leaves crowded on lateral branchlets, grey-green. They are evenly and deeply saw toothed to the mid-rib, the teeth curving outwards and sharply pointed; petiole to 2 cm long. Inflorescence almost sessile on older stems, surrounded by leaves; involucral bracts linear-subulate from broad base, glabrous at base, then pubescent, then plumose; flowers 30-50 per head. The flower heads are quite small, about 30 mm in diameter and borne terminally on short, lateral branches. Perianth yellowish green, sparsely spreading-pubescent (Flora of Australia, 1999).

Distribution: *Dryandra pulchella* is known from 10 populations and 11 sites all in the Wongan-Ballidu Shire. Of the 11 population sites, four exist on private property, three in the threatened environment of a shire road verge and four on nature reserves, including the largest population.

Habitat requirements

Soils:	Orange-brown clay/gravel soils. Lateritic hillsides.
Vegetation:	Usually open/dense mallee woodlands/shrublands of various species and smaller shrubs present.
Associated Species:	*Eucalyptus drummondii*, *E. ebbanoensis*, *E. eudesmioides*, *E. longicornis*, *E. gracilis*, *Allocasuarina campestris*, *Dryandra* sp. aff. *hewardiana*, *Acacia semicircinalis*, *Isopogon divergens* and *Daviesia* sp.

Biology

Fire:	Being non-lignotuberous, it is killed by fire and depends on seed for regeneration (George, 1984).
Disturbance:	Unknown, but does grow in some disturbed areas such as road verges.
Propagation:	Propagated from seed but not easy to establish (Sainsbury, 1985).

Pollination: Unknown, but may be by birds.

Summary of population information for *Dryandra pulchella*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01-	Wongan Hills	Rd Verge SHIRE	29/09/91	9	Healthy
02-	Elphin	Private Property	26/09/91	22	Disturbed
03-	Elphin	Private Property	22/08/80	20	Healthy
04a	Wongan Hills	Rd Verge SHIRE	28/09/91	34	Disturbed
04b	Rogers	Nature Reserve	8/08/01	10	Healthy
05-	Mt Matilda	Nature Reserve	27/10/80	200	Healthy
06-	Mt O'Brien	Private Property	9/08/01	85	Healthy
07-	Rogers	Nature Reserve	8/08/01	3000	Healthy
08-	Wongan Hills	Rd Verge SHIRE	29/09/91	2	Disturbed
09-	Mt Matilda	Nature Reserve	24/08/01	119	Healthy
10-	Rogers	Private Property	26/08/01	4	Healthy
			No. of plants	**3505**	
			No. of pop'ns	**10**	

RECOVERY ACTIONS

Future Recovery Actions

As this species has a Priority 4 conservation status, specific recovery actions have not been recommended. There are only a small number of threats facing the species, and their overall impact is low. A range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Germplasm collection and storage
- Liaise with land managers
- Monitor populations

Dryandra wonganensis

Common name: Long-toothed Wongan Dryandra
Family: Proteaceae
Priority: 4
Flowering period: August to October
Information is accurate: 2004

Photo: Nicole Willers

BACKGROUND

Current status: *Dryandra wonganensis* was previously listed as a Priority 2 taxon but has been downgraded to Priority 4 status due its improved conservation status. Priority 4 listing includes plant taxa which are considered to have been adequately surveyed and which, whilst being rare, are not currently believed to be threatened.

Description: *Dryandra wonganensis* is a sprawling to erect shrub to 3 m, without lignotuber. Stems with a few appressed hairs, soon glabrous. Leaves are grey-green, linear, acuminate, often strongly curved, pinnatifid (George, 1996). Flowers cream to yellow.

Dryandra wonganensis is similar to *D. trifontinalis* and *D. hewardiana* but differs in the narrow leaf lobes, prominent yellowish petiole and larger flowers without scent (George, 1996).

Distribution: *Dryandra wonganensis* is known from only 5 populations and 8 sites in the Shire of Wongan-Ballidu. Population 1a is the largest population, and occurs on Nature Reserve. All other populations occur on private property.

Habitat requirements

Soils: Gravelly loam, lateritic soils; frequently on or near breakaways
Vegetation: Open woodland and dense scrub
Associated Species: *Dryandra comosa*, *Microcorys eremophiloides*

Biology

Fire: As this species has no lignotuber, it is assumed that adults are killed by fire and regeneration is from canopy-stored seed
Disturbance: Unknown
Propagation: Unknown
Pollination: Unknown, but may be by birds

Summary of population information for *Dryandra wonganensis*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01a	Wongan-Ballidu	Nature Reserve	30/09/2000	2500	Healthy
01b	Wongan-Ballidu	Private Property	30/09/2000	150	Healthy
02-	Wongan-Ballidu	Private Property	9/08/2000	153	Healthy
03-	Wongan-Ballidu	Private Property	24/08/2001	50	Healthy
04-	Wongan-Ballidu	Private Property	24/08/2001	30	
05a	Wongan-Ballidu	Private Property	26/08/2001	500	Healthy
05b	Wongan-Ballidu	Private Property	26/08/2001	400	Healthy
05c	Wongan-Ballidu	Private Property	26/08/2001	60	Healthy
			No. of plants	**3643**	
			No. of pop'ns	**5**	

RECOVERY ACTIONS

Existing Recovery Actions

- Monitoring and further surveys were undertaken in 2000 and 2001, and found a number of new populations in addition to approximately quantifying plant numbers and health at known populations. This enabled the downgrading of this species from Priority 2 to Priority 4, which will help to optimise the distribution of available resources.
- Many of these surveys were assisted by volunteers, and involved liaison with private property owners, promoting awareness of this species within the community.

Future Recovery Actions

As this species has a Priority 4 conservation status, specific recovery actions have not been recommended. There are only a small number of threats facing the species, and their overall impact is low. A range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Germplasm collection and storage
- Liaise with land managers – particularly with regard to Population 2, to manage the risk to plants posed by road maintenance works
- Monitor populations

Hemigenia conferta

Common name: None
Family: Lamiaceae
Priority: Priority 4
Flowering period: September to October
Information is accurate: 2004

Photo: Nicole Willers

BACKGROUND

Current status: *Hemigenia conferta w*as previously listed as a Priority 2 taxon but was downgraded to Priority 4 in August 2001 due to more plants being found. Priority 4 listing includes plant taxa which are considered to have been adequately surveyed and which, whilst being rare, are not currently believed to be threatened.

Description: *Hemigenia conferta* is an erect to spreading shrub, 0.3-1.4 m high. Branches are sparsely to moderately hairy along a narrow longitudinal region between leaf bases and the next more basal node. Leaves opposite, sessile, glabrous; flowers white-cream-purple (Conn, 1986).

Hemigenia conferta is vegetatively very similar to *Microcorys obovata*, but the leaves are opposite in *H. conferta* and in whorls of three in *M. obovata.* The dimorphic leaves of this species readily distinguish it from *M. obovata* and other *Hemigenia* species (Conn, 1986).

Distribution: *Hemigenia conferta* is known from 3 populations and 8 sites in the Shire of Wongan-Ballidu. Of the 8 population sites, 6 exist on private property and 2 on nature reserves.

Habitat requirements

Soils:	Shallow soils on lateritic rise
Vegetation:	*Petrophile* dominated shrubland
Associated Species:	*Allocasuarina campestris*, *Calothamnus asper*, *Daviesia spiralis*, *Eucalyptus drummondii*, *E. ebbanoensis* and *Melaleuca radula*

Biology

Fire:	Unknown
Disturbance:	Unknown
Propagation:	Unknown
Pollination:	Unknown

Summary of population information for *Hemigenia conferta*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01a	Mt Matilda	Nature Reserve	29/09/01	112	Healthy
01b	Mt Matilda	Private Property	29/09/01	4000	Healthy
02a	Elphin	Private Property	30/04/00	1500	Healthy
02b	Rogers	Nature Reserve	30/04/00	3500	Healthy
02c	Rogers	Private Property	26/08/01	400	Healthy
02d	Elphin Hills	Private Property	26/08/01	50	Healthy
03a	Mt Rupert	Private Property	5/08/00	20	Healthy
03b	Mt Rupert	Private Property	5/08/00	2000	Healthy
			No. of plants	**11582**	
			No. of pop'ns	**3**	

RECOVERY ACTIONS

Existing Recovery Actions

- Approximately 4000 seeds were collected by the Threatened Flora Seed Centre in December 2001. The germination rate is currently being tested. Half of this seed will be sent to the Millennium Seed Bank at Kew Gardens in 2003.

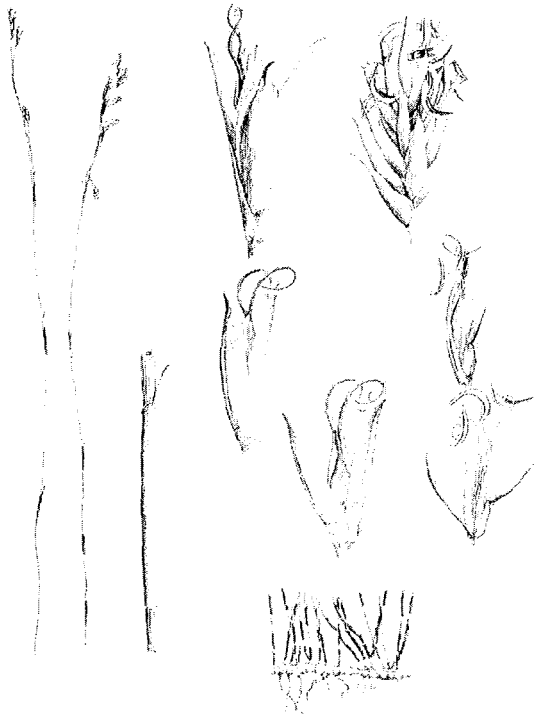
Future Recovery Actions

As this species has a Priority 4 conservation status, specific recovery actions have not been recommended. There are only a small number of threats facing the species, and their overall impact is low. A range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Germplasm collection and storage
- Liaise with land managers
- Monitor populations

Loxocarya albipes

Common name: White-footed Sedge
Family: Restionaceae
Priority: 4
Flowering period: August to September
Information is accurate: 2004



Line drawing: by Ellen Hickman. Reproduced with permission from Australian Rushes (Meney and Pate, 1999)

BACKGROUND

Current status: *Loxocarya albipes* was listed as a Priority 1 taxon in 1997 and downgraded to Priority 4 status in 2001 following the discovery of new populations (13,000 plants on Nature Reserve) and the limited threats to which it is now subject. Priority 4 listing includes plant taxa which are considered to have been adequately surveyed and which, whilst being rare, are not currently believed to be threatened.

Description: *Loxocarya albipes* is a densely tufted, perennial, rhizomatous herb (sedge-like) about 50-80 cm tall, clumps up to 1.5 m across. Rhizome shortly-creeping, superficial, red-brown, densely villous with continuous covering of white woolly hairs, weathering with age; scale leaves widely-spaced, orange-brown. Male flowers sessile to very short, 7-12 per spikelet; inflorescence bracts light brown with pronounced scarious margins. Female flowers 2 per spikelet; inflorescence bracts striate and tuberculate, red-brown. Fruit a heart-shaped indehiscent capsule, compressed with a prominent persistent woody stylar beak (Meney, Pate & Dixon, 1996).

Loxocarya albipes shows closest affinity to *Loxocarya striata* in habit, fruit characters and rhizome features. However, *L. albipes* is generally smaller in habit, with smaller spikelets and has distinctive white woolly rhizomes visible at soil level (Meney and Pate, 1999). This species is typical of the genus *Loxocarya*, particularly in fruit characteristics (Meney, Pate & Dixon, 1996).

Distribution: *Loxocarya albipes* is known from 3 populations in the Shire of Wongan-Ballidu. Populations 1 and 2a occur on private property while Populations 2b and 3 occur on a nature reserve. Combined, they contain approximately 25,000 plants.

Habitat requirements

Soils: Red-brown gravel over laterite
Vegetation: Heath and thicket
Associated Species: *Daviesia spiralis*, *Isopogon* sp., *Grevillea* sp.

Biology

Fire: Lack of rhizome starch and superficial location of rhizomes suggest that plants are probably killed by fire (Meney, Pate & Dixon, 1996)
Disturbance: Probably a disturbance opportunist (Meney, Pate & Dixon, 1996)
Propagation: Unknown
Pollination: Unknown
Other: Seed maturation occurs in 10-12 months. *L. albipes* is an obligate seeder. (Meney & Pate, 1999).

Summary of population information for *Loxocarya albipes*

Pop'n	Locality	Land Type	Survey date	Mature	Condition
01	Wongan Hills	Private property	25/09/99	73	Healthy
02a	Wongan Hills	Private property	30/04/00	12000	Healthy
02b	Rogers	Nature Reserve	30/04/00	13000	Healthy
02c	Rogers	Private property	26/08/01	200	Healthy
03-	Rogers	Nature Reserve	23/06/00	20	Healthy
			No. of plants	**25093**	
			No. of pop'ns	**3**	

RECOVERY ACTIONS

Existing Recovery Actions

- Monitoring and further surveys were undertaken in 1999 and 2000, and found several new populations in addition to approximately quantifying plant numbers and health at known populations. This enabled the downgrading of this species from Priority 1 to Priority 4, which is useful to optimise the distribution of available resources.

- Many of these surveys were assisted by volunteers, and involved liaison with private property owners, promoting awareness of this species within the community.

Future Recovery Actions

As this species has a Priority 4 conservation status, specific recovery actions have not been recommended. There are only a small number of threats facing the species, and their overall impact is low. A range of common recovery actions are detailed in Part 4: Management Strategies. Those that are particularly relevant include:

- Community education
- Germplasm collection and storage
- Liaise with land managers – particularly with regard to Population 1, to manage the risk to plants posed by gravel extraction
- Monitor populations

PART FOUR: PROGRAM STRATEGIES

1. Coordination of Recovery Process (Recovery Team)

A Threatened Flora Recovery Team oversees the implementation of recovery actions for threatened flora over a geographic area (usually a CALM Region or District), and is made up of people able to contribute to the recovery of targeted threatened plant taxa. Typically, recovery teams include representatives from relevant government departments (eg, CALM, Department of Agriculture), local government authorities, research scientists, utility providers (eg, Western Power, Telstra), community groups and landholders. The Wongan-Ballidu Threatened Flora Recovery Team (WBTFRT) previously addressed threatened flora issues in the Wonagn-Ballidu Shire. However, this role has now been taken on by the Merredin District Threatened Flora Recovery Team (MDTFRT).

CALM's Merredin District encompasses the Shire of Wongan-Ballidu and fifteen other shires.

2. Community participation

Several members of the disbanded Wongan-Ballidu Threatened Flora Recovery Team have now formed a 'Wongan-Ballidu Bush Care' group. In terms of threatened flora management and recovery this group is represented on the MDTFRT.

The MDTFRT and Wongan-Ballidu Bush Care group are currently implementing a number of measures aimed at raising the level of awareness of threatened flora in the Wongan-Ballidu community. Included amongst these has been the development of a Endangered Flora Calendar to assist in the recognition of threatened plant taxa that occur in the area. It is hoped that this increased awareness and appreciation of the unusual concentration of endemic and rare plant taxa will give a sense of ownership and pride, and lead to community participation in the conservation of these plant taxa.

The form that other initiatives will take will depend very much on the interests of individuals concerned, but may include searching for new populations of threatened plant taxa, 'keeping an eye out' for damaging activities, or participation in recovery actions.

3. Population monitoring

Population monitoring needs to be undertaken on a regular basis so that management and recovery actions are appropriate and the levels of threat assessed.

4. Recovery planning

Plant taxa that are declared as Rare Flora and ranked Critically Endangered under World Conservation Union (IUCN) Red List criteria are deemed to be under imminent threat of extinction. Recovery Plans or Interim Recovery Plans are prepared and implemented as a matter of urgency for these plant taxa.

5. Conservation status review

During monitoring or through further survey it may be found that the conservation status of a taxon has changed or becomes more clearly understood. This may be an improvement in conservation status or the taxon may be found to be more threatened than previously thought. In these situations a conservation status review is carried out.

When a Priority flora taxon is thought to meet the criteria for Rare Flora status, a nomination form is prepared and reviewed by the Threatened Species Scientific Committee (TSSC). If they find that it does meet criteria for declaration as Rare Flora, a recommendation is made to the Minister for the Environment and, if approved, the taxon is added to the list of Declared Rare Flora that is published annually in the Government Gazette.

When a Declared Rare Flora taxon is found to be more abundant, adequately reserved or less threatened than previously thought and no longer meets the criteria, a recommendation is made to the TSSC and, if approved by them and the Minister for the Environment, it is removed from the list of Declared Rare Flora and listed as Priority 4 to enable monitoring in case the conservation status of the taxon again declines.

PART FIVE: MANAGEMENT STRATEGIES

1. Access management

Objective

The objective of this strategy is to reduce the likelihood, onset or impact of threats arising from pedestrian and vehicular access through or near population sites by controlling access.

Considerations

Physical barriers, signage and access realignment are commonly used to divert pedestrian and vehicular access away from populations of threatened or priority flora. Information from a range of sources indicates that the effectiveness of the strategy is maximised when all three methods of access control are used together.

Implementation

Implementation of any access management strategy typically involves the following steps.

Plan: Depending on the type of access that is to be controlled, an assessment needs to be made of what barrier, signage and realignment options are available, taking into account land manager preferences. The best options need to be defined and a proposal developed. The proposal should include site plans as well as costings for materials and other expenses.

Liaise with land manager: Permission must be obtained from the land manager. Any preferences expressed by land manager must be taken into consideration, and agreement sought. It is imperative that the land manager understands and supports the initiative. Discussions should cover the nature of the threats arising from access and options for resolving the issue.

Gain approvals and agreements: Approvals must be secured from land managers before proposal can be implemented. Agreement should also be secured from other stakeholders (eg, indigenous interests, regular recreational users such as pony clubs etc) where applicable and when possible.

Install: Access management controls (barriers, signs and realignments) must be installed according to the approved plan.

Monitor: Monitoring should be undertaken as part of the routine population monitoring program to determine the effectiveness of the access management controls put in place, modify if necessary, and maintain in good working order.

2. Community education

Objective

The objective of this strategy is to build in the community an appreciation of the values of native vegetation generally, and threatened flora in particular.

Considerations

It is hoped that this action may lead to the discovery of populations of threatened flora, which will enable the protection of rare plant taxa and help determine the conservation status of the lesser known Priority flora. A positive belief in the value of native vegetation would also lead to other benefits to flora and fauna still existing in fragments of habitat in the wheatbelt, such as retention of existing vegetation, a greater effort made to ensure biodiversity in revegetation works, and so on.

Implementation

Implementation will include the following steps:

Produce printed material: The Recovery Team will provide advice on what type of material would be suitable for and interest the community. Usually, photos that illustrate threatened plant taxa and habitat are a key feature, as the image can sidestep problems associated with technical terminology in descriptions. Double-sided glossy information sheets will be produced for the Critically Endangered plant taxa in the shire, and on the advice of the Recovery Team, distributed to each household through the local newspaper, the Wongan Boomer. This action is made practicable by the small number of households within the Shire relative to those within the District boundaries. When possible, a written column will be contributed to the Wongan Boomer raising awareness of a range of issues relating to conservation of native vegetation.

Present talks to community groups: These will highlight the flora of the shire, and discuss habitat preferences and threatening processes among other things. Where possible a 'hands-on' element may be introduced.

Maintain the Threatened Flora Garden: This Garden is located near the tourist information bay at Wongan Hills townsite. It has been present for a number of years (present during the 1980s), and is being revitalised in 2003 with a change in soil and addition of new plants. An interpretive sign will be erected which will put the threatened flora of the shire into context, and name plates will be added to individual plants.

Assist with 'Wildflower Walks': These guided tours of bushland will highlight flora and fauna, and are planned by community members in Spring.

3. Biological and ecological research

Objective

The objective of this strategy is to gather information on the ecology of the plant taxa and their habitat that would be useful in planning and conducting threat abatement or recovery operations.

Considerations

Community function will be investigated to determine the factors the taxon requires to maintain healthy, functioning populations. This may include investigation of the causes of low seed production or viability, pollinator type and availability, genetic studies, cause of insect damage and so on. When the key factors are determined these will be incorporated into rehabilitation and restoration works where existing populations are currently degraded and appear to be lacking ecological resources. This work will be done in liaison with the Science Division's Flora Conservation Group.

Implementation

Implementation typically involves the following steps:

Develop project proposal: The proposal must be developed in conjunction with an appropriate research scientist to ensure that the information obtained is maximised and robust. The proposal will describe the ways in which the project will add to knowledge of the taxons' biology and/or ecology and assist in their recovery. It will also outline the experimental design of the project, including treatments to be applied (eg, weed control, seed bags etc.) and controls, details of the monitoring to be undertaken and a timetable.

Liaise with land manager: Permission must be obtained from the land manager. Any preferences expressed by land manager must be taken into consideration, and agreement sought.

Seek Ministerial permission to 'take': If the project affects (or may affect) a Declared Rare species, an application for Permission to take Declared Rare Flora must be submitted to S&CB in advance of the operational period. This usually takes approximately 4 weeks, but can be attempted in less time for emergency situations. This gives legal protection in the case of any accidental damage to Declared Rare Flora, including the seed bank.

Implement research according to proposal: Implement the project at the appropriate time with minimised impact on non-target plant taxa. Implementation will include monitoring requirements.

Complete report: A written report must detail the method and results of the research, and make appropriate recommendations for management. A copy must be retained in the District, and a copy submitted to S&CB.

4. Fencing

Objective

The objective of this strategy is to exclude threatening agencies such as stock, pest animals and people from population sites where grazing and trampling impacts populations directly through death or injury to plants, or indirectly through the spread of weeds and disease, erosion or other habitat degradation.

Considerations

It is important to fence habitat as well as just the target taxon to provide a buffer area and retain as much supporting vegetation as possible. If there is very little supporting vegetation, it is desirable to include a buffer area within the fence that could be rehabilitated or at least to allow natural regeneration by excluding grazing of seedlings.

Implementation

Implementation typically involves the following steps:

Liaise with land manager: The exact placement of the fence and the responsibility for installing the fence needs to be determined through negotiations with relevant land manager/s.

Install fence: Install fence to a standard appropriate to type of animals that are to be excluded.

Monitor and maintain condition of fence: The fence should be monitored periodically and maintained as necessary to ensure its continued effectiveness.

4. Fire management

Objective

The objective of this strategy is to minimise the incidence of unplanned fire and reduce the impact of any unplanned fires on plant taxa and their habitats until such time as the effects of fire are found to be beneficial or neutral. This will be framed within the imperative to protect life and property from wildfire.

Considerations

Many plant taxa in South-Western Australian ecosystems are thought to require fire to facilitate germination. However, different fire intensities have different effects on vegetation – a milder burn may scarify seed, stimulating germination, while an extremely hot burn can kill seed through the overheated soil.
There is a paucity of information on how threatened, priority and other associated species in the Wongan-Ballidu Shire respond to fire. Concerns have also been expressed about post-fire impacts leading to habitat degradation, such as erosion and weed invasion.

Consequently, this strategy is based firmly in the precautionary approach, and in most cases the objective will be to exclude fire from habitat thought to be vulnerable to fire. However, an exception will apply to the limited and experimental burn trials proposed under Strategy 15: *Reproduction and Recruitment Research and Enhancement* and Strategy 6: *Fire Response Research.* These trials will assess the role of fire in species recruitment, and other post-fire effects such as erosion, weed invasion and other habitat changes. The results of these trials, and any unplanned fires that do occur, will be used to determine how best to manage fire in threatened flora habitats.

Implementation

Implementation typically involves the following steps.

Prepare preliminary fire exclusion plans: This will include preparation of a map of the area's fences, gates and firebreaks, plus anything else of relevance to a fire-fighting scenario.

Liaise with land manager. Land managers should be involved in preparation of the fire exclusion plans, and should have a copy.

Liaise and coordinate with local fire organisations: Local fire organisations should also be aware of the fire exclusion plans and have copies of maps showing firebreaks etc.

Educate and inform community: The public (local community and visitors) should be made aware of the threat of fire to vegetation, and signs advising of fire risk kept current.

Integrate research findings and revise fire exclusion plans: When research gives better information about the fire response of target plant taxa, this should be applied to the fire exclusion plan, and if appropriate a recommendation made for a prescribed burn rotation. Often this may vary rotation to rotation to allow for different responses in the same vegetative community.

Further Reading

Abbott, I. & Burrows, N. (Eds). (2003) *Fire in ecosystems of south-west Western Australia: impacts and management.* Backhuys Publishers, The Netherlands.

6. Fire response research

Objective

The objective of this strategy is to gain specific knowledge about the fire response of a range of plant taxa and their critical habitats, and to determine the most beneficial fire regime for the threatened plant taxa and their communities while achieving protection of life and property.

Considerations

Knowledge of the fire response of these plant taxa may be crucial to their long-term recovery. However, some areas have too many values at risk, or contain other practical constraints, to trial fire in them without having evidence that it is likely to be beneficial. It would be desirable to run a series of experimental burn trials for a number of plant taxa at low-risk sites that contain existing plants of the target plant taxa, and may contain seed of others. It may also need manipulation of seed and where possible living plants to scientifically assess the response of these plant taxa to fire.

Monitoring of the post-burning response will include evidence of weed invasion, grazing and erosion, as well as the response of the target plant taxa and their communities.

Opportunities to investigate the impacts and effects of unplanned fires on populations of threatened and priority flora should also be a priority.

Implementation

Implementation typically involves the following steps:

Develop project proposal: The proposal must be developed in conjunction with an appropriate research scientist to ensure that the information obtained is maximised and robust. The proposal will describe the ways in which the project will add to knowledge of the taxons' biology and/or ecology and assist in their recovery. It will also outline the experimental design of the project, including treatments to be applied (fencing to exclude post-fire grazing etc.) and controls, details of the monitoring to be undertaken and a timetable.

Liaise with land manager: Permission must be obtained from the land manager. Any preferences expressed by the land manager must be taken into consideration, and agreement sought.

Seek Ministerial permission to 'take': If the project affects (or may affect) a Declared Rare species, an application for Permission to take Declared Rare Flora must be submitted to S&CB in advance of the operational period. This usually takes approximately 4 weeks, but can be attempted in less time for emergency situations. This gives legal protection in the case of any accidental damage to Declared Rare Flora, including the seed bank.

Implement research according to proposal: Implement the project at the appropriate time of year with minimal impact on non-target plant taxa.

Monitor effects: Over the specified period of time, monitor the impact of treatment on seed production, germination and/or recruitment in the target plant taxa, any signs of regeneration of associated native species and any other observed effects on habitat (for example, increased weed presence or erosion).

Complete report: A report detailing the implementation process, operational variables such as weather, the results of the research and any recommendations for future management must be completed, with a copy retained at the District and a copy submitted to S&CB.

Further reading

Abbott, I. & Burrows, N. (Eds). (2003) *Fire in ecosystems of south-west Western Australia: impacts and management*. Backhuys Publishers, The Netherlands.

7. Germplasm collection and storage

Objective

The objective of this strategy is to provide an ex-situ genetic resource in storage, with potential for use in translocation projects if deemed necessary in the future.

Considerations

Any seed collection and storage should be in accordance with protocols developed by the Department's Threatened Flora Seed Centre, including that only 20% of the seed on any individual plant may be collected, and that seed should be collected from a number of plants if possible. This helps to ensure that the majority of seed remains as an in-situ source of recruitment, and that there is genetic diversity in the seed collected.
Careful record should be kept of what material was collected, from how many plants, and from which exact location.

Implementation

Implementation typically involves the following steps.

Gain consent of storage agency: Ensure that the Threatened Flora Seed Centre or Botanic Gardens and Parks Authority are prepared to accept the material. Resources are consumed by appropriate storage, and if substantial collections of that taxon already exist in storage or nursery, then it may be deemed superfluous to conservation of the taxon.

Liaise with land manager: Obtain permission to be on the land and the manager's agreement to take seeds or cuttings.

Collect material: Appropriate hygiene practices should be followed; for example, cuttings should be taken with bleached clean secateurs. The genetic diversity of material collected should be maximised, and only a limited proportion of the total material available should be collected. Supporting information should be provided with the material according to the requirements of the storage agency – for example, the taxon's name, date and site collected from, if appropriate the individual, habitat characteristics and so on.

Ensure appropriate storage in transit: For example, cuttings should be kept cool and moist.

Ensure appropriate long-term storage: The Threatened Flora Seed Centre accepts seed, the Botanic Garden and Parks Authority nursery accepts cuttings for propagation and the Botanic Garden and Parks Authority laboratory accepts material to be tissue cultured and cryostored.

Further reading

Australian Network for Plant Conservation (1997a) *Germplasm Conservation Guidelines for Australia* (A.S. George, ed.). Australian Network for Plant Conservation, Canberra.

8. Habitat restoration and rehabilitation

Objective

The objective of this strategy is to provide additional habitat, ecological support and resources, such as shade from taller vegetation, increased presence of pollinators and a greater barrier to weed invasion and/or chemical sprays to increase the viability of threatened flora populations.

Considerations

Most often, this strategy would be employed on a single site, but occasionally may be used to create a corridor to connect two areas together. The aim may be to meet one particular need such as shade, and limit actions to address only that need. Alternatively, a general improvement in vegetation may be planned, with the hope that this will then lead to general improvements in ecosystem function, such as increased insect and animal presence, some of which are hopefully pollinators or seed dispersal agents.
Any plants to be planted in the rehabilitation should be propagated from local material to maintain the genetic provenance.
Revegetation and habitat restoration should follow suitable principles and techniques such as those outlined in Hussey and Wallace (1993) and Mullan and White (2001; 2002).

Implementation

Implementation typically involves the following steps.

Plan: It is necessary to identify exactly what resources are required to increase the viability of a threatened flora population. For example, if a lack of pollinators is limiting seed production and recruitment, then habitat restoration may include the provision of resources, such as nectar, required by the pollinator. Where the habitat is isolated it may be necessary to construct suitable linkages to other areas of habitat to permit pollinator movement from nearby bushland areas.

Liaise with land manager: Permission must be obtained from the land manager. Any preferences expressed by the land manager must be taken into consideration, and agreement sought.

Implement: Once the approach has been agreed to then the actions required are implemented as appropriate.

Monitor: Long-term monitoring is necessary to ascertain whether the action has been successful in providing the intended ecological resources.

9. Land management options

Objective

The objective of this strategy is to provide protection to populations through increased security of tenure.

Considerations

These actions aim to improve security by providing long-term assurance that the area concerned will be managed in a way sympathetic to conservation. Land management options to be considered may include fencing agreements, Land for Wildlife listing, conservation covenants (offered through a range of agencies), land donation, land swap or land purchase. Land swap or land purchase would involve major negotiation, and the land parcel would need to meet statewide conservation priorities.

Implementation

Implementation typically involves the following steps.

Liaise with land managers: Discussions should cover the full range of options and incentives, and aim for a cooperative approach rather than CALM taking over all responsibility for the changes.

Liaise with any other relevant bodies or agencies:

Implement chosen option: Once a mutually acceptable option has been negotiated, that option will be implemented as appropriate.

10. Liaison with land managers

Objective

The objective of this strategy is to ensure shared approaches to conservation of declared rare and priority plant taxa.

Considerations

Effective communication between conservation workers and land managers can be of great benefit to both parties, and can particularly benefit the threatened flora. Land managers are able to alert conservation workers to threats they may not otherwise have been aware of, and conservation workers can inform land managers of how to avoid damage to these populations – a legal obligation for declared rare flora, and for many managers, a facet of good land management.

Implementation

Implementation typically involves the following steps:

Contact land manager: It is preferable to arrange on on-site meeting with land managers early in the liaison process, so that both parties have a shared understanding of location and issues.

Maintain a two-way exchange of information: Keep land manager informed of new developments, and seek their input for actions proposed or occurring on-site.

11. Mallee harvest management

Objective

The objective of this strategy is to reduce habitat degradation caused by illegal cutting of timber for didgeridoos in Western Australia.

Considerations

Harvesting of hollow mallee stems for didgeridoo manufacture and sale has impacted on the habitat of *Acacia pygmaea* and lead to a population decline. The loss of the mallee canopy probably altered the site's micro-climate, increasing the temperature and rate of evaporation of the surrounding rocky habitat. Under the *Wildlife Conservation Act 1950* a licence is required to harvest eucalypt stems from Crown land in WA for making didgeridoos, and for the sale of didgeridoo material taken from private property. The licence conditions ensure that the stems are harvested in a sustainable manner. One of the conditions is that all stems harvested must be tagged with a CALM authorised tag at the points of harvest and sale. Tagging was introduced in 2000 to reduce illegal harvesting in Western Australia from both Crown and private land.

Implementation

Implementation typically involves the following steps.

Assess applications and issue license and tags: When a person applies for a licence to harvest didgeridoos on

- Unallocated Crown Land, an endorsement is issued by the local CALM office, subject to suitable stands being available for harvest over and above conservation requirements. Royalty tags are issued with endorsement and licence.
- Private land, the local CALM office conducts a site inspection to determine if suitable stands are available. If so, tags are issued with the licence.

Monitor: Wildlife officers assess areas that are being or have been harvested, and check records at point of sale. CALM maintains a tag register of all didgeridoo tags issued and to whom. Information from community members also plays an important role in detecting illegal harvesting.

'Liaison with Land Managers' and 'Community Education': These strategies will be employed in tandem with the licensing system to maximise protection.

12. Marker installation

Objective

The objective of this strategy is to protect populations that occur in high maintenance risk zones from damage during maintenance in those areas. High risk zones include access lines such as roads, rails and firebreaks, and utility areas such as areas used by Telstra or Western Power.

Considerations

It is in the interests of both land managers and CALM to prevent accidental destruction of threatened flora during maintenance or other operations. Markers are installed to alert operational staff to the presence of significant flora so they can take due care to minimise the risk. Therefore, it is necessary to install the markers and also to ensure that relevant operational staff know what the markers signify. Markers may be installed by land managers or by CALM staff. If installed by CALM staff, they should be aware of any safety procedures set down by the land manager (for example, Westrail requires people operating near rail lines to wear an orange vest, as well as other requirements).
Land managers should be notified when markers are in place, and if possible informed of their location in appropriate units (for example, numbered poles on Westrail lines, or Straight Line Kilometres for Main Roads). This information will make it easier for the land manager to be aware of any populations of threatened flora that may be impacted on by maintenance activities, and thus minimise those impacts.

Implementation

Implementation typically involves the following steps.

Liaise with land manager: It is necessary to get permission to be on the land and to install markers. Any preferences expressed by land manager must be taken into consideration, and agreement sought. Ensure that the relevant people know what the markers signify.

Install markers:

Maintain visibility: Routine population monitoring should include checking the condition of these markers to ensure that they are still present and visible.

13. Grazing control

Objective

The objective of this strategy is to reduce the impact of pest animals on threatened plant taxa and their habitat through direct grazing, the spread of weeds or other habitat degradation.

Considerations

The grazing pest animal most in need of control within the Shire of Wongan-Ballidu is the rabbit. Rabbits directly graze plants, particularly impacting on recruitment through their preference for fresh young growth. The digging of warrens disturbs the soil, providing opportunities for weed establishment. Their droppings spread weed seed and add nutrients to soils, further assisting weed establishment.

Implementation

Implementation typically involves the following steps.

Select control method: A control method will need to be appropriate to the environmental characteristics of the site, the target plant taxa and the level of animal presence.

Liaise with land manager: Permission must be obtained from the land manager. Any preferences expressed by the land manager must be taken into consideration, and agreement sought.

Undertake method chosen: Once an appropriate method has been chosen, implement with a minimum of disturbance and damage to non-target plant taxa.

Monitor effects: Over a period of time, monitor the impact of control on levels of animal presence, and assess the need for follow-up control. Also monitor any signs of flora regeneration in response to animal control.

Complete report: A report detailing the treatment applied, the results of monitoring and any recommendations for follow-up control must be completed, with a copy kept at the District and a copy submitted to S&CB.

14. Population monitoring

Objective

The objective of this strategy is to maintain current information about the conservation status of the population, in terms of general plant health, reproductive success and threatening processes.

Considerations

CALM policy is to monitor Rare Flora annually and Priority flora every few years as possible, in order to maintain an awareness of whether individual plant taxa are in marked decline, and if so what action may be taken.
Record will be made of the number of plants in the population, including the number of juveniles and dead plants, the general state of health of the plants, observation of pollination and seed production, the condition of the associated habitat and present or foreseeable threats. If markers are present, their visibility will be monitored and maintained. If management actions have been implemented, their effectiveness will be monitored (eg, whether weeds have been successfully controlled, or whether follow-up treatment of the same or different kind is needed).

Implementation

Implementation will include the following steps.

Obtain permission for access: For land not managed by CALM, permission must be obtained from the appropriate land manager to gain access for monitoring purposes.

Inspect population: A preference is expressed for monitoring during the flowering period of the plant taxa wherever possible, as even those that can be confidently identified in their vegetative state are usually more conspicuous when in flower.

Complete report: A report detailing all relevant observations should be completed with any appropriate maps and Global Positioning System (GPS) points, with a copy retained at the District and a copy submitted to S&CB.

15. Reproduction and recruitment enhancement

Objective

The objective of this strategy is to enhance the production and germination of seed, and the recruitment of juveniles by increasing the survival percentage of ramets or seedlings.

Considerations

This may involve tasks such as hand-pollination of plant taxa if pollinators are absent, stimulation of germination by soil disturbance, application of smoke water or fire, removal of canopy cover, and so on. All tasks should be undertaken on an experimental basis, and concluded with a written report on what was implemented and what results were achieved. All work on declared Rare Flora will need to be conducted under an approved Permit to Take, in case accidental damage occurs to those plant taxa. Also refer to Strategy 6 *Fire Response Research.*

Implementation

Implementation typically involves the following steps.

Investigate and select treatments: Treatments applied will need to be appropriate to the intended outcome, to the biology of the taxon concerned, and to specific environmental conditions of the site. For example, fire would not be trialled in areas where it is likely to be uncontrollable.

Develop project proposal: The proposal must be developed in conjunction with an appropriate research scientist to ensure that the information obtained is maximised and robust. The proposal will describe the ways in which the project will assist the recovery of the taxon. It will also outline the experimental design of the project, including treatments to be applied and controls, details of the monitoring to be undertaken and a timetable.

Liaise with land manager: Permission must be obtained from the land manager. Any preferences expressed by land manager must be taken into consideration, and agreement sought.

Seek Ministerial permission to 'take': If the project affects (or may affect) a Declared Rare taxon, an application for Permission to take Declared Rare Flora must be submitted to S&CB in advance of the operational period. This usually takes approximately 4 weeks, but can be attempted in less time for emergency situations. This gives legal protection in the case of any accidental damage to Declared Rare Flora, including the seed bank.

Implement research according to proposal: Implement the project at the appropriate time of year with a minimum of damage to non-target plant taxa.

Monitor effects: Over the specified period of time, monitor the impact of treatment on seed production, germination and/or recruitment in the target plant taxa, any signs of regeneration of associated native plant taxa and any other observed effects on habitat (for example, increased weed presence).

Complete report: A report detailing the implementation process, operational variables such as weather, the results of monitoring and any recommendations for future management must be completed, with a copy kept at the District and a copy submitted to S&CB.

16. Signage

Objective

The objective of this strategy is to alert people on site to the presence of a threatened flora, and the need to prevent disturbance in the area.

Considerations

Some thought must be given to the likely result of signage – in some areas, signs inform and enable protection, while in others they may attract destructive attention.

Implementation

Implementation typically involves the following steps.

Liaise with land manager: Permission must be obtained from the land manager. Any preferences expressed by the land manager must be taken into consideration, and agreement sought.

Plan content and placement of signage:

Manufacture signage:

Install at appropriate access points:

17. Surface water management

Objective

The objective of this strategy is to minimise damage done to threatened flora populations by water erosion.

Considerations

Water erosion is a natural process in some situations, and may be beneficial to recruitment as a disturbing process. However, in other situations a loss of ground cover vegetation may accelerate the movement of water, or a compacted surface layer increase the amount of water running off the surface, such that erosion is accelerated and may be removing soil from the root zone or depositing it over vegetation downslope.
If found to be a threatening process, an assessment needs to be made of the pattern of water flow and the most appropriate method of control. This may involve cut-off drains and/or silt containment mechanisms.

Implementation

Implementation typically involves the following steps.

Liaise with land manager: Permission must be obtained from the land manager. Any preferences expressed by the land manager must be taken into consideration, and agreement sought.

Assess nature of threat, and plan site-specific solution: This needs to be done with the guidance of the Shire Works Manager, or if unavailable, an appropriately qualified consultant to ensure an appropriate and practical solution is reached which does not create a new erosion problem at another site.

Install works as appropriate:

Monitor and ensure that solution is functioning:

18. Surveys

Objective

The objective of this strategy is to locate new populations of threatened and priority plant taxa and subsequently re-evaluate their conservation status and recovery requirements.

Considerations

Surveys to locate new populations are conducted during the flowering period of the taxon, while many are at their most conspicuous, and others are easiest to positively identify. Key habitat features such as soil type and associated vegetation are noted and then similar habitat identified and searched. Sites that have very similar habitat but do not contain the target plant taxa should be noted for consideration if a translocation becomes necessary.

Implementation

Implementation typically involves the following steps.

Identify habitat characteristics: Key characteristics are those that are common to the different populations of the same taxon. It should be noted that while some plant taxa do show strict preferences of habitat, others may be more variable, and it is sensible not to be too restrictive in areas searched, particularly where only one or two populations are known.

Identify areas of similar habitat: This should consider private land as well as public where possible, and may be assisted by aerial photos, soil maps, vegetation maps and so on.

Land manager consultation: Obtain permission to access the lands targeted.

Survey targeted areas: This would preferably be done with a number of people, particularly in areas of vegetation larger than a road verge. This will maximise chances of seeing the target plant taxa if present.

Complete report: A report detailing the areas surveyed should be completed so that there is a record of those areas being checked. Complete a Rare Flora Report Form for any new populations identified with all relevant observations, appropriate maps and Global Positioning System (GPS) points. All of the above should have a copy retained at the District and a copy submitted to S&CB.

Re-evaluate: the conservation status of threatened and priority plant taxa where the results of a survey are likely to lead to the Threatened Species Scientific Committee recommending a change in its conservation status.

19. Translocation

Objective

The objective of this strategy when creating new populations is to multiply the number of locations that contain a population of the target taxon, protecting genetic diversity of that taxon from loss through catastrophe. The objective when reinforcing existing populations is to provide a greater number of individuals in a population and increasing its viability.

Considerations

Conducting a translocation is a resource and time intensive operation, and not guaranteed of success, and so should not be undertaken lightly. However, translocation may become necessary in certain situations - for example, to prevent a taxon with only one or two closely occurring populations being lost to a single catastrophic event; to establish a taxon with very small, fragmented, insecure populations in more secure vegetation where ecological resources are more available; or to increase the viability a population at great risk of extinction.

Translocation design should be done in liaison with the Science Division's Flora Recovery Group, who will be able to share insights into good translocation design gained from their experience of some twenty translocations in process, the first of which started in 1998. They can also advise on any genetic considerations regarding the source or destination of material.

There are several types of translocation undertaken for different reasons. Restocking translocations are those which supplement existing populations with additional plants, enhancing the population's chance of survival. Restocking translocations are only be necessary for outcrossing species, as those species that do not require cross-pollination can be self-sustaining with even a small number of plants. All the genetic content of a clonal population can be expressed by a few individuals, and the addition of extra clones to that population would not aid its conservation. In situations involving outcrossing species, where a very small number of flowering plants are present and particularly in small remnants of vegetation, the percentage pollination may be low as appropriate pollinators are infrequent or absent. Where cross-pollination is absent the genetic pool may shrink, reducing the species' ability to adapt to changing environmental conditions. This process may be reversed with the introduction of more flowering plants, possibly in tandem with rehabilitation of the habitat to facilitate pollinator presence.

In extreme situations where conditions for germinating available seed have not been met for a period of time longer than the viability of that seed, a population may have senesced without replacing itself. Usually management would prevent this from occurring, but sometimes the conditions necessary for germination are not understood in time, or other imperatives prevent the use of a tool (for example, the use of fire in high-risk areas). Germination triggers that can be used as management tools should be identified before a restocking translocation is undertaken. This will ensure that once the population is re-established it may continue to function, as management can ensure that germination is periodically stimulated, artificially if not naturally.

Reintroductions are conducted into sites which are known to have previously contained the taxon, usually into areas where the cause of population extinction is being or has been addressed. Introductions are translocations into areas of suitable habitat which are not known to have previously contained the target taxon, and often occur when previously known sites have been extensively disturbed (such as through land clearing), or where original distribution is not well known.

When attempting to establish new populations, it is important to translocate into an area with similar habitat to that of existing populations to maximise the chances of success. However, some populations are so disturbed that it is hard to ascertain the ideal habitat and best-guess judgement must be used. The site chosen should preferably fall within the current or previously known range of the taxon, but it is fairly common in the wheatbelt that the taxon's original range is unknown because of the extent of clearing.

Another important consideration is the security of tenure of the proposed translocation site. The long-term future of the population should be positive to justify the resources committed. Thought should also be

given to the ramifications of introducing new genetic material to the proposed site – whether another taxon is present with which it might hybridise, whether the introduction of this taxon will upset the existing balance of vegetation in good condition by displacing a taxon already present etc.

The genetic diversity of the stock to be introduced should be as broad as possible to best allow the new population to respond to changes in the environment. This means that seed or cuttings used to generate translocates should be collected from as many plants as possible, but care needs to be taken with mixing genetic material from different populations, and advice should be sought from the Flora Recovery Group on this issue.

Initial translocations should be conducted on an experimental basis to gain an understanding of the response of this taxon to different treatments and methods of establishment. Thought should be given to the design of the translocation and what site preparation would be beneficial (for example, ripping of soil, summer watering, protection of juvenile plants from wind, weed control).

Monitoring is necessary to obtain information about the success of the translocation overall and the relative effect of each treatment. This will need to continue over several generations of the plant to assess the persistence and viability of the population.

Implementation

Implementation typically involves the following steps.

Select site: Select a site taking into account the considerations above, and gain approval from the land manager. It may be useful to select several and state preferences and the reasons for those in the Translocation Proposal.

Design the Translocation and prepare a proposal: This document must be consistent with Policy Statements 9 and 29 and submitted to S&CB for peer review. Following any necessary changes it is submitted for the approval of the Director of Nature Conservation. Timing for preparing a Translocation Proposal should take into account the lead time needed to grow the plants for translocation and undertake suitable site preparation including ripping, and control of weeds and browsers/grazers.

Propagate translocates: The seed or cuttings necessary for propagation will need to be collected or accessed from seed storage. The Botanic Garden and Parks Authority Nursery generally propagates material for translocation as they are accredited, have recordkeeping procedures in place and have expertise in threatened flora. Very rarely the taxon may require resource intensive techniques such as tissue culture to generate translocates (for example, *Synaphea* species produce little to no viable seed, and generally do poorly from cuttings).

Plant translocates according to the approved Translocation Proposal: Install any equipment outlined in Proposal (for example, watertanks and driplines).

Monitor according to the approved Translocation Proposal:

Complete annual reports on the progress of the Translocation: These would include figures about survival rates and any emerging patterns about which treatments are beneficial. A copy of these should be kept at the District, and a copy sent to S&CB.

Further reading

Australian Network for Plant Conservation (1997b) *Guidelines for the Translocation of Threatened Plants in Australia* (A.S.George, ed.). Australian Network for Plant Conservation, Canberra.

Mullan, G.D. and White, P.J. (2001). *Seedling Quality: Making informed choices*. Bushcare and the Department of Conservation and Land Management, Western Australia.

Mullan, G.D. and White, P.J. (2002). *Revegetation site-preparation in the WA Wheatbelt – Ripping and Mound Ploughing*. Bushcare and the Department of Conservation and Land Management, Western Australia.

20. Water and salinity control

Objective

The objective of this strategy is to limit the losses of threatened flora likely to be sustained from salinisation of habitat.

Considerations

Rising salinity is a major issue facing the wider wheatbelt landscape, affecting the agricultural sector's primary production as well as the ongoing health of remaining native vegetation. Widespread clearing of vegetation and the substitution of shallow-rooted crops and pasture has led to greater recharge of rainfall to groundwater, bringing natural soil salts closer to the soil surface in solution. The higher the level of salinity of the soil, the greater the range of plants that can not live successfully in those soils.

As this problem is derived from an interaction of factors on a landscape scale, the solution must also be applied at a landscape level, requiring cooperation from a wide range of landholders and agencies over the long-term.

Salinity is a threat on a landscape scale, as slow to respond to treatment as it was to establish, and can not in itself be ameliorated through this Management Program. The State Salinity Strategy attempts to deal with the process and its immediate threats, and has resources available for projects addressing species or communities affected by salinity.

Translocations are one timely way to conserve the genetic material of a population threatened by salinity, if appropriate habitat can be identified elsewhere.

Implementation

Implementation typically involves the following steps.

Monitoring: Changes in hydrology and salinity should be monitored near sites where these are thought likely to be a threat, particularly around sandplain at Ballidu and Cadoux.

Take appropriate action: Where it has been demonstrated that salinity or hydrological changes are a threat, appropriate action must be planned and implemented. This may include a translocation program (see Strategy 17), or intensive on-site rehabilitation such as groundwater pumping, vegetation plantings and so on (for example, like that undertaken at Lake Toolibin). Given the extremely high level of resources necessary for on-site rehabilitation, it is only possible in situations where the conservation values are extremely high and no other options are available.

21. Weed control

Objective

The objective of this strategy is to reduce competition faced by threatened species via invasive weeds, which can reduce plant vigour and reduce or eliminate recruitment.

Considerations

The decision to undertake weed control should be based on the level of threat posed by weeds – if weeds are present but not likely to become highly competitive, then the disturbance caused by undertaking weed control may be a greater threat than the weeds themselves. Any weed control should only be undertaken with a thorough understanding of the biology of the weed species involved. Knowledge of further weed seed sources may be helpful, although in agricultural areas this is frequently adjoining farmland, with little possible control. In some situations the planting of buffer vegetation may be an adjunct consideration.

The chosen control method will need to be appropriate to the species of weeds and species of native vegetation present, to the level of weed invasion and the capacity for follow-up treatment. Control methods that could be considered include the application of herbicide by wick or spray, the application of high temperature steam, weed matting or the removal of weeds by hand, possibly with the assistance of volunteers or Greencorp teams.

Implementation

Implementation typically involves the following steps.

Investigate and select weed control method: A control method will need to be appropriate to the species of weeds and species of native vegetation present, to the level of weed invasion and the capacity for follow-up treatment.

Liaise with land manager: Permission must be obtained from land manager. Any preferences expressed by land manager must be taken into consideration, and agreement sought.

Seek Ministerial permission to 'take': If weed control is proposed for a Declared Rare taxon, an application for Permission to take Declared Rare Flora must be submitted to S&CB in advance of the operational period. This usually takes approximately 4 weeks, but can be attempted in less time for emergency situations. This gives legal protection in the case of any accidental damage to Declared Rare Flora.

Undertake method chosen: Once an appropriate method has been chosen, implement with a minimum of disturbance and damage to non-target plant taxa. If appropriate, establish and monitor a control plot.

Monitor effects: Over a period of time, monitor the impact of treatment on weeds, and assess the need for follow-up treatment. Also monitor any signs of regeneration of native species.

Complete report: A report detailing the treatment applied, operational variables such as weather, whether a control plot was monitored, the results of monitoring and any recommendations for follow-up treatments must be completed, with a copy kept at the District and a copy submitted to S&CB.

Further reading

Brown, K. and Brooks, K. (2003) *Bushland weeds : a practical guide to their management with case studies from the Swan Coastal Plain and beyond.* Environmental Weeds Action Network, Western Australia.

Table 4. Recovery strategies for Declared Rare Flora ranked as Critically Endangered

Strategy	Target plant taxa
Access management	*Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides* *Verticordia staminosa* subsp. *staminosa*
Community education	*Acacia cochlocarpa* subsp. *velutinosa* *Acacia pharangites* *Calothamnus accedens* *Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides*
Coordination of Recovery Process (Recovery team)	All plant taxa
Biological and ecological research	*Acacia pharangites* *Grevillea dryandroides* subsp. *dryandroides*
Fencing	*Acacia pharangites* *Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides* *Verticordia staminosa* subsp. *staminosa*
Fire management	*Acacia pharangites* *Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides* *Lysiosepalum abollatum* *Verticordia staminosa* subsp. *staminosa*
Fire response research	*Acacia cochlocarpa* subsp. *velutinosa* *Grevillea dryandroides* subsp. *dryandroides*
Germplasm collection and storage	*Acacia cochlocarpa* subsp. *velutinosa* *Acacia pharangites* *Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides* *Lysiosepalum abollatum*
Grazing control	*Grevillea dryandroides* subsp. *dryandroides* *Verticordia staminosa* subsp. *staminosa*
Habitat restoration and rehabilitation	*Acacia pharangites* *Lysiosepalum abollatum* *Lysiosepalum abollatum*
Land management options	*Acacia cochlocarpa* subsp. *velutinosa* *Acacia pharangites* *Gastrolobium glaucum*
Liaison with land managers	*Acacia cochlocarpa* subsp. *velutinosa* *Acacia pharangites* *Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides* *Lysiosepalum abollatum*
Marker installation	*Acacia cochlocarpa* subsp. *velutinosa* *Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides*
Population monitoring	*Acacia cochlocarpa* subsp. *velutinosa* *Acacia pharangites* *Calothamnus accedens* *Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides*
Reproduction and recruitment enhancement	*Acacia pharangites* *Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides* *Lysiosepalum abollatum*

	Lysiosepalum abollatum
Signage	*Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides* *Verticordia staminosa* subsp. *staminosa*
Surface water management	*Acacia pharangites* *Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides* *Lysiosepalum abollatum*
Surveys	*Acacia cochlocarpa* subsp. *velutinosa* *Acacia pharangites* *Calothamnus accedens* *Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides* *Lysiosepalum abollatum*
Translocation	*Acacia pharangites* *Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides* *Lysiosepalum abollatum* *Verticordia staminosa* subsp. *staminosa*
Water and salinity control	*Gastrolobium glaucum*
Weed control	*Gastrolobium glaucum* *Grevillea dryandroides* subsp. *dryandroides* *Verticordia staminosa* subsp. *staminosa*

Table 5. Recovery strategies for Declared Rare Flora ranked as Endangered

Strategy	Target plant taxa
Access management	*Conostylis wonganensis* *Philotheca wonganensis* *Stylidium coroniforme*
Community education	*Acacia pygmaea* *Conostylis wonganensis* *Melaleuca sciotostyla* *Philotheca wonganensis* *Stylidium coroniforme*
Biological and ecological research	*Acacia pygmaea*
Fencing	*Acacia pygmaea* *Conostylis wonganensis* *Melaleuca sciotostyla* *Philotheca wonganensis* *Stylidium coroniforme*
Fire management	*Acacia pygmaea* *Conostylis wonganensis* *Melaleuca sciotostyla* *Philotheca wonganensis* *Stylidium coroniforme*
Fire response research	
Germplasm collection and storage	*Conostylis wonganensis* *Melaleuca sciotostyla* *Philotheca wonganensis* *Stylidium coroniforme*
Grazing control	*Acacia pygmaea*
Habitat restoration and rehabilitation	*Conostylis wonganensis*
Land management options	*Melaleuca sciotostyla* *Stylidium coroniforme*
Liaison with land managers	*Acacia pygmaea* *Conostylis wonganensis* *Melaleuca sciotostyla* *Philotheca wonganensis* *Stylidium coroniforme*
Mallee harvest management	*Acacia pygmaea*
Marker installation	*Conostylis wonganensis*
Population monitoring	*Acacia pygmaea* *Conostylis wonganensis* *Melaleuca sciotostyla* *Philotheca wonganensis* *Stylidium coroniforme*
Reproduction and recruitment enhancement	*Conostylis wonganensis* *Stylidium coroniforme* *Philotheca wonganensis* *Stylidium coroniforme*
Signage	*Acacia pygmaea*
Surface water management and salinity control	*Conostylis wonganensis* *Melaleuca sciotostyla* *Philotheca wonganensis* *Stylidium coroniforme*
Surveys	*Acacia pygmaea* *Conostylis wonganensis* *Melaleuca sciotostyla*

	Philotheca wonganensis *Stylidium coroniforme*
Translocation	*Conosty[illegible]nganensis*
Walk trial diversion	*Acacia [illegible]gmaea*
Weed control	*Acacia pygmaea* *Conostylis wonganensis* *Stylidium coroniforme*

Table 6. Recovery strategies for Declared Rare Flora ranked as Vulnerable

Strategy	Target plant taxa
Access management	*Eremophila ternifolia*
Change conservation status	*Microcorys eremophiloides*
Community education	*Eucalyptus recta* *Eremophila ternifolia* *Microcorys eremophiloides* *Rhagodia acicularis*
Fencing	*Rhagodia acicularis* *Eremophila ternifolia* *Eucalyptus recta* *Rhagodia acicularis*
Fire management	*Eucalyptus recta* *Microcorys eremophiloides* *Rhagodia acicularis*
Germplasm collection and storage	*Eucalyptus recta* *Rhagodia acicularis*
Habitat restoration and rehabilitation	*Eremophila ternifolia* *Eucalyptus recta* *Microcorys eremophiloides* *Rhagodia acicularis*
Land management options	*Eucalyptus recta* *Rhagodia acicularis*
Liaison with land managers	*Eremophila ternifolia* *Eucalyptus recta* *Microcorys eremophiloides* *Rhagodia acicularis*
Marker installation	*Eucalyptus recta* *Microcorys eremophiloides*
Population monitoring	*Eremophila ternifolia* *Eucalyptus recta* *Microcorys eremophiloides* *Rhagodia acicularis*
Reproduction and recruitment enhancement	*Eucalyptus recta* *Microcorys eremophiloides*
Surface water management and salinity control	*Eremophila ternifolia* *Microcorys eremophiloides*
Surveys	*Eremophila ternifolia* *Eucalyptus recta* *Rhagodia acicularis*
Vegetation buffers	*Eucalyptus recta*
Weed control	*Rhagodia acicularis* *Eremophila ternifolia* *Eucalyptus recta* *Microcorys eremophiloides*

Table 7. Recovery strategies for Priority Flora

Strategy	Target plant taxa
Reassess conservation status	*Verticordia wonganensis*
Community education	*Acacia botrydion* *Acacia congesta* subsp. *wonganensis* *Acacia semicircinalis* *Dampiera glabrescens* *Daviesia spiralis* *Dryandra comosa* *Dryandra pulchella* *Dryandra wonganensis* *Grevillea kenneallyi* *Hemigenia conferta* *Loxocarya albipes* *Verticordia wonganensis*
Fencing	*Acacia congesta* subsp. *wonganensis* *Grevillea kenneallyi* *Verticordia wonganensis*
Fire management	*Acacia congesta* subsp. *wonganensis* *Dampiera glabrescens* *Grevillea kenneallyi* *Verticordia wonganensis*
Germplasm collection and storage	*Acacia botrydion* *Acacia congesta* subsp. *wonganensis* *Acacia semicircinalis* *Dampiera glabrescens* *Daviesia spiralis* *Dryandra comosa* *Dryandra pulchella* *Dryandra wonganensis* *Grevillea kenneallyi* *Hemigenia conferta* *Loxocarya albipes* *Verticordia wonganensis*
Land management options	*Acacia congesta* subsp. *wonganensis* *Dampiera glabrescens* *Verticordia wonganensis*
Liaison with land managers	*Acacia botrydion* *Acacia congesta* subsp. *wonganensis* *Dampiera glabrescens* *Daviesia spiralis* *Dryandra pulchella* *Dryandra wonganensis* *Grevillea kenneallyi* *Hemigenia conferta* *Loxocarya albipes* *Verticordia wonganensis*
Marker installation	*Dampiera glabrescens* *Verticordia wonganensis*
Population monitoring	*Acacia botrydion* *Acacia congesta* subsp. *wonganensis* *Acacia semicircinalis* *Dampiera glabrescens* *Daviesia spiralis* *Dryandra comosa*

	Dryandra pulchella *Dryandra wonganensis* *Grevillea kenneallyi* *Hemigenia conferta* *Loxocarya albipes* *Verticordia wonganensis*
Surveys	*Acacia congesta* subsp. *wonganensis* *Grevillea kenneallyi* *Verticordia wonganensis*
Weed control	*Acacia congesta* subsp. *wonganensis* *Grevillea kenneallyi*

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APPENDIX 1: Characteristics of Map Units Illustrated in Figure 3 (Soil-Landscape Map of the Shire of Wongan-Ballidu)
Table supplied by the Natural Resources Assessment Group, Department of Agriculture.

MAP UNIT (MU)	MU NAME	MU SUMMARY DESCRIPTION	MU LANDFORM	MU GEOLOGY	MU SOIL	MU VEGETATION	MU LOCATION
Bg	Burabidge Hill System		Undulating rises to low hills with rock outcrop	Granite, migmatite, gneiss	Brown and red loamy and sandy earths, yellow/brown shallow loamy duplex and some stony soil	York gum-jam woodland	East of Moora
Bg2	Burabidge Hill 2 Subsystem		Undulating rises to undulating low hills granite rock outcrops. All slope position	Granite rocks	Brown sandy earth, Red shallow loamy duplex, shallow and deep sand, Stony soil, Red shallow loam, Red sandy earth, bare rocks	York gum and jam	
Bg8	Burabidge Hill 8 Subsystem		Undulating low hills, plateau residual, very gently to gently inclined undulating plain and hillslopes	Colluvium, sand and gravel	Grey/brown shallow loamy duplex, shallow gravel, sandy and loamy gravel and minor of sandy earth, yellow deep sand, and deep sandy duplex	Low woodland Acacia spp., Jam and melaleuca spp.	
Gh	Greenhills System	Undulating granitic terrain, in the northern Zone of Rejuvenated Drainage, with deep sandy duplex (grey and red), red/brown deep loamy duplex, bare rock and shallow loamy duplex. York gum-jam-salmon gum-wandoo-sheoak woodland.	Undulating rises to undulating low hills with rock outcrops and skirting colluvium	Granite, granodiorite, adamellite and colluvium deriving from these	Grey sandy duplexes, some loamy duplexes and sandy earths	York gum-Jam and Wandoo-Sheoak woodland with some Wandoo-Salmon gum woodland on lower slopes and footslopes	Avon River Catchment to the east of Northam and Beverley
Gh4	Greenhills 4 Subsystem	Tributaries of the Mortlock river, expressing as flat narrow valleys with saline soils, semi-wet soils and grey sandy duplexes, vegetated by Wandoo-Salmon-York gum woodlands, east of Northam and Beverley	Very gently undulating to flat narrow valley floors (to 400m wide) and minor footslopes	Alluvium and minor colluvium	Saline soil, semi-wet soil, and grey sandy duplexes	Wandoo-Salmon-gum woodlands with minor York gum-Jam woodlands	Avon River Catchment to the east of Northam and Beverley
GhYO	Greenhills York Subsystem	Areas of soils derived from freshly exposed rock. This unit is typified by the red soils of the Avon Valley but also includes areas of similar, but often greyer and lighter textured soils to the east of the valley.					
GhYO3	York 3 Subsystem		Undulating rises to undulating low hills.	Migmataitic rocky outcrops.	Sandy earth, shallow and deep sandy duplex, shallow to deep	York gum, wandoo, salmon gum, jam	

MAP UNIT (MU)	MU NAME	MU SUMMARY DESCRIPTION	MU LANDFORM	MU GEOLOGY	MU SOIL	MU VEGETATION	MU LOCATION
					loamy duplex, deep sandy gravel and, stony soil.		
256GhYO4	York 4 Subsystem	Gradual rise to undulating low hills.;Mainly sandy and loamy duplex, alkaline sandy and loamy duplex, sandy earth.;York gum, Wandoo, Salmon gum, jam.	Gradual rise to undulating low hills.	Residual and colluvial deposits.	Mainly sandy and loamy duplex, alkaline sandy and loamy duplex, sandy earth.	York gum, Wandoo, Salmon gum, jam.	
GhYO5	York 5 Subsystem		Undulating rises.	Granitic rocks.	Shallow gravel, brown loamy earth, bare rock.	York gum, Jam, wandoo.	
Go	Goomalling System	Poorly drained valley flats, in the northern Zone of Rejuvenated Drainage, with grey deep sandy duplex (sometimes alkaline) and saline wet soil. York gum-jam-wandoo-salmon gum-sheoak woodland.	Poorly drained valley flats	Alluvium and colluvium over granitic rocks	Grey deep sandy duplexes, alkaline grey deep sandy duplexes and saline wet soils	York gum-jam-wandoo-salmon gum-sheoak woodland and samphire flats	Central wheatbelt from Goomalling to Beverley
GoSD	Goomalling Saline Drainage Subsystem		Narrow drainage lines to broad level salt plains in broad mature valleys	Alluvium	Red-brown hardpan shallow loams and saline wet soils	York gum woodland and halophtic vegetation	northern agricultural area
GoSD1	Goomalling Saline Drainage, phase 1		Broad level salt plains and lakes, areas of tertiary salinity.	Saline silt and clay.	Red and yellowish brown sandy loams over clay.	Saltbush, and samphire.	
GoSD2	Goomalling Saline Drainage, phase 2		Ancient drainage lines and salt lake chains.	Quaternary sand.	Hard setting, reddish brown soils on pan.	Saltbush, and samphire.	
Gt	Glentrome System	stripped, weathered plateau with undulating low hills and rises; loamy earths, loams, loamy gravel and some clay and rock; weathered granite and migmatite	Stripped, weathered plateau with undulating low hills and rises	Granite and migmatite	loamy gravel, red and brown loamy earths and some sandy and loamy duplexes	York gum and Wandoo woodlands	New Norcia to Moora area
GtUG	Glentrome Udamong Subsystem	partially stripped lateritic plateau with undulating low hills and undulating to gently undulating rises; loamy gravel, minor pale sand and clay; deep weathered granitic gneiss, gneiss and schist	Partially stripped lateritic plateau	Deeply weathered profile and colluvium over metasediments	Loamy gravels and shallow gravels	Wandoo woodland	northern Darling Range near New Norcia
GtUG1	Glentrome Udamong Subsystem, phase 1	plateau residual, very gently to gently inclined undulating plain and hillslopes; shallow loamy gravels over duricrust,					

MAP UNIT (MU)	MU NAME	MU SUMMARY DESCRIPTION	MU LANDFORM	MU GEOLOGY	MU SOIL	MU VEGETATION	MU LOCATION
		loamy gravels, some sandy gravels					
Mb	Morbinning System	Undulating sandplain remnants, breakaways and slopes, in the northern Zone of Rejuvenated Drainage, with grey deep sandy duplex (often alkaline), pale deep sand and yellow sandy earth. Wandoo-jam-salmon gum woodland and heath.	Upper slopes of rejuvenated terrain dominated by undulating lateritic remnants with breakaways and colluvial duplex slopes underlain by granite	Margins of granite pluton. (Adamellite, some Granodiorite, minor migmatite. Dolerite intrusions.)	Grey sandy duplexes (some alkaline), yellow sandy earths, pale deep sands and some sandy gravels and gravelly pale deep sand	Wandoo-jam-salmon gum woodland and mixed heath	Eastern margin of rejuvenated terrain from Wongan Hills to Quairading
Mb4	Morbinning 4 Subsystem	Narrow tributary valleys of the Goomalling system with duplex soils and Wandoo vegetation	Narrow tributary valleys of the Goomalling system, usually 100-500 metres wide	Alluvium and colluvium	Saline soil, grey and yellow/brown sandy and loamy duplex soils	Wandoo woodland, minor Flooded gum	Eastern margin of rejuvenated terrain from Wongan Hills to Quairading
MbES	Ewarts Subsystem	Hillslopes containing sand and loamy sand over yellowish clay soils, with some gravel ridges, and some heavier soils that often occur immediately below a breakaway.					
MbES3	Ewarts 3 phase		Gradual rises with numerous shallow drainage lines.	Residual clay and sand with bands of ferruginous gravels, and few granite rock outcrops.	Shallow gravel, loamy gravel, pale and yellow deep sand, yellow to brown sandy earth, sandy duplex, loamy duplex, pale to yellow shallow sand.	Wandoo, Melaleuca, Acacia spp. Minor of Jarrah, yorkgum, Tammer and mallee.	
Wg	Wongan Hills System		Undulating sandplain with occasional low rock hills	Sand and laterite over granitic and metamorphic rocks	Yellow deep sands, loamy and shallow gravels brown loamy earths and loamy duplexes	Mixed heath with tammar and salmon gums	Northern wheatbelt near Wongan Hills
Wg1	Wongan Hills 1 Subsystem	Undulating low hills, with granite rock outcrops.;Grey brown shallow and deep loamy duplex, sandy and loamy earth and minor of shallow and deep sand.;Salmon gum, Melaleuca, Acacia, gimlet and mallee.	Undulating low hills, with granite rock outcrops.	Granite, gneiss, schist, laterite, residual clay sands.	Grey brown shallow and deep loamy duplex, sandy and loamy earth and minor of shallow and deep sand.	Salmon gum, Melaleuca, Acacia, gimlet and mallee.	
Wg2	Wongan Hills 2 Subsystem		Gradual rise to undulating low hills. Low to mid slope.	Schist, laterite and associated sand.	Mainly loamy gravel, deep sandy gravel and shallow gravel, minor of loamy earth and clay.	Tammer, mallee, Hakea, Grevillea spp.	
Wg3	Wongan Hills 3 Subsystem		Gently to undulating rises. All slopes.	Aeolian soil.	Mainly sandy earth and deep sands.	Acacia, Melaleuca.	
Wg4	Wongan Hills 4 Subsystem		Gently undulating rises.	Colluvium, residual	Mainly yellow deep sand,	Acacia, Melaleuca, Hakea,	

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			Midslope and upper slope.	sand and clay and granitic rocks.	shallow sand, sandy earth, shallow sandy duplex and minor of loamy earth.	grevillia spp.	
Wg5	Wongan Hills 5 Subsystem		Level plains adjacent to valley plain.	Colluvium clay and sand.	Mainly red shallow loamy duplex.	Morrell, Melaleuca, Acacia, mainly cleared.	
WgGO	Wongan Hills Goomalling Subsystem	Poorly drained valley flats, in the northern Zone of Rejuvenated Drainage, with grey deep sandy duplex (sometimes alkaline) and saline wet soil. York gum-jam-wandoo-salmon gum-sheoak woodland.	Poorly drained valley flats	Alluvium and colluvium over granitic rocks	Grey deep sandy duplexes, alkaline grey deep sandy duplexes and saline wet soils	York gum-jam-wandoo-salmon gum-sheoak woodland and samphire flats	central wheatbelt from Goomalling to Beverley
Bd	Ballidu System		Gently undulating sandplain	Sands and laterite over granite	Brown and yellow sandy earths, yellow deep sands, brown and yellow loamy earths, shallow and loamy gravels and loamy duplex soils	Sandplain scrub	Between Wongan Hills and Dalwallinu
Bd1	Ballidu 1 Subsystem	Upland, gently undulating rises. Mainly brown sandy earth, shallow gravel, bare rock, stony soil and minor of shallow loamy duplex, red deep sandy duplex, red loamy earth. York gum, jam, Melaleuca, Tammer, Acacia spp..	Upland, gently undulating rises. Mainly crests, mid and upper slopes.	Archaean. Mainly granite rock outcrop with scattered feldspar.	Mainly brown sandy earth, shallow gravel, bare rock, stony soil and minor of shallow loamy duplex, red deep sandy duplex, red loamy earth.	York gum, jam, Melaleuca, Tammer, Acacia spp..	
Bd2	Ballidu 2 Subsystem	Gently undulating rises, often with surface rock fragments. Non-cracking and cracking clay, shallow loamy duplex, loamy & sandy earth. Salmon gum, Gimlet, Melaleuca spp. Yorkgum, Tammer, Quandong.	Gently undulating rises with rock fragments on surface occasionally adjacent to the drainage lines and associated with Bd1, Bd3 and Bd4.	Quaternary: Pleistocene to recent; colluvium.	Non-cracking and cracking clay, shallow loamy duplex, loamy earth, minor of sandy earth.	Salmon gum, Gimlet, Melaleuca spp. Yorkgum, Tammer, Quandong.	
Bd3	Ballidu 3 Subsystem	Lateritic outcrops, broad gravely ridges. Adjacent to drainage line. Mainly loamy gravel, Yellow deep sand, sandy & loamy earth, Red shallow loamy duplex, sandy loamy duplex. Tammer, Mallee, Acacia, Melaleuca, Gravillia, Hakea spp..	Lateritic outcrops, broad gravely ridges. Occasional outcrops of basement rocks. Adjacent to drainage line.	Cainozoic; Tertiary, laterite and associated sand.	Mainly loamy gravel, Yellow deep sand, sandy and loamy earth, Red shallow loamy duplex, minor of sandy loamy duplex.	Tammer, Mallee, Acacia, Melaleuca, Gravillia, Hakea spp..	
Bd4	Ballidu 4 Subsystem	Gently undulating	Gently undulating sandplain	Colluvium lithic	Mainly sandy earth, deep sand,	Mallee, Acacia, Tammer,	

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		sandplain & sandy rises with long gentle slopes. Sandy earth, deep sand, loamy earth, shallow loamy & sandy duplex, gravelly soils, red brown non-cracking clay, shallow sand. Mallee, Acacia, Tammer, melaleuca, Salmon gum.	to gently undulating sandy rises with long gentle slopes.	sand, rock fragments, laterite and associated sand.	loamy earth, shallow loamy and sandy duplex, gravelly soils, red brown non-cracking clay, shallow sand.	melaleuca, Salmon gum.	
Bd5	Ballidu 5 Subsystem		Gently undulating rises, seepages areas and sand plain, few lakes in low lying areas.	Cainozoic;Tertiary: residual yellow and white quartz sand, residual clay and sand.	Mainly yellow deep sand, shallow sandy and loamy duplex, and gravelly soils.	Woody pear, Cyperus pine, Tammer spp. Acacia spp. Quandong, Melaleuca, Banksia.	
Bd6	Ballidu 6 Subsystem	Valley slope mainly tributary to major drainage lines. Red sandy and loamy earth, Red shallow loamy duplex. Salmon gum, Gimlet, Acacia.	Valley slope mainly tributary to major drainage lines.	Quaternary: Pleistocene to recent; colluvium.	Red sandy and loamy earth, Red shallow loamy duplex.	Salmon gum, Gimlet, Acacia.	
Bd7	Ballidu 7 Subsystem	Valley floors, in the central Zone of Ancient Drainage, with alkaline red shallow loamy duplex, alkaline grey sandy duplex (shallow and deep), calcareous loamy earth and hard cracking clay. Salmon gum-gimlet-wandoo-York gum woodland.					
Bd8	Ballidu 8 Subsystem	Areas of tertiary salinity; often heads of drainage lines, shallow depressions and areas of recent salt encroachment. Soils are salt affected variants of red-brown hardpan shallow loams and other soils of adjacent systems.					
Bc	Beacon System		Valley floor around the salt lakes	Quaternary alluvium	Calcareous loamy earths, red loamy and sandy earths, minor red sandy and loamy duplexes and clays	Salmon gum-gimlet-wandoo-York gum woodland	North-eastern wheatbelt around Beacon
BcCL	258Bc Cleary Subsystem	Valley floors and lower slopes, in the northern Zone of Ancient Drainage,					

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		with calcareous loamy earth, red shallow sand and alkaline red loamy duplex (deep and shallow). Salmon gum-gimlet woodland.					
Br	Bonnie Rock System		Gently undulating sandplain and associated slopes and minor rock outcrop	Sandy deposits and deeply weathered mantle over granite	Acid yellow and yellow sandy earths, yellow deep sands, red sandy earths, loamy gravels and minor loams, duplexes and rock outcrops	Heath and shrubland, salmon gum woodland	North eastern wheatbelt west of Bonnie Rock
BrKO	Koorda Subsystem	Gently undulating sandplain, in the central Zone of Ancient Drainage, with yellow sandy earth (often acid) and yellow deep sand. Heath and shrubland.					
BrKW	258Br Kwelkan Subsystem	Undulating granitic low hills, in the central Zone of Ancient Drainage, with bare rock, deep sandy duplex (grey and red), shallow sand (red and yellow/brown) and red loamy duplex. York gum-jam woodland.					
BrKW1	Kwelkan 1 phase	Gently undulating to undulating rises. Brown sandy earth, shallow loamy duplex, deep loamy duplex, deep and shallow sand. York gum, Jam, Melaleuca spp., Acacia spp., Tammer spp., Salmon gum., Quandong.	Gently undulating to undulating rises.	Archaean. Mainly granite rocks and scattered feldspar.	Brown sandy earth, shallow loamy duplex, deep loamy duplex, deep and shallow sand.	York gum, Jam, Melaleuca spp., Acacia spp., Tammer spp., Salmon gum., Quandong.	
BrNE	258Br Nembudding Subsystem	Rises and low hills, in the northern Zone of Ancient Drainage, with alkaline red loamy duplex (mostly shallow) and yellow sandy earth. Mallee scrub and woodland.					
BrNU	258Br Nungarin Subsystem	Gently undulating plains, in the central Zone of Ancient Drainage, with grey sandy duplex (shallow and deep) and					

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		grey shallow loamy duplex (often alkaline). Salmon gum-gimlet-wandoo woodland and mallee scrub.					
BrTR	Bonnie Rock Trayning Subsystem	Valley floors, in the central Zone of Ancient Drainage, with alkaline red shallow loamy duplex, alkaline grey sandy duplex (shallow and deep), calcareous loamy earth and hard cracking clay. Salmon gum-gimlet-wandoo-York gum woodland.					
BrWI	258Br Wialki Subsystem	Undulating rises, in the central Zone of Ancient Drainage, with red shallow sand and alkaline red loamy duplex (mostly shallow). Salmon gum woodland.					
Dw	Dalwallinu System		Gently undulating rises and alluvial flats	Colluvium	Red loamy earths and duplexes, brown and yellow sandy earths,	York gum, salmon gum, gimlet and morrell woodland and mallee	Northern wheatbelt near Dalwallinu
Dw1	Dalwallinu 1		Mid slope gently undulating rises adjacent to the drainage lines	Colluvium lithic sand, clay, sand and gravel	Brown sandy earth, red shallow loamy duplex, , minor of Yellow sandy earth and Yellow deep sand	York gum, Acacia spp., Mallee spp., Salmon gum	
Dw2	Dalwallinu 2		Level alluvial flat with occasional areas of gilgai microrelief, alkaline.	Colluvium clay and loam	Alkaline red shallow loamy duplex, shallow and deep loamy duplex, shallow sandy duplex	Salmon gum, Gimlet, Morrel, Melaleuca spp.	
Kb	Kellerberrin System	Valley floors, in the central Zone of Ancient Drainage, with alkaline red shallow loamy duplex, alkaline grey sandy duplexes mainly in branch valleys (shallow and deep), calcareous loamy earth and hard cracking clay. Salmon gum-gimlet-wand	Valley floors	Quaternary alluvium	Alkaline red shallow loamy duplexes, alkaline grey sandy duplexes (shallow and deep), calcareous loamy earths and hard cracking clays	Salmon gum-gimlet-wandoo-York gum woodland	
KbTR	Trayning Subsystem	Valley floors, in the central Zone of Ancient Drainage, with alkaline red shallow loamy duplex,					

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		alkaline grey sandy duplex (shallow and deep), calcareous loamy earth and hard cracking clay. Salmon gum-gimlet-wandoo-York gum woodland.					
KbTRs	Trayning saline phase	Level to gently undulating plain, broad valley floor, tributary to the main salt lake chain mainly adjacent to salt lakes.;Mainly saline soils, loamy duplex and sandy earth.;Salmon gum, York gum, Acacia spp., Saltbush	Level to gently undulating plain, broad valley floor, tributary to the main salt lake chain mainly adjacent to salt lakes.	Cainozoic, Quaternary Colluvium- clay and loam.	Mainly saline soils, loamy duplex and sandy earth.	Salmon gum, York gum, Acacia spp., Saltbush spp., Samphire.	
Ky	Kwolyin System	Gently undulating granitic terrain of the Kellerberrin batholith with large outcrops of granite, dominated by duplex soils with minor sandplain. York gum/ Salmon gum woodlands with minor Wandoo, Jam, Sheoak and heath.	Gently undulating terrain comprising irregularly undulating granitic domes and torrs skirted by large colluvial mantles and only minor sandplain	Medium to coarse grained siliceous sheet granites (Kellerberrin Batholith) with dolerite intrusions	Duplex soils and soils formed on fresh rock with minor yellow sandplain	York gum/ Salmon gum woodlands on duplex slopes with Jam and sheoak thickets around rock outcrops, scattered Kwongan on sandplain patches.	Uplands in the central wheatbelt between Bruce Rock & Kellerberrin
KyKW	Kwelkan Subsystem	Undulating granitic low hills, in the central Zone of Ancient Drainage, with bare rock, deep sandy duplex (grey and red), shallow sand (red and yellow/brown) and red loamy duplex. York gum-jam woodland.					
KyKW1	Kwelkan 1 phase	Gently undulating to undulating rises.;Brown sandy earth, shallow loamy duplex, deep loamy duplex, deep and shallow sand.;York gum, Jam, Melaleuca spp., Acacia spp., Tammer spp., Salmon gum., Quandong.	Gently undulating to undulating rises.	Archaean. Mainly granite rocks and scattered feldspar.	Brown sandy earth, shallow loamy duplex, deep loamy duplex, deep and shallow sand.	York gum, Jam, Melaleuca spp., Acacia spp., Tammer spp., Salmon gum., Quandong.	
KyKW2	Kwelkan 2 phase	Gently undulating rises.;Grey deep sandy duplex, Grey/brown shallow to deep loamy	Gently undulating rises.	Residual clay and sand with bands of ferruginous gravel.	Grey deep sandy duplex, Grey/brown shallow to deep loamy duplex, Brown sandy earth.	Grevillea sp., Tammar, Melaleuca spp., (mainly cleared).	

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		duplex, Brown sandy earth.;Grevillea sp., Tammar, Melaleuca spp., (mainly cleared).					
KyNE	Nembudding Subsystem	Rises and low hills, in the northern Zone of Ancient Drainage, with alkaline red loamy duplex (mostly shallow) and yellow sandy earth. Mallee scrub and woodland.					
KyTR	Kwolyin Trayning Subsystem	Valley floors, in the central Zone of Ancient Drainage, with alkaline red shallow loamy duplex, alkaline grey sandy duplex (shallow and deep), calcareous loamy earth and hard cracking clay. Salmon gum-gimlet-wandoo-York gum woodland.					
Wa	Wallambin System	Salt lake chains, in the central Zone of Ancient Drainage, with salt lake soil and calcareous loamy earth. Mallee, morrell woodland and saltbush-bluebush-samphire flats.	Broad valley floor dominated by salt lakes with minor dunes	Quaternary alluvium	Salt lake soils, calcareous loamy earths	Bare areas and samphire-saltbush-bluebush flats	North-eastern wheatbelt
Wa1	Wallambin 1 Subsystem	Salt lakes, bare surface. In winter they contain water but dry to a surface of salt crystals in summer.	Salt lakes, bare surface. In winter they contain water but dry to a surface of salt crystals in summer.	Playas- clay, silt, peats, saline or fresh water.	Bare surface.	Mallee, morrel woodland and saltbush-bluebush-samphire flats.	
Wa2	Wallambin 2 Subsystem	Salt lake chains and surrounding dunes and flats	Salt lake chains and surrounding dunes and flats	Cainozoic, Quaternary acolian and alluvial deposits	salt lake soil, and in fringes; Red sandy earth, Red sandy earth, Grey deep sandy duplex, Yellow deep sand	Mallee, morrel woodland and saltbush-bluebush-samphire flats.	