Australian Government

Government of South Australia
Department for Environment and Heritage

Draft Recovery Plan for the Endangered Jumping-Jack Wattle *Acacia enterocarpa* (R.V. Smith)

(2007 - 2012)

A Recovery Plan prepared under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC, 1999).

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Further copies of this Recovery Plan are available from:
Doug Bickerton
Department for Environment and Heritage
Plant Biodiversity Centre
PO Box 1047
Adelaide SA 5000

Released for public comment October 2007.

Cover photograph: *Acacia enterocarpa* in flower at Aberdour Conservation Park.
By Tim Croft (Department for Environment and Heritage, SA).

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Abbreviations

ARC	Agricultural Research Council, South Africa
CITES	Convention on International Trade in Endangered Species
DEH	Department for Environment and Heritage, South Australia
DSE	Department of Sustainability and Environment, Victoria
DTEI	Department for Transport, Energy and Infrastructure, South Australia
EP	Eyre Peninsula
EPBC	*Environment Protection and Biodiversity Conservation Act* 1999
F&FG	*Flora and Fauna Guarantee Act 1988*
IUCN	International Union for the Conservation of Nature
NPW	*National Parks and Wildlife Act 1972*
NRM	Natural Resource Management
PBC	Plant Biodiversity Centre, Adelaide
RT	Recovery Team for *Acacia enterocarpa***
SA	South Australia
SE	South East of South Australia
SENRM	South East Natural Resource Management Board
spp	species (plural)
ssp	subspecies
syn	synonym
TFO	Threatened Flora Officer
TPAG	Threatened Plant Action Group
Vic	Victoria

** An *Acacia enterocarpa* Recovery Team will be established through this recovery planning process.

Acknowledgements
The authors would like to thank the following people who greatly assisted in the development of this National Recovery Plan. They include Peter Copley, Jody Gates, David Hinchliffe, Randall Johnson, Philip Keane, Glenn Rudolph, Yvonne Steed, Wendy Stubbs, David Thompson, Dale Tonkinson and Roman Urban.

Part 1. Species Information and General Requirements

1.1 Species Conservation Status and Taxonomy

1.1.1 Current Conservation Status:

Acacia enterocarpa (R.V. Smith) is listed as nationally Endangered, IUCN criterion EN C1, on the 1997 *IUCN Red list of Threatened Plants* (Walter & Gillett, 1998). It is listed as nationally Endangered on the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC, 1999). It is listed as Endangered in South Australia on Schedule 7 of the *National Parks and Wildlife Act 1972* (NPW, 1972), and Endangered in Victoria under the *Flora and Fauna Guarantee Act*, *1988* (F&FG, 1988). According to currently available data it no longer warrants listing under IUCN criterion EN C1, since previously unknown sub-populations were discovered on Yorke Peninsula in 2001, boosting the total population size to more than 5000 plants. However the species continues to warrant listing under criteria EN B2a and b(v), since the area of occupancy remains less than 500 km^2 and there has been observed population decline at known sites.

1.1.2 Taxonomy:

Family name:	Leguminosae
Scientific name:	*Acacia enterocarpa*
Common Name:	jumping-Jack wattle

Acacia enterocarpa is a small dense prickly much-branched spreading shrub to 1.5 m high and 1.5 m wide (Whibley 1980; Jessop and Toelken 1986). Branchlets are asperulate, reddish brown and ribbed (Cowan & Maslin, 2001). Phyllodes are linear 2 – 4.5 cm long, 1- 1.3 cm wide and straight or slightly curved, with 10-12 distinct raised asperulate nerves. Phyllodes have a sharp reddish-brown rigid tip. Flowers are bright yellow globular balls, axillary and generally occur in pairs. Flowers occur as 20 together on peduncles approximately 5 mm long (Whibley, 1980). Flowering occurs between May and October (winter – spring) (Whibley, 1980). Pods are typically a zigzag shape, undulate to +/-2 cm long and 2 mm wide, conaceous, brown with thickened yellow margins and sparsely appressed, puberulous (Whibley 1980; Cowan & Maslin 2001). The common name, jumping-Jack wattle, is derived from the pod resembling a jumping jack cracker. Seeds are longitudinal, oblong to elliptic +/- 3 mm long (Whibley, 1980).

Acacia enterocarpa is closely related to *A. hexaneura*, which has persistent, spinose stipules, longer, 6-nerved phyllodes and less contorted pods (Cowan & Maslin, 2001). It is also similar in appearance to *A. nyssophylla* and *A. colletioides*, but differs from both by its asperulate-ribbed branchlets and phyllodes, as well as by its strongly plicate pods having seeds with smaller, whitish arils (Cowan & Maslin, 2001).

1.2. Objects of the EPBC Act

d) Promoting a co-operative approach to the protection and management of the environment involving governments, the community, landholders and indigenous peoples.

Successful implementation of this recovery plan is dependent on the involvement of a wide range of stakeholders (see Section 1.4).

e) Assisting in the co-operative implementation of Australia's international environmental responsibilities.

Implementation of this recovery plan will meet policy and legislative objectives at a national, state and regional level. It is expected that the involvement of a diverse range of stakeholders (see Section 1.4)

in this implementation process will also ensure that this is done using a co-operative approach that embraces Australia's international environmental obligations. This is also outlined in Section 1.3.

f) Recognising the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity.
g) Promoting the role of indigenous peoples' knowledge with the involvement of, and in co-operation with, the owners of the knowledge.

Indigenous communities involved in the regions affected by this plan have not yet been identified. Implementation of recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region. Consultation will determine the role and interests of indigenous communities with regard to the implementation of this plan.

1.3. International Obligations

Acacia enterocarpa is not listed under any relevant international agreements and the implementation of Australia's international environmental responsibilities will not be affected by this plan. The actions identified in the plan are fully consistent with Australia's obligations under the Convention on Biological Diversity, ratified by Australia in 1993 and the proceeding National Strategy for the Conservation of Australia's Biological Diversity. The plan does not impact on obligations made under the Convention on Wetlands or the Convention on Migratory Species. The species is not listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

1.4. Affected Interests

Approximately 55 community groups, private landowners, land managers and statutory organisations have been identified as current and potential stakeholders in the management of *Acacia enterocarpa* within South Australia and Victoria (Appendix I).

Nineteen of these stakeholder groups/individuals currently directly own or manage habitat critical for this species. During the development of this recovery plan many regional and state listed stakeholders were contacted and informed of the planning process. Each was invited to provide input into and/or comment on the plan's development. Significant information contained within this plan, including information about new sites and threats to species, is the direct result of this consultation. Opportunities for the involvement of all potential stakeholders in the proposed recovery actions are extensive and outlined in full in the Actions section of this plan (Section 4.3.

1.5. Roles and Interests of Indigenous People

In South Australia, the relevant indigenous groups are being contacted and consulted by the Aboriginal Partnerships Unit, Department for Environment and Heritage (DEH). In Victoria, the indigenous communities involved in the regions affected by this plan have not yet been identified. Implementation of recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region.

1.6. Benefits to other Species/Ecological Communities

Through the implementation of this plan broader biodiversity benefits will include the protection and management of ecological communities and individual species that occur within the habitat critical to *Acacia enterocarpa*.

The range of *Acacia enterocarpa* overlaps a number of floral species of conservation significance at the national level. There are eight floral species of national listing and two of state listing known to occur in areas where *A. enterocarpa* has been recorded. On Yorke Peninsula one nationally endangered species *Euphrasia collina* ssp*. osbornii* (Osborn's eyebright) and three nationally vulnerable species *Olearia pannosa* ssp*. pannosa* (silver-leafed daisy), *Caladenia brumalis* (winter

white spider-orchid) and *A. rhetinocarpa* (resin wattle) occur with *A. enterocarpa*. On Eyre Peninsula preliminary surveys record *A. enterocarpa* as occurring near sites containing the nationally endangered *Thelymitra epipactoides* (metallic sun-orchid) and *Haloragis eyreana* (prickly raspwort) and the nationally vulnerable *A. imbricata* (feathery wattle). In the Wimmera it shares habitat with *A. glandulicarpa* (hairy-pod wattle), which is nationally vulnerable. In the South East of South Australia it is recorded from areas containing the State-listed rare plants *Leionema microphyllum* syn. *Phebalium brachyphyllum* (limestone phebalium) and *H. eichleri* (Eichler's raspwort). The nationally vulnerable *O. pannosa* ssp. *pannosa* has also been recorded from Aberdour Conservation Park.

In Victoria *Acacia enterocarpa* is associated with *Allocasuarina luehmannii* (buloke) Woodland; a Nationally-listed Endangered Ecological Community (EPBC, 1999) and also listed under the F&FG Act (Overman & Venn, 1999). In addition, many sites occur within remnant vegetation and roadside reserves which are important corridors and wildlife refuges. It has been suggested that the decline of *Acacia enterocarpa* from many sites may indicate a decline in the general health of its ecological community. Recovery actions are therefore aimed at restoration of the ecological community in which this species lives and it is considered that there would be no negative impacts or perceived negative impacts on other species or ecological communities through the implementation of this plan.

1.7. Social and Economic Impacts

This recovery plan is unlikely to cause overall adverse social or economic impacts on the community. A number of beneficial social and economic impacts are however likely to result from the implementation of many of the recovery plan actions. Amongst the social benefits are the education of the community about natural resource management, enhanced skills of community members for undertaking threatened plant management, employment of one or more Threatened Flora Officers and communication between regional Natural Resource Management (NRM) boards. Identified economic benefits include managing weeds that may have potential to impact on productive land and local employment opportunities created through provision of fencing to landholders. Contractors have already been brought to the South East region for the maintenance of *Acacia enterocarpa* sites on a number of occasions and have contributed to the local economy through the purchase of fuel, accommodation and food.

Local Government may benefit from financial assistance for the management of roadside reserves. Protecting existing sub-populations on road reserves may however affect the manner in which road works, maintenance or service installations are conducted and a cost may be incurred. The cost of redirecting services such as powerlines or optical fibre cables or road realignment may be prohibitive and in such cases, alternative strategies for conserving sub-populations might need to be canvassed (Overman & Venn, 1999).

Certain management may need to be altered to better manage this species, such as grazing regimes, use of fire and other disturbance methods. These activities could create an economic or resource impact on some landowners. Landowners may potentially experience loss of income through, for example, reduced grazing area or grazing time. Landholders in the Ironstone Ridge area of Victoria may lose potential income from gravel extraction if remnant stands on freehold land are set aside for conservation (Overman & Venn, 1999). Actions are outlined in Section 4.2 to consult and work with landholders to minimise any potential economic impact of implementing this recovery plan.

Part 2. Distribution and Location

2.1. Current Distribution and Important Sub-populations

2.1.1 Current Distribution

Acacia enterocarpa occurs in South Australia and Victoria. In South Australia it is found in several disjunct sub-populations on Eyre Peninsula, Yorke Peninsula and in the South East. In Victoria it is restricted to a small area in the State's west, in the Diapur-Kaniva area of the Wimmera. The stronghold for the species is on Yorke Peninsula and in Victoria.

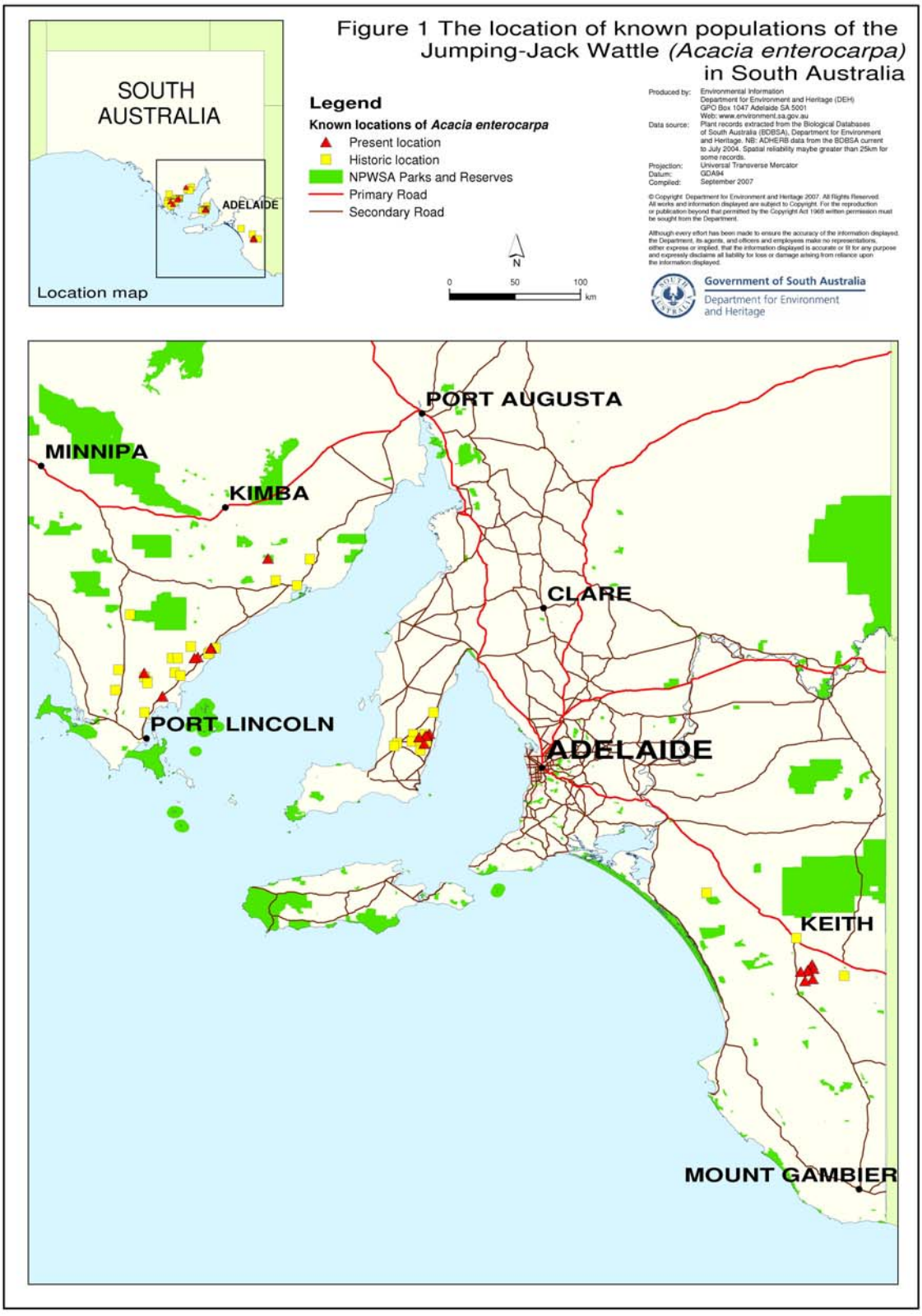
For the preparation of this recovery plan data was collated from the Plant Population Database, DEH (DEH, 2007); Adelaide Herbarium (PBC, 2004); Threatened Species Database, Department of Sustainability and Environment, Victoria (DSE, 2004) and personal communications with individuals that have undertaken work on the species. A total of 77 distinct extant sites have been identified in this recovery plan, totalling between 5,680 and 6,900 individual plants across the species range (Table 1; Figures 1 and 4). For this recovery plan data collected since 1990, has been included as the current distribution of this species. Data older than this was deemed historical data and is dealt with in Section 2.2. Current sub-populations are recorded as containing between 1 and 940 individual plants. In South Australia there are 34 known sub-populations with a total of approximately 3,886 individual plants (Table 1). Victoria has 43 current sites and between 1,795 and 3,000 individual plants (Overman and Venn, 1999).

In South Australia the species is only conserved in one reserve (Aberdour Conservation Park, in the South East) and in one Heritage Agreement, on Yorke Peninsula. In Victoria it is reserved in Sandsmere Flora Reserve and Diapur Flora Reserve; however it was planted into the latter in 1977 where it is believed to have once occurred naturally (Stuwe, 1980). It was also planted into Lonsdale Forest Block near Stawell in 1976. Most of the other sub-populations are restricted to roadside or rail reserves, with a few sub-populations occurring on private land, mostly on Yorke Peninsula and in the South East.

This species is reported to be growing in cultivation in the Botanic Gardens of Adelaide, Australian National Botanic Gardens, Royal Botanic Gardens Melbourne and Royal Botanic Gardens Sydney (Meredith and Richardson, 1992, cited in Green, 1993).

Table 1 Known sub-populations of *Acacia enterocarpa*

Location	Current sub-populations	Extent of occurrence (km^2)	Area of occupancy (km^2)	No. of plants (approximate)
Eyre Peninsula	18	5700	0.065	786
Yorke Peninsula	7	290	<0.500	2,850
South East of SA	9	1240	<0.090	250
Wimmera	43	-	-	1,795
Total	**77**	**7230**		**5,681**


SOUTH AUSTRALIA
ADELAIDE
Location map
Figure 1 The location of known populations of the Jumping-Jack Wattle (Acacia enterocarpa) in South Australia
Legend
Known locations of Acacia enterocarpa
Present location
Historic location
NPWSA Parks and Reserves
Primary Road
Secondary Road
N
0
50
100
km
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Data source: Plant records extracted from the Biological Databases of South Australia (BDBSA), Department for Environment and Heritage. NB: ADHERB data from the BDBSA current to July 2004. Spatial reliability maybe greater than 25km for some records.
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Datum: GDA94
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2.1.2 Important Sub-populations

South Australia

Eyre Peninsula

Acacia enterocarpa has a distribution of approximately 5700 km^2 on Eyre Peninsula, occurring across Lower Eyre Peninsula from Edillilie in the south to Kapinnie, Butler Tanks and Port Neill to the north (Figure 2) (Freebairn & Pobke, 2007). Several records also exist for northern Eyre Peninsula between Cowell and Whyalla. Further work is required to assess the validity of these northern sites as they may contain a similar species of *Acacia* (Freebairn & Pobke 2007; Lang pers. comm. 2004). The total number of plants is estimated to be 786, with the number of plants per site ranging from 1 to 320. The majority of sub-populations on Eyre Peninsula are small and occur in highly fragmented vegetation on road and rail reserves (Freebairn & Pobke, 2007).

Yorke Peninsula

On Yorke Peninsula in the area between Curramulka, Minlaton and Pt. Vincent there are seven sub-populations of *Acacia enterocarpa*, found predominantly on roadside reserves and private land (Table 1, Figure 3) (Green 1993). Of the estimated 3000 plants, 1740 occur in blocks of native vegetation on two private properties (DEH 2004; Steed pers comm. 2004). Further important sub-populations, containing 970 plants, occur off the Port Julia - Port Vincent Road on Sections 39 and 47 and roadsides adjacent to several sections in this area (DEH, 2004). There are no conserved sub-populations on Yorke Peninsula (Green, 1993). The total area this species occupies on the Yorke Peninsula is <0.5 km^2. Significantly, there is no fungal gall recorded on *A. enterocarpa* plants on Yorke Peninsula, however plants are reported to be senescing and little regeneration has been observed (Steed pers. comm. 2004; Pavy pers. comm. 2004).

South East

Approximately 250 *Acacia enterocarpa* plants occur in the upper South East of South Australia at nine sub-populations (DEH 2004; PBC 2004). This population count is based on seven of the nine sites where this taxon has been collected in this region. It is in the South East that South Australia's only reserved sub-population occurs, in Aberdour Conservation Park, where 122 plants persist at two sites (Davies, 1995). The remaining eight sub-populations occur between Bordertown, Coonalpyn and Desert Camp, and range from 1 – 53 plants. The majority of *A. enterocarpa* plants in the South East are severely affected by fungal gall, and roadside sub-populations are threatened by weed invasion, competition and road maintenance activities (Steed pers. comm., 2004; Johnson pers. comm. 2004).

Victoria

Wimmera

In Victoria *Acacia enterocarpa* is found at 43 sub-populations, within the Wimmera in the area between Nhill in the east, Kaniva in the west and Broughton and Sandsmere to the north (DSE, 2004). It is reserved in Sandsmere Flora Reserve and Diapur Flora Reserve. The concentration of sub-populations is mainly on the Lawloit Range (Overman & Venn 1999). Sub-populations range in size from 1 to 380 plants. Population estimates are mostly based on 19 sites where surveys were undertaken in 1979 and 2000. Important sub-populations include two sites on Honeymans' Road, which contain 378 and 254 plants. A further site 19 km northwest of Kaniva on the Kaniva - Broughton Road contains 375 individual plants. A site in Lonsdale Forest Block near Stawell was selected in 1976 for a small plantation of *Acacia enterocarpa*. Currently this plantation is thought to comprise approximately 20 plants including juveniles (Rudolph, pers. comm. 2008). There are a further 23 sites for which no current information is available.

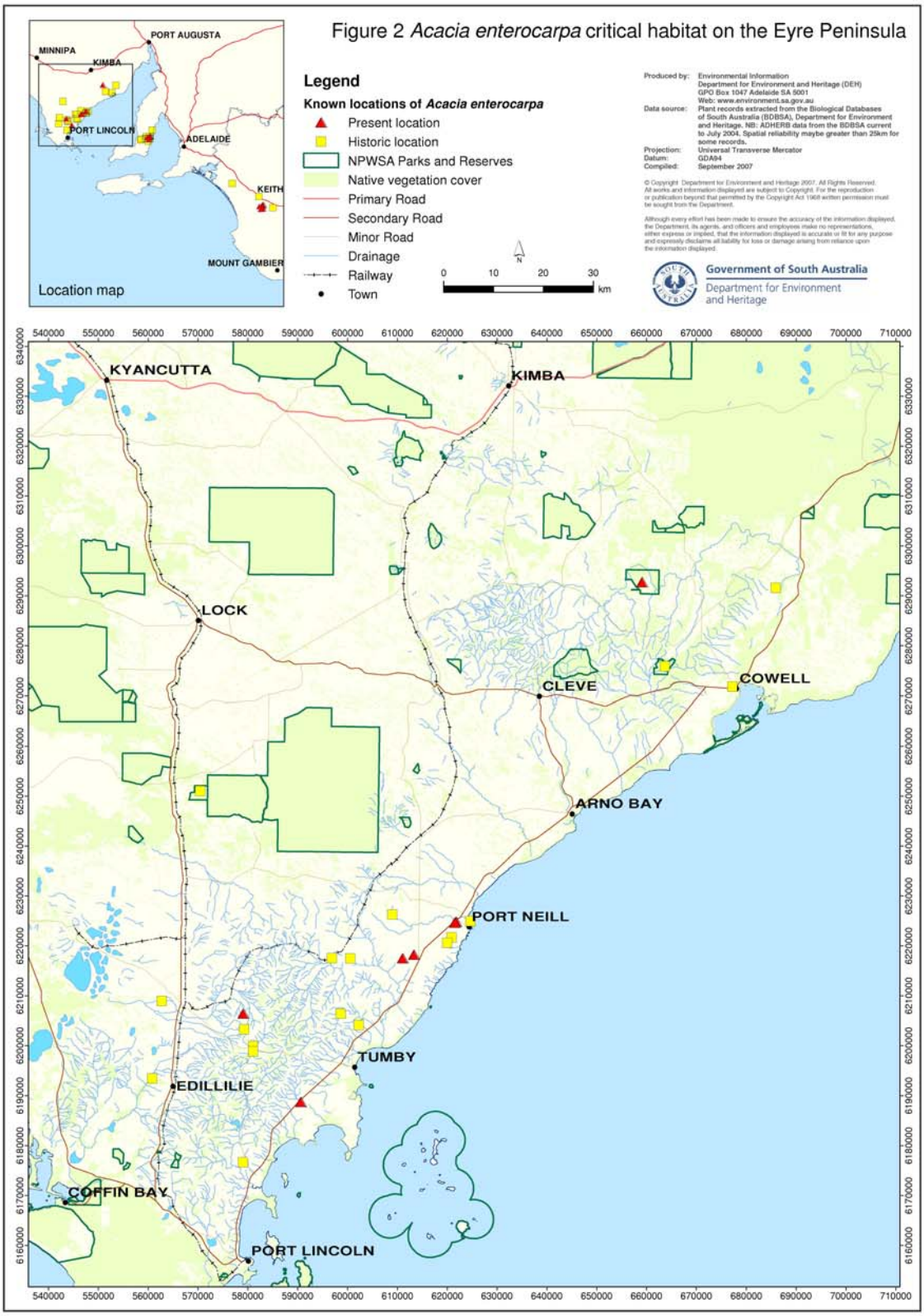
Figure 2 *Acacia enterocarpa* critical habitat on the Eyre Peninsula
Location map
PORT AUGUSTA
MINNIPA
KIMBA
PORT LINCOLN
ADELAIDE
KEITH
MOUNT GAMBIER
Legend
Known locations of *Acacia enterocarpa*
Present location
Historic location
NPWSA Parks and Reserves
Native vegetation cover
Primary Road
Secondary Road
Minor Road
Drainage
Railway
Town
0 10 20 30
km
Produced by: Environmental Information
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Data source: Plant records extracted from the Biological Databases of South Australia (BDBSA), Department for Environment and Heritage. NB: ADHERB data from the BDBSA current to July 2004. Spatial reliability maybe greater than 25km for some records.
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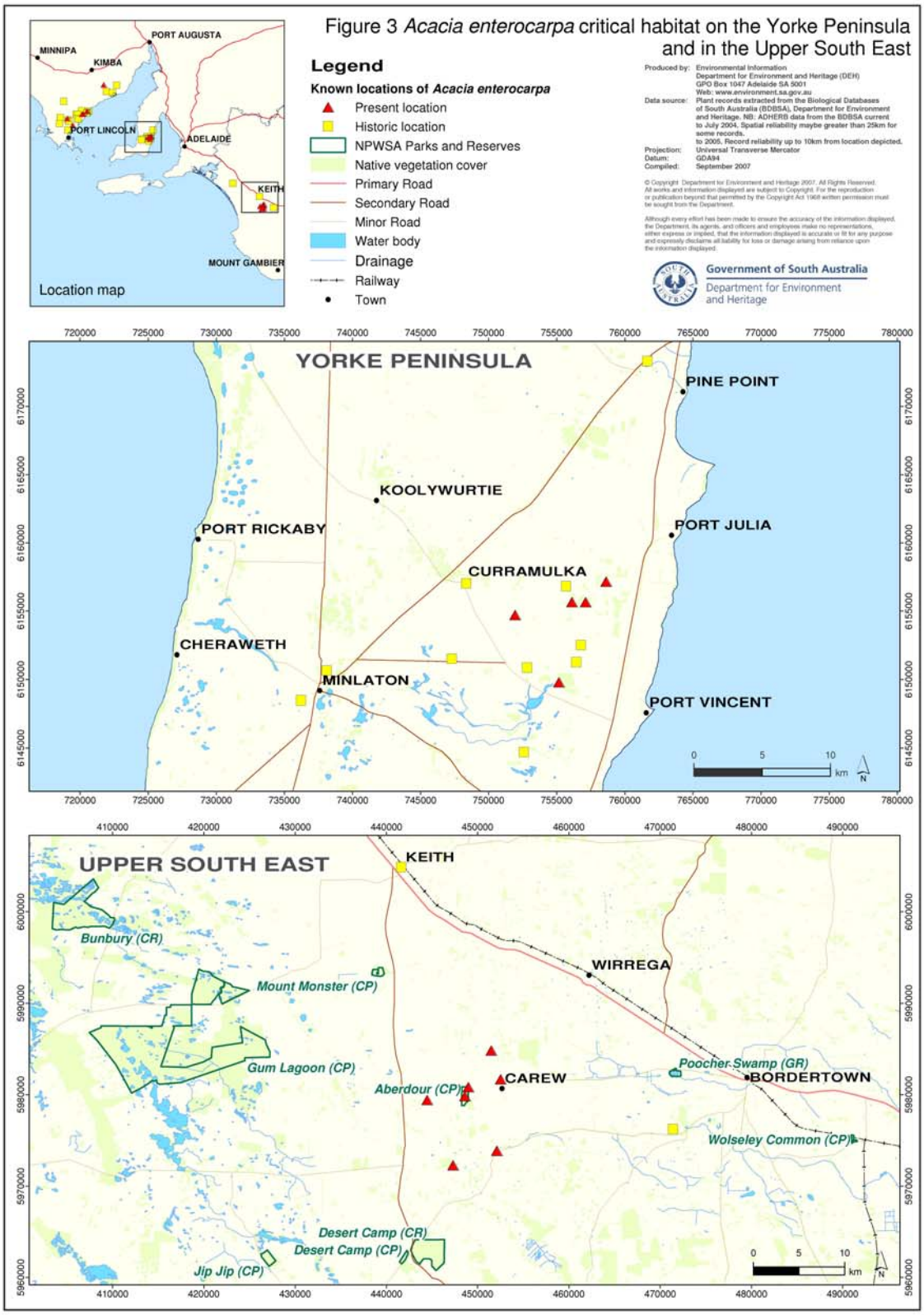
Figure 3 Acacia enterocarpa critical habitat on the Yorke Peninsula and in the Upper South East
Location map
PORT AUGUSTA
MINNIPA
KIMBA
PORT LINCOLN
ADELAIDE
KEITH
MOUNT GAMBIER
Legend
Known locations of Acacia enterocarpa
Present location
Historic location
NPWSA Parks and Reserves
Native vegetation cover
Primary Road
Secondary Road
Minor Road
Water body
Drainage
Railway
Town
Produced by: Environmental Information
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YORKE PENINSULA
PINE POINT
KOOLYWURTIE
PORT RICKABY
PORT JULIA
CURRAMULKA
CHERAWETH
MINLATON
PORT VINCENT
0 5 10 km N
UPPER SOUTH EAST
KEITH
Bunbury (CR)
WIRREGA
Mount Monster (CP)
Gum Lagoon (CP)
Poocher Swamp (GR)
CAREW
BORDERTOWN
Aberdour (CP)
Wolseley Common (CP)
Desert Camp (CR)
Desert Camp (CP)
Jip Jip (CP)
0 5 10 km N

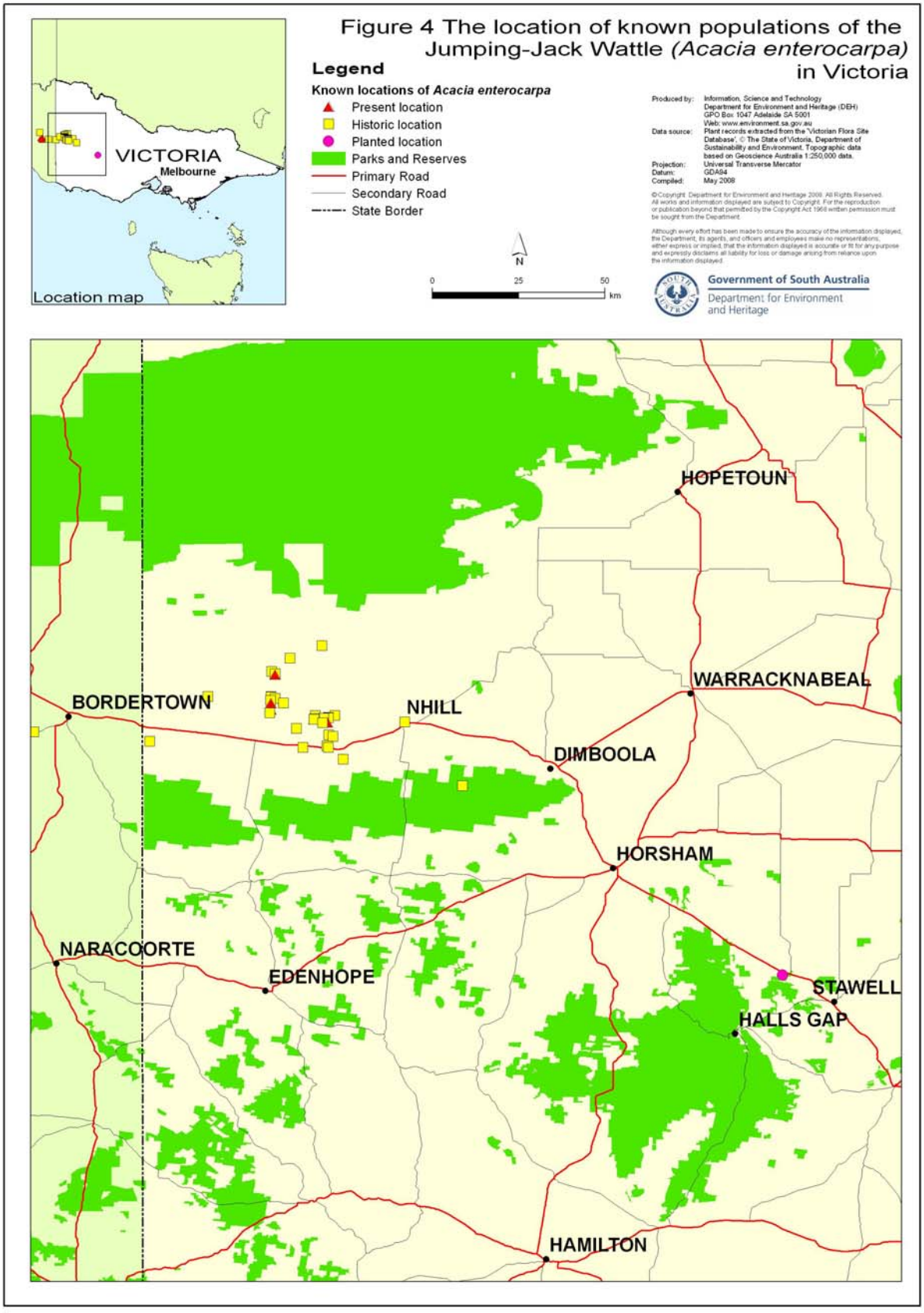
Figure 4 The location of known populations of the Jumping-Jack Wattle (Acacia enterocarpa) in Victoria
Legend
Known locations of Acacia enterocarpa
Present location
Historic location
Planted location
Parks and Reserves
Primary Road
Secondary Road
State Border
VICTORIA
Melbourne
Location map
N
0
25
50
km
Produced by: Information, Science and Technology
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Data source: Plant records extracted from the 'Victorian Flora Site Database', © The State of Victoria, Department of Sustainability and Environment. Topographic data based on Geoscience Australia 1:250,000 data.
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HAMILTON

Past Distribution

Acacia enterocarpa occupies a variety of habitats within its range and thus may have been more widespread before clearance for agriculture (Overman & Venn, 1999). It is recorded as occurring in areas of fertile soils that further support the suggestion that it may have been found in areas that would have been preferentially cleared for agriculture. Overman and Venn (1999) conjectured that the current limited range of the species could also be due to its apparent requirement for largely undisturbed areas of remnant vegetation.

Historic sites in South Australia include four sites in the South East, three on Yorke Peninsula and 13 on Eyre Peninsula (Figure 1). In the South East two sites are recorded near Mundulla (1964), one site at Keith (1951) and another site containing one remnant plant on the corner of Carew Road and Desert Camp Road that was reported to have died since 2000 (PBC 2004; Steed, pers. comm. 2004). Seed was collected from this last site and 25 plants have been replanted into the area (Steed, pers. comm. 2004). One historic site known from the Yorke Peninsula occurs on the Pine Point Road near Curramulka (1975) (PBC, 2004). There are several records for both southern and northern Eyre Peninsula, which are deemed historic (Freebairn & Pobke 2007).

In Victoria the species has been recorded from 24 sites deemed historic (DSE, 2004). There is no information available about the number of plants at these sites and all were surveyed before 1979. The species has disappeared from at least one site since 2000: on the Sandsmere - Bleakhouse Road where severe fungal gall was evident (DSE, 2004). Two sub-populations were planted: one at Diapur Reserve in 1977, where it was once believed to occur (Stuwe, 1980) and one in Lonsdale Forest Block near Stawell.

2.2. Habitat Critical to the Survival of the Species

Given that this species is nationally endangered it is considered that all known habitat is critical to its survival. Actions that should be undertaken include surveying for new sub-populations that could lead to the identification of additional habitat critical to this species.

Acacia enterocarpa occurs in many different habitats from red gum and SA blue gum woodlands to mallee and broombush, and is often found on fertile soils. However some habitat types appear to be preferred by this species.

In South Australia *Acacia enterocarpa* is recorded from a variety of habitats. On Yorke Peninsula it is recorded in a variety of mallee woodlands including *Eucalyptus gracilis* (yorrell), *E. conglobata* (cong mallee), *E. incrassata* (ridge-fruit mallee) or *E. socialis* (red mallee), over a shrub layer of *Melaleuca uncinata* (broombush) and an understorey of herbs and grasses (Steed pers. comm. 2004; DEH 2004) (Appendix II). Green (1993) recorded that the overstorey of mallee was generally sparse and in places it had been totally cleared leaving an exposed understorey. In the South East it is recorded from remnant woodlands of *E. leucoxylon* (SA blue gum), *E. camaldulensis* (red gum) or *E. fasciculosa* (pink gum) on sandy loam soils. On Eyre Peninsula it is also recorded in a variety of mallee associations, including *E. calycogona* (square-fruit mallee), *E. dumosa* (white mallee) *E. gracilis, E. incrassata, E. peninsularis* (Cummins mallee) and *E. socialis*, typically over *M. uncinata* and *M. lanceolata* (dryland tea-tree) (Freebairn & Pobke, 2007). It has been noted to occur on Eyre Peninsula primarily on mottled-yellow duplex soils interspersed with red duplex and red friable loams in the south and on red calcareous, hard pedal red duplex soils and dense brown loams in the north (Freebairn & Pobke, 2007).

In Victoria it has a limited geographic range, but it grows in a range of habitats from *Melaleuca uncinata* on the highest parts of the northern Lawloit Range on gravely duplex ironstone soils, to mallee scrub and grassy woodlands of *Eucalyptus leucoxylon*, *E. microcarpa* (grey box) and *Allocasuarina luehmannii* (buloke) on more fertile soils in adjacent areas (Stuwe 1980; DSE 2004).

Part 3. Threats and Impediments to Recovery

3.1 Biology and Ecology Relevant to Threatening Processes

Reproductive Biology

Little information is available concerning the reproductive biology of *Acacia enterocarpa*. The species is a perennial shrub. No information is available on its longevity or minimum reproductive age. There is also no information available concerning the reproductive biology of the closely related species *A. hexaneura*, *A. nyssophylla* and *A. colletioides*. Whibley (1980) notes that *A. enterocarpa* flowers between May and October (winter – spring). However, Green (1993) suggests that these ranges may be conservative as they were based on flowering specimens from the herbarium collection, and no specimens were ever collected between February and May.

Cheal (1992) noted that its principle vegetation associations were rarely subjected to fire. He implied that it must have alternative agents of regeneration; however it is not known what these are. Green (1993) suggests that ants could possibly transport seeds and feed on their fleshy arils, helping to break their dormancy.

Gall fungus

A gall rust fungus has been recorded as attacking *Acacia enterocarpa* plants in Victoria and the South East of South Australia. In severe attacks the whole canopy can be covered with these galls, which appear to weaken the plant, reduce leaf canopy, inhibit seed production and even kill the tree (Tonkinson, pers comm. 2004). Fungal samples collected from Victorian specimens of *Acacia enterocarpa* in 1996 were identified as the Australian native gall rust fungus *Uromycladium spp.* (Keane, pers. comm. 2004). It has not been determined if this is the same species that occurs on *A. enterocarpa* in the South East.

Studies have not been undertaken into the effect of this fungal species on *Acacia enterocarpa* and the information that follows is what is understood about the impact of the gall rust on hosts. Rusts of the *Uromycladium* genus produce galls that appear as large, brown, irregularly shaped swellings on the actively growing branches, phyllodes or flower buds of the host tree, generally during spring (Keane, pers. comm. 2004). Witches' brooms (abnormally bushy shoots) may also be produced (ARC, 2004). Heavily infected host plants may bear several hundred or even thousands of galls and witches' brooms that drain away the nutrients that would have gone into normal growth and reproduction (ARC 2004). As a result, very few phyllodes, flowers and pods are produced; shoot tips die back and branches often break when weakened by the galls (ARC 2004). Severely affected plants are killed (ARC 2004). Insects will enter the gall, generally when the gall rust has run its course (Keane, pers. comm. 2004).

There is no known natural or other control of this gall fungus other than removal of the galls. It has been suggested that burning may provide a means of managing infestations by removing the reservoir of fungal galls (Tonkinson, pers. comm. 2004).

3.2 Identification of Threats

Acacia enterocarpa is threatened at most sites at which it occurs. Threats to sub-populations include poor recruitment, senescence of plants and disease by fungal gall infestation, although gall has not been recorded on the Yorke and Eyre Peninsulas. The other main threats include road and rail maintenance activities, competition by environmental weeds, and inappropriate disturbance regimes, causing reduced sub-population sizes and an increased likelihood of extinction.

Eight threats have been identified and these are detailed below (Table 2). Each threat is addressed individually under the Actions, Section 4.3.

Table 2 Potential Threats to the Recovery of *Acacia enterocarpa*

	Potential Threats
1.	Poor recruitment
2.	Small population size
3.	Disease by fungal gall
4.	Road and rail management activities
5.	Environmental weeds
6.	Herbivore grazing
7.	Disease (e.g. *Phytophthora* and Mundulla Yellows)
8.	Inappropriate disturbance regimes
9.	Mining

3.2.1 Poor recruitment

Many *Acacia enterocarpa* sub-populations in South Australia and Victoria are reported to exhibit poor recruitment (DSE 2004; DEH 2004). However, there have been no studies undertaken to determine recruitment rates at any sub-populations and this needs to be a priority action within this recovery plan. Anecdotal information collated from monitoring and opportunistic site surveys indicates that in Victoria, over half the surveyed sites (68%) have poor recruitment levels (DSE 2004). All surveyed sub-populations on Eyre Peninsula were reported to display poor seed set and no recruitment was evident (Freebairn & Pobke 2007). However the means of determining seed set and recruitment is not qualified. Sub-populations of *A. enterocarpa* on Yorke Peninsula have been reported to contain healthy plants but very few seeds and seedlings have been observed (DEH 2004; Green, 1993; Steed, pers. comm. 2004). The *A. enterocarpa* seed from at least two sites in the South East was reported to be viable, based on successful seedling propagation, but there has been no natural recruitment observed at most sites for at least 20 years; however again this has not been investigated formally (Johnson, pers. comm. 2004). Poor recruitment may be related to a range of other threats including inappropriate disturbance regimes, fungal gall infection, weed invasion, grazing of seedlings and/or poor genetic viability.

3.2.2 Small population size

Acacia enterocarpa is suspected to have occurred more widely than its current known distribution. As a result of fragmentation and clearance of its habitat in the past, it is now found in mostly small and often disjunct sub-populations. Small and isolated sub-populations may experience threats including being susceptible to extinction by a single catastrophic event and having a high edge to area ratio and are therefore more likely to be subject to impacts along their edges (i.e. weed invasion, small-scale clearing, grazing, and exposure to fertiliser drift). The isolated and scattered nature of sites in conjunction with small sub-population sizes may also result in a lack of genetic variability in some sub-populations, exhibited by low recruitment.

3.2.3 Disease by fungal gall

Gall infestation represents a serious potential threat to sub-populations, with 11 of 19 Victorian sites and at least five of the nine South Eastern SA sites reported to be infested with a gall-producing fungal rust of the *Uromycladium* genus (Keane, pers. comm. 2004). These rusts affect their host by stressing the plant and prevent optimal seed set by reducing vigour and health (McAlpine 1906). Poor health following gall infestation may also leave plants open to insect attack or other secondary infections. Gall infection also has other implications including reducing available seed for collection and limiting the ability to undertake revegetation. Gall infection was reported to be a major limiting factor in revegetation of the Diapur Flora Reserve in the 1970's (Overman & Venn 1999); however the small plantation in Lonsdale Forest is reportedly healthy and free of galls (Rudolph, pers. comm., 2008).

3.2.4 Road and rail maintenance activities

Sites that occur on roadside and rail reserves are generally small and isolated, contain a small number of individual plants and occupy narrow remnant vegetation. Threats experienced by such small isolated sub-populations are outlined in Section 3.2.2. Road and rail sub-populations are also subject to specific threats related to management works and location including vegetation clearance, dumping of rubbish and road building materials, burning for fire management, installation of services (i.e. power lines and cables), herbicide drift from adjoining land, stock droving and damage from vehicles or heavy machinery. Roadside reserves are also potentially threatened by the work of contractors maintaining power, water and telecommunication services along easements. Moreover large edge/area ratios of road reserves increase their susceptibility to weed invasion and nutrient input from adjacent agricultural land (Hobbs, 1991). Roadside sub-populations of this species are important, as they constitute over 60% of known sites.

3.2.5 Environmental weeds

The presence of environmental weeds poses a threat to the recovery of *Acacia enterocarpa*, however the extent and impact of weeds on this species has not been fully determined. Weeds have the potential to directly impact on the growth, recruitment and survival of *A. enterocarpa* by smothering existing plants and preventing regeneration of seedlings. Sub-populations that are within small fragmented areas including those on roadside reserves are potentially at greatest risk. Certain management practices may also increase the risk of introducing and proliferating weeds, such as fire and other disturbance methods. The major weeds reported to occur at *A. enterocarpa* sites include *Asparagus asparagoides* (bridal creeper), *Marrubium vulgare* (horehound) and the introduced grasses *Phalaris aquatica* (phalaris), and *Ehrharta calycina* (perennial veldt grass) (DEH 2004; DSE 2004; Johnson, pers comm. 2004; Steed, pers comm. 2004). The impact of these weed species on the different life stages of *Acacia enterocarpa* has not been investigated.

3.2.6 Herbivore grazing

The available information indicates that grazing by domestic stock and introduced herbivores, rabbits and hares pose a potential, although probably minor, threat to the recovery *of Acacia enterocarpa*. However, the extent of this threat has not been fully determined, although grazing impacts have been noted for several sites across the species range (DEH 2004: DSE 2004). Green (1993) suggests that individual plants are likely to survive in grazed remnants of vegetation once seedlings have become established, due to the prickly nature of the phyllodes. However, surveys by Green found no plants smaller than 30cm high (Green 1993). Observations of land adjoining *A. enterocarpa* roadside sites showed no regeneration to occur when cropping or grazing was present, suggesting that these activities do not assist regeneration (Overman & Venn 1999). Sites that occur on roadside reserves may be further impacted on by stock droving in drought years.

3.2.7 *Phytophthora* and Mundulla Yellows

Acacia enterocarpa occurs where *Phytophthora* species have the potential to occur, based on annual rainfall. In addition, the main sub-population of *A. enterocarpa* in the South East is known to occur within 20 km of Mundulla Yellows sites (Johnson, pers. comm. 2004). The potential impact of *Phytophthora* and Mundulla Yellows on this species is not known, however both are known to affect *Acacias*. *Phytophthora* species are water borne moulds that attack the roots of susceptible plants, cutting off water supply and eventually killing the host plant. *Phytophthora cinnamomi* is the most common species recorded in South Australia and has a large host range, including *Acacia* species. Mundulla Yellows is observed as a yellowing of the leaves and results eventually in plant death. It is considered to be the result of an imbalance in soil chemistry (Czerniakowski *et al* 2006).

3.2.8 Inappropriate disturbance regimes

Species of the genus *Acacia* are generally known as early colonisers, following disturbances such as fire and some *Acacias* show dependence on a disturbance event to stimulate plant reproduction and recruitment. The disturbance requirements of *Acacia enterocarpa* have not been determined, however the low recruitment noted from several sites across the range of the species suggests that disturbance regimes may be inappropriate (DEH 2004; DSE 2004). The regeneration of *A. enterocarpa* has been noted on disturbed, as well as undisturbed sites in Victoria (Overman & Venn 1999; Stuwe 1980). Little is known about the effects of specific disturbance methods, such as fire, on the species.

3.2.9 Mining

The extent of this threat has not been fully determined, however at least one site where *Acacia enterocarpa* occurs, on private land in Victoria, has been historically worked to remove gravel. Overman and Venn (1999) state that if this activity continues it could seriously affect the *A. enterocarpa* sub-population at this site. Mining therefore poses a potential threat through the possible direct removal of plants to access quarry materials and the indirect impacts of mining activities.

3.3 Areas under Threat

Acacia enterocarpa plants are threatened at most sites. Threats to specific areas are detailed below and some information regarding threats to sub-populations is also contained in Section 3.2, 'Potential of Threats'.

South Australia

Yorke Peninsula

The majority of *Acacia enterocarpa* plants on Yorke Peninsula are reported to be healthy with only a few plants in each sub-population showing signs of moderate dieback (DEH 2004). Significantly, there is no fungal gall recorded on Yorke Peninsula. A major threat to sub-populations may be a general lack of recruitment at most sites. Observations over a seven-year period of plants on several roadsides on Yorke Peninsula resulted in no seed or regeneration being observed in the area (Pavy pers. comm. 2004). Stock and rabbit grazing in some areas is a potential threat and large numbers of rabbits and warrens have been recorded for several sites (DEH, 2004; Steed, pers. comm. 2004). Weeds also pose a potential threat to the Yorke Peninsula plants, including bridal creeper, *Avena fatua* (wild oats), perennial veldt grass, *Euphorbia terracinna* (false caper), *Echium plantagineum* (salvation Jane) and *Lycium ferocissimum* (African boxthorn) (DEH, 2004; Steed, pers. comm. 2004).

South East

Severe fungal gall infestations, low recruitment and senescence, roadside management works, weeds and rabbit grazing threaten *Acacia enterocarpa* in the South East (DEH 2004; Johnson, pers. comm. 2004). Records show that at least five of the locations in the South East are infested with fungal gall. Of the two sub-populations in Aberdour Conservation Park, the smaller site containing only 5 plants is reported to be healthy with no gall, while the other containing 117 plants has 95% of plants affected by gall (Davies 1995). Many plants are also reported to be senescing, including plants in the large sub-population at Aberdour Conservation Park (Davies 1995).

The majority of *Acacia enterocarpa* sites in the South East occur on roadsides. To protect sub-populations from inappropriate road works, fencing and signage have been erected at two locations (108 Road and Carew / Desert Camp Road) (Steed, pers comm. 2004). Other roadside sub-populations remain at risk from potential inappropriate road management works. Weeds, including bridal creeper and phalaris, also pose a threat to plants at most sites (Steed, pers. comm. 2004; Davies 1995; Johnson, pers. comm. 2004). In addition, rabbit grazing is reported to be a major threat at one site (Steed, pers. comm. 2004).

Eyre Peninsula

A full threat assessment of *Acacia enterocarpa* on Eyre Peninsula has not been undertaken. Sites that have been visited are reported to display poor seed set and no recruitment (Freebairn & Pobke 2007). Freebairn and Pobke (2007) do not report the presence of fungal gall on *A. enterocarpa* on Eyre Peninsula. The majority of sub-populations are small and isolated, occurring in highly fragmented vegetation on road and rail reserves (Freebairn & Pobke 2007). These sub-populations may therefore be subject to inappropriate roadside and rail management works. Significant weed competition also threatens many of these sub-populations, and on private property, grazing by livestock has reduced habitat quality (Freebairn & Pobke 2007).

Victoria

Wimmera

Poor recruitment and disease by gall are the two major threats to *Acacia enterocarpa* in Victoria (DSE 2004). Fourteen of the 19 monitored sites in Victoria are reported to have poor recruitment and 11 sites are affected by gall (DSE 2004). Fifteen sites occur on roadsides or rail reserves and are

potentially threatened by roadside and rail management works (DSE 2004). Fire prevention works along roadsides also threaten most sub-populations (DSE 2004). Weeds, including bridal creeper and horehound, also pose a threat to plants as may the slender dodder Laurel (*Cassytha glabella*) and the small leafed clematis (*Clematis microphylla*) (Overman & Venn 1999). Additional threats noted for these sites include small population size, inappropriate burning regimes and grazing by stock, especially in drought years when droving along roadsides is prevalent (DSE 2004; Overman & Venn 1999).

Part 4. Objectives, Recovery Actions and Performance Criteria

4.1 Previous Recovery Actions

Acacia enterocarpa has been the subject of various recovery activities across its range. An Action Statement has been developed under the Flora and Fauna Guarantee Act for the species in the Wimmera, Victoria. The species is part of a multi-flora Recovery Plan on the Eyre Peninsula and an Action Plan for threatened plants in the South East of South Australia has also been drafted. These and other recovery actions that have been undertaken previously for this species are outlined below.

Eyre Peninsula

- *Draft Recovery Plan for 23 Plant Taxa on Eyre Peninsula* includes *Acacia enterocarpa* (Freebairn & Pobke, 2007).
- Threatened Flora Officer appointed to Eyre Peninsula to undertake recovery of nationally threatened flora including *A. enterocarpa* (2002).
- Known sub-populations of *A. enterocarpa* surveyed during production of the multi-species recovery plan (2002-03).
- Workshop held by Threatened Plant Action Group (TPAG) at Port Neil to encourage community involvement in recovery actions of *A. enterocarpa* (2002).

Yorke Peninsula

- Funding received through Threatened Species Network Community Grants to undertake *A. enterocarpa* management, including weed management and surveying (1999).
- Survey of roadsides and private property on Yorke Peninsula undertaken by Doug Bickerton (TPAG) to map *A. enterocarpa* (2002).
- Fencing and weed control undertaken at one site (1999).

South East

- Action Plan developed for *A. enterocarpa* (2004).
- Threatened Flora Officer (TFO) appointed to the South East to undertake recovery of nationally threatened flora (2004).
- TFO has been undertaking a bridal creeper management program at Aberdour Conservation Park using chemical methods and biological control agent (2004).
- Funding secured from Department for Transport, Energy and Infrastructure (DTEI) and the South East NRM Board (SENRM) to continue weed management at three sites along the Bordertown-Desert Camp Road (Carew, 108 and Desert Camp Roads, see below) (2004).
- TPAG has undertaken work on roadside sub-populations over a three-year period, including Desert Camp, Sugarloaf, Carew, and 108 Roads. Activities have included fencing, signage, weed control, rabbit control and mapping (2000-03).
- Translocation of seedlings propagated by Andrew Pritchard (DSE) undertaken at Aberdour CP, Sugarloaf Rd and the Corner of Carew Rd and Desert Camp Road.
- Survey of distribution, abundance and health of plants in Aberdour Conservation Park (1995).
- Two new sub-populations discovered on private property (2007).

Victoria

- Action Statement under Flora and Fauna Guarantee Act (1988) developed for *A. enterocarpa* (1999).
- Nineteen of the 43 sub-populations surveyed in 1979 and 2000. Factors recorded include abundance, health, presence and extent of threats (1979 and 2000).
- Signage erected at four rail reserve sites (1990).
- Detailed maps of roadside sites provided to local shires (1999).
- Several small surveys conducted between 1990 and 1996 to locate species.
- Introduction by Hindmarsh Shire Council of a schedule to their Vegetation Protection Overlay, aimed specifically to protect *A. enterocarpa* plants on roadsides. (Rudolph, pers. comm., 2008) The overlay requires a planning permit for destruction or removal of *A. enterocarpa* or its habitat, and overrides the usual vegetation removal exemptions.
- Revegetation using *A. enterocarpa* at Lonsdale State Forest (1976).

4.2 Objectives

Long-term Objective:
The overall objective of this Recovery Plan is to reduce the extinction risk of *Acacia enterocarpa* so that it is downlisted from an IUCN category of Endangered to one of Vulnerable (IUCN, 2001).

Short-term Objectives:
1. Maintain or increase the number of sub-populations, area of occupancy and abundance of *Acacia enterocarpa*.

2. Manage the sub-populations to ensure sufficient recruitment is occurring, by investigating into each step of the recruitment process.

3. Mitigate threats caused by gall infestations, road management activities and weed invasion.

4. Minimise the loss of genetic viability of the species.

4.3 Actions Required

Recovery Plans and Action Statements have been developed for *Acacia enterocarpa* at regional and state levels. An Action Statement has been developed for the species in Victoria (Overman & Venn 1999), under the Flora and Fauna Guarantee Act (1988). The species is part of a multi-species recovery plan that covers threatened flora on Eyre Peninsula (Freebairn & Pobke 2007) and an Action Plan has been developed for the species in the South East of South Australia (Johnson 2005). These plans provide some detail of actions required at specific sub-populations and sites. The only region that does not have a recovery plan for this species is the Yorke Peninsula.

This National Recovery Plan for *Acacia enterocarpa* provides broad statements of actions that are required across the species range. It also provides detailed recommendations for key actions requiring national delivery including evaluating recruitment, investigating fungal gall impacts and seed collection and storage. Other actions including surveying existing sites and undertaking threat abatement activities are outlined in this plan, however for detailed prescriptions, locations and priority sites for action, the relevant regional plans (Overman & Venn 1999, Johnson 2005, Freebairn & Pobke 2007) should also be referred to.

The timelines for implementation of recovery actions have been summarised below and detailed timelines are contained in Section 6.2:

P1	Action required immediately, in first year.
P2 - P3	Action required in short term, years two to three.
P4 – P5	Action required in longer term, years four to five.

1. Survey existing sub-populations.

1.1 Survey existing sub-populations recording details of location, number of plants, life history structure, area inhabited, habitat type, % survival, % gall infected and possible *Phytophthora* or Mundulla Yellows damage,. (P2)
1.2 Assess major threats to each sub-population. (P2)
1.3 Enter data onto the SA Threatened Plant Population Database and the Victorian Threatened Species Database. (P3)

Justification and Methods:
Quantitative data needs to be obtained covering the exact location, number of plants, relative age structure, recruitment, area of occupancy, plant health and description of habitat, including plant association and topography to allow for effective recovery. Surveys to determine the presence and extent of threats at each site will also need to be undertaken, including weed infestation, grazing impacts and disease. Surveys should record the type of threat present and measure extent of the threat by using indicators including the number of seedlings, seedling survival, age structure and plant health. Surveys should be undertaken during spring and autumn, if possible, to identify seasonal

threats, such as weeds. The surveys should include consideration of any potentially new threatening processes. Surveys will need to be undertaken at sites that have not been visited since 1995 to ensure information is current, as well as sites visited since 1995. All data will need to be accurately mapped and information reported back to the centralised state threatened species databases.

Responsibility: RT, TFOs.

2. Identify priority sites to conserve by evaluating information gained in Action 1.

2.1 Assess the information obtained in action one to determine which priority sites to conserve and manage. (P2)

Justification and Methods:
Based on the information gathered in surveys to determine distribution, abundance and threats to each sub-population, priority sites for action should be determined. The list of priority sites will need to be prioritised for recovery actions based on the number of plants at the site, area of occupancy, quality of habitat, health of plants, presence of threats and regional importance.

Responsibility: RT, TFOs.

3. Ensure protection of priority sites.

3.1 Negotiate Heritage Agreements or binding conservation covenants if appropriate. (P3)
3.2 Negotiate site protection with appropriate stakeholders including landowners, local councils, DTEI etc. (P2)
3.3 Undertake the initial reduction of risk at priority sites. (P3)
3.4 Work with Local Government to ensure that development approvals have no impact on the species. (P3)
3.5 Monitor and evaluate to ensure risk reduction is having the desired effect. (P3)

Justification and Methods:
Priority sites to be targeted for protection will be identified based on current information and the results of surveys. Long-term formal protection and management of priority sites will be pursued with landholders. Options for formal protection will include Heritage Agreements or conservation covenants that are binding on present and subsequent landowners. Advice and assistance will be provided to landholders for management of priority sites. The initial reduction of threats to the species at priority sites will be undertaken. For example if grazing is determined as the primary threat then the site may be fenced, if weeds are the major threat then weed management will be undertaken, if gall is the major threat then the results of Action 7.3 will be implemented. In addition the Recovery Team and Threatened Flora Officers will work with and provide information to Local Government, to prevent new developments negatively affecting the species. They will also work with current land managers to ensure that management and land uses do not cause a significant impact on the species. Mitigation actions will be monitored and evaluated during the recovery implementation, to ensure that a reduction in the level of risk is occurring.

Responsibility: RT, TFOs, land owners/managers.

4. Manage priority sub-populations on road reserves

4.1 Based on Action 2, identify priority sites on roadsides. (P2)
4.2 Work with appropriate Councils to ensure that *Acacia enterocarpa* is included in Council Roadside Management Plans. (P2)
4.3 Implement the Roadside Marker System (SA) and erect signage identifying priority sites (Vic) within relevant district Councils. (P3)

Justification and Methods:
The long-term conservation of plants on roadside reserves depends on sustainable management practices being undertaken by land managers. Threatened Flora Officers will work closely with Local Councils to inform them of the species identification, site location and management requirements and to assist with management practices. The inclusion of management requirements in Council

Roadside Management Plans will be encouraged and Management Agreements should be developed with the relevant Councils. Roadside sites will be marked using the recognised Roadside Marker System or with signage identifying the presence of significant flora.

Responsibility: RT, TFOs, Local Government.

5. Collect seeds for the Millennium seed bank project.

5.1 Collect samples of seed from a sample of sub-populations. (P1)
5.2 Run seed viability tests on a sub-sample of these seeds in order to estimate what percentage of the seeds are viable. (P1)
5.3 Consult with the Seed Conservation Unit (DEH) and Melbourne Herbarium to negotiate seed storage. (P1)
5.4 Place the remaining seeds in storage. (P1)

Justification and Methods:
It is necessary to store germplasm as a genetic resource ready for use in translocation and as an ex situ genetic 'blueprint' of the species. A sample of seed should be collected from a sample of sub-populations across the species range to provide an adequate representation of the genetic diversity of the species. Seed should also be collected as a priority from small sub-populations to ensure a future supply of *ex situ* seed.

Responsibility: RT, TFOs, State seed banks and herbaria.

6. Evaluate the extent of recruitment occurring at each site, and investigate the cause of any limit to recruitment observed.

6.1 Evaluate survey data to determine whether there is a lack of recruitment in each sub-population. (P2)
6.2 In a sample of the sub-populations where recruitment is found to be limiting, conduct field surveys to identify which step or steps is limiting recruitment (Pollination, seed set, germination or establishment). (P3)
6.3 Conduct field/glasshouse experiments to determine why this step is limiting and how to overcome it. (P4)
6.4 If recruitment is found to be limiting and the studies from Action 6.3 indicate that it would be improved by fire, investigate the potential use of fire at some sites. (P5)
6.5 If recruitment is found to be limiting, re-assess the number of seeds placed in storage, ensuring that sufficient seeds are left for recruitment in the wild. (P2)

Justification and Methods:
It is suspected that the species experiences low recruitment at the majority of sites across the distribution of the species. There is however no formal evidence to support this suspicion. Detailed research is therefore required to determine if recruitment is limiting and the possible cause. If necessary, research methods will need to be developed for field and laboratory experiments to determine why recruitment is limiting. Results will be used to adaptively manage the population in the wild.

Responsibility: RT, TFOs, DEH, DSE.

7. Manage sub-populations to ensure sufficient recruitment.

7.1 Evaluate the information gained from Action 6 to hypothesize the best methods of ensuring sufficient recruitment within each site. (P3)
7.2 Manage each sub-population to ensure sufficient recruitment based on the hypotheses derived for each sub-population in Action 7.1. (P3)
7.3 Monitor and evaluate whether these actions are having the desired effect, changing hypotheses and management techniques if necessary. (P4)

Justification and Methods:
See Action 6.

Responsibility: RT, TFOs, DEH, DSE.

8. Investigate the threat of gall to the species.

8.1 Evaluate the data collected under Action 1 to determine to what extent the fungal gall has infested each of the sub-populations. (P3)
8.2 Have the fungal gall formally identified. (P4)
8.3 Investigate methods of controlling this species of gall. (P4)
8.4 Monitor gall infestations and mortality within natural sub-populations. (P3 - P5)

Justification and Methods:
If gall is identified as a threat to *Acacia enterocarpa* a number of research activities are required in order for it to be adequately managed. Knowledge of the impact of the fungal gall on plant health, seed set and reproduction are required. One method of investigating this is to experimentally remove gall from sites and monitor the results, in conjunction with monitoring sites with various levels of infection. The fungal gall should be formally identified using experts in the field of fungal research. Field and laboratory experiments should be conducted to investigate ways of controlling the gall in the wild.

Responsibility: RT, TFOs, DEH, DSE

9. Investigate the threat of Phytophthora and Mundulla Yellows to the species.

9.1 Evaluate the data collected under Action 1 to determine whether *Phytophthora* or Mundulla Yellows are possibly damaging plants at any site. (P3)
9.2 Conduct tests to determine the presence of *Phytophthora* at suspected sites. (P4)
9.3 Investigate methods for controlling *Phytophthora* or Mundulla Yellows if necessary. (P4)
9.4 Monitor infestations and mortality within sub-populations. (P3 - P5)

Justification and Methods:
If *Phytophthora* or Mundulla Yellows are identified as a threat to *Acacia enterocarpa* a number of research activities will be required before adequate management can be undertaken. Knowledge is required of the impact of these diseases on the health, seed set and reproduction of *Acacia enterocarpa*. Hygiene principles will need to be implemented at confirmed *Phytophthora* infestation sites. Field and laboratory experiments should be conducted to investigate ways of controlling Mundulla Yellows in the wild.

Responsibility: RT, TFOs, DEH, DSE

10. Survey for potential habitat and undiscovered sub-populations.

10.1 Survey possible habitat for undiscovered sub-populations and map potential sites for revegetation and translocation projects. (P3)

Justification and Methods:
Possible habitat of *Acacia enterocarpa* will be identified by interrogating GIS mapping and identifying preferred vegetation associations, soil type, topography and rainfall. Maps of potential habitat will be developed based on this work and used to undertake dedicated surveys to search for new sub-populations and potential revegetation sites.

Responsibility: RT, TFOs, DEH, DSE.

11. Undertake strategic revegetation and translocation.

11.1 Using results of Action 10.1, identify strategic revegetation and translocation sites. (P3)

11.2 Work with landholders adjoining priority roadside sites to undertake revegetation to buffer sites. (P4)

Justification and Methods:

Translocation into new sites will aim to increase the number of established sub-populations and establish sub-populations in secure areas. Areas should be sought that are protected, secure and free from gall infection. Translocation and revegetation activities should also aim to increase the size of roadside sites, thus reducing edge effects and buffering areas from impacts. Consultation should be undertaken with owners of land adjoining roadside sites, in order to determine actions to assist increasing the size, or buffering, of priority roadside sites.

Responsibility: RT, TFOs, land owners / managers, local councils.

4.4 Evaluation of Success or Failure

The Department for Environment and Heritage, South Australia in conjunction with the Recovery Team will evaluate the performance of this recovery plan. The plan is to be reviewed within five years of its implementation. Any changes to management and recovery actions will be documented accordingly.

4.5 Performance Criteria

Action	Associated Performance Criteria
1.1. Survey existing sub-populations.	Existing known sites surveyed and baseline information collated for all known sites by the end of the second year.
1.2. Assess major threats to each sub-population.	Existing known sites surveyed to determine threats and potential threats by the end of the second year.
1.3 Enter data into State databases.	Information collected from surveys and monitoring entered into the SA Plant Population Database and the Victorian Threatened Species Database by the end of the third year.
2.1. Determine the priority sites to conserve and manage.	Priority sites for formal protection identified by the end of the second year.
3.1. Negotiate Heritage Agreements or binding conservation covenants if appropriate.	Negotiations for formal protection of all priority sites commenced by the end of the third year.
3.2. Negotiate site protection with appropriate stakeholders	Liaison with stakeholders for management of priority sites by the end of the second year.
3.3. Undertake the initial reduction of risk at priority sites.	Threat mitigation implementation initiated for priority sites by the end of the third year.
3.4. Work with Local Government to ensure that development approvals do not impact on the species.	Development approvals not impacting on species by the end of the third year.
3.5. Monitor and evaluate to ensure risk reduction is having the desired effect.	Risk reduction monitoring underway by the end of the third year.
4.1. Identify priority sites on roadsides.	Priority roadsides identified by the end of the second year.
4.2. Work with appropriate Councils to ensure that the species is included in Council Roadside Management Plans.	Species incorporated into Council Roadside Management Plans by the end of the second year.
4.3. Implement the Roadside Marker System (SA) and erect signage identifying priority sites (Vic) within relevant district Councils.	Roadside Marker System and signage implemented by the end of the third year.
5.1. Collect samples of seed from a sample of sub-populations.	Seed collected from a sample of sub-populations by the end of the first year.
5.2. Run seed viability tests	Seed viability test completed by the end of the first year.
5.3 & 5.4. Place the remaining seeds in storage	Seed stored in Seed Conservation Centres by the end of the first year.
6.1. Evaluate survey data to determine whether there is a lack of recruitment in each sub-population.	Each sub-population investigated to determine if recruitment is a limiting factor by the end of the second year.
6.2. Conduct field surveys to identify which step or steps are limiting recruitment.	The steps limiting recruitment identified in the field by the end of the third year.
6.3. Conduct field/glasshouse experiments to determine why this step is limiting and how to overcome it.	Experiments determined why the step is limiting and how to overcome this by the end of the fourth year.

Action	Associated Performance Criteria
6.4. Investigate the potential use of fire at some sites, if necessary.	The use of fire investigated as a method for increasing recruitment by the end of the fifth year.
6.5. Re-assess the number of seeds placed in storage, ensuring that sufficient seeds are left for recruitment in the wild.	The number of seeds placed in storage reflecting the level of recruitment in the field factor by the end of the second year.
7.1. Hypothesize the best methods of ensuring sufficient recruitment within each site.	Hypotheses developed for managing recruitment at each site by the end of the third year.
7.2. Manage each sub-population to ensure sufficient recruitment based on the hypotheses.	Using hypotheses, each priority sub-population being managed to ensure sufficient recruitment by the end of the third year.
7.3. Monitor and evaluate whether these actions are having the desired effect, changing hypotheses and management techniques if necessary.	Adaptive management being implemented as a result of monitoring and evaluation being undertaken by the end of the fourth year.
8.1. Evaluate the survey data collected to determine to what extent the fungal gall has infected each of the sub-populations.	The extent and impact of fungal gall determined for each sub-population by the end of the third year.
8.2. Formally identify the fungal gall.	Fungal gall formally identified by the end of the fourth year.
8.3. Investigate methods to control this species of gall.	Methods of controlling fungal gall determined by the end of the fifth year.
8.4. Monitor gall infestations within natural sub-populations.	Natural sub-populations monitored for the effects of gall infestations, commencing in year three.
9.1 Evaluate the data collected under Action 1 to determine whether *Phytophthora* or Mundulla Yellows are possibly damaging plants at any site.	Population data evaluated for possible *Phytophthora* or Mundulla Yellows damage by the end of the third year.
9.2 Conduct tests to determine the presence of *Phytophthora* at suspected sites.	Tests conducted to determine the presence of *Phytophthora* at suspected sites by the end of the fourth year.
9.3 Investigate methods for controlling *Phytophthora* or Mundulla Yellows if necessary.	Control methods for *Phytophthora* or Mundulla Yellows investigated by the end of the fourth year.
9.4 Monitor infestations and mortality within sub-populations.	Annual monitoring of suspected *Phytophthora* or Mundulla Yellows sites commenced by the third year.
10.1. Survey possible habitat for undiscovered sub-populations and map potential sites for translocation and revegetation projects.	Strategic surveys undertaken to search for new sub-populations and translocation sites by the end of the third year.
11.1. Identify strategic translocation and revegetation sites.	Revegetation sites identified by the end of the third year.
11.2. Work with landholders adjoining priority roadside sites to undertake translocation and revegetation to buffer sites.	Strategic translocation, revegetation and regeneration undertaken by the end of the fourth year.

Part 5: Management Practices

Management practices undertaken in the vicinity of *Acacia enterocarpa* should be planned and implemented with careful consideration to ensure that this species and its habitat is not impacted upon. Management prescriptions within this recovery plan are designed to better manage the threatened species and its habitat *in situ*. Recovery actions are structured to (i) acquire baseline data, (ii) reduce risks (iii) manage habitat and threatening processes, (iv) undertake research to improve knowledge of ecology and biology, and (v) engage the community in recovery actions.

Risk reduction involves achieving legal protection of *in situ* sub-populations, providing information and assistance to Councils to better manage roadside reserve sites, closely monitoring sub-populations for early detection of risks and to monitor the success of management practices, and *ex situ* conservation measures to collect and store seed. Actions will be undertaken to encourage regeneration into sites to increase the size of existing sites, to translocate the species into new secure sites and to revegetate areas and.

The recovery plan outlines on-ground management actions that aim to mitigate threatening processes and manage habitat to reduce the potential for extinction. Major threats requiring management include change of land use and accidental destruction, competition from environmental weeds, fungal gall infestations, grazing by herbivores and inappropriate disturbance regimes. Strategies that may be employed to manage threats include signage of sites, implementation of appropriate hygiene practices, weed control, pest animal control, fencing, fire management and introducing appropriate disturbance regimes.

Research to increase the knowledge of the biology and ecology of the species and the impact of threatening processes upon its community are also advocated in this plan. Actions to be undertaken include field and laboratory experiments to investigate life history attributes and the impact and potential to manage fungal gall infestations.

The community will be engaged to assist in the implementation of on-ground works including monitoring sub-populations.

To reduce the likelihood of development activities with a negative impact upon *Acacia enterocarpa* the recovery plan recommends that relevant information be provided to Local and State Governments, including information on distribution, ecology and habitat. Local and State Governments have a key role in the approval of new developments and in preventing developments that may have the potential to impact on this species. Increased awareness of all relevant parties should allow for better decisions to be made to prevent negative impacts.

Part 6: Duration of Recovery Plan and Estimated Costs

Table 3 Duration and Indicative Costs

Action	Description	Cost estimates per year					
		First	Second	Third	Fourth	Fifth	Total
1.	Survey existing sub-populations	3000	2000	2000			7000
2.	Identify priority sites	4000					4000
3.	Ensure protection of priority sites	5000	7000	13000	18000	12000	55000
4.	Manage priority roadside sub-populations	1000	2000	1000	1000	2000	7000
5.	Collect seeds	3500	200	200	200	1000	5100
6.	Evaluate extent of recruitment and limitations		4000	4000	4000	4000	16000
7.	Manage sub-populations to ensure sufficient recruitment		3000	3000	3000	2000	11000
8.	Investigate threat of gall		3000	3000	3000	2000	11000
9.	Investigate threat of *Phytophthora* and Mundulla Yellows			3000	3000	2000	8000
10.	Survey for potential habitat and new sub-populations	2000	2000	1000	1000		6000
11.	Undertake strategic revegetation		1000	3000	3000	1000	8000
	Recovery Process and Communication	26000	28000	27000	26000	26000	133000
	Total	44500	52200	60200	62200	52000	271100

Threatened Flora Officer (TFO) is required for all actions, but costed separately.

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Appendices

Appendix I List of current and potential Regional, State and National stakeholders in the management of *Acacia enterocarpa.*

Regional Stakeholders	Group	Manage / own	Contacted?
Friends Groups and Volunteers	Friends of Upper South East (SA)		
	Friends of Sandsmere Flora Reserve (Vic)		
	Friends of Diapur Flora Reserve (Vic)		
	Field Naturalists Club of Victoria, Horsham (Vic)		
	West Wimmera Tree Group (Vic)		
	Diapur Lions Club (Vic)		
	Natural Resources Conservation League (Wail)		
General community	General community / Private landholders	X	
Local councils	District Council Yorke Peninsula	X	X
	Lower Eyre Peninsula	X	X
	District Council Tatiara	X	X
	Diapur-Kaniva Council	X	X
Natural Resource Management (NRM) Boards	South East Natural Resources Consultative Committee		X
	Northern and Yorke NRM Board		X
	Eyre Peninsula NRM Board		X
	Catchment Management Authority, Wimmera, Vic		
State Stakeholders			
Conservation Council of SA			
Country Fire Service			
Department for Environment and Heritage, SA			
- Science and Conservation Directorate	Doug Bickerton, Rob Brandle, Peter Copley, Manfred Jusaitis, Peter Lang, Nick Neagle, Rosemary Taplin		X
- Coastal Protection Board			
- Regional Conservation	Randall Johnson (South East)	X	X
	Mid-North		X
	Eyre Peninsula		X
Department for Water, Land and Biodiversity Conservation, SA			X
- Native Vegetation Council	Craig Whisson		X
Department of Sustainability and Environment, Horsham, Vic	Glenn Rudolph	X	X
-	Horsham (Vic)	X	X
Department of Transport, Energy and Infrastructure, SA	Tim Reynolds		X
General Public			
Greening Australia	Todd Berkinshaw (Adelaide)		X
	Mid-North (Anne Brown)		X
	Greening the Wimmera (Dale Tonkinson)	X	X
Indigenous community			
Parks Victoria Flora and Fauna Unit			
Primary Industries and Resources SA	PIRSA revegetation SE		X
	PIRSA revegetation EP (Simon Bey)		X
SA Water			
Scientific Advisory committee			
Threatened Plant Action Group	Tim Jury		X
Trees for Life	Andrew Allanson		X
Vic Roads			

National Stakeholders	Contact	Manage / own	Contacted?
Australian Network for Plant Conservation			
CSIRO			
Department of Environment and Water Resources (DEWR)			
General public			
World Wide Fund For Nature - Threatened Species Network			

Appendix II Plant associations in which *Acacia enterocarpa* has been recorded in Australia

Region	Sub-population	Structure	Dominant species	Understorey species
SE	Carew Rd	Woodland	red gum	
	108 Rd	woodland	blue gum	
	Aberdour A	low open woodland	*Eucalyptus fasciculosa, E diversifolia*	over *Acacia enterocarpa* and *A. rupicola*; over *Lepidosperma* sp.,+/- *Lasiopetalum baueri, Kunzea pomifera* (+/- *Hibbertia riparia*)
	Aberdour B	open scrub	*Eucalyptus diversifolia*	*Baekia behrii, Lasiopetalum baueri, Pomaderris obcordate, Calytrix tetragona, Hibbertia riparia*
YP	D. Way		*Eucalyptus gracilis, E. conglobata, Melaleuca lanceolata, Danthonia* spp*. (Gahnia* spp.*)*	
	Parsons	Mallee.	*Eucalyptus incrassata / E. socialis*	over *Melaleuca acuminata, M. uncinata, Lasiopetalum bauerii, L. behrii, Exocarpos aphyllus, Grevillea ilicifolia.* Low shrub layer comprises *Enchylaena tomentosa* and ground cover comprises *Lomandra* sp., *Triodia* sp., *Stipa* sp., and *Clematis microphylla*
	Pokinghorne	Mallee.	*Eucalyptus incrassata / E. socialis*	over *Melaleuca uncinata, M. lanceolata, Pittosporum phylliraeoides, Lasiopetalum behrii, Correa reflexa* and *Exocarpos aphyllus*. Low shrubs include *Enchylaena tomentosa and Grevillea ilicifolia. Ground cover comprises Triodia sp., Dianella* sp., *Lepidosperma* sp. and *Clematis microphylla*
	D. Short	Mallee	*Eucalyptus socialis / E. oleosa / E. porosa / E. incrassata*	over *Melaleuca acuminata, M. uncinata, Pittosporum phylliraeoides, Acacia ligulata, A. rigens, Grevillea ilicifolia, Lasiopetalum behrii, L. baueri, Exocarpos aphyllus, Chloretrum* sp., *Bursaria* sp., *Enchylaena tomentosa, Correa reflexa, Rhagodia parabolica, Olearia pannosa, Leucopogon clelandii, L. rufus, Lomandra* sp., *Dianella revoluta, Stipa* sp., *Danthonia* sp., *Lepidosperma* sp., *Clematis microphylla.*
Vic	Diapur A	Forest	mallee-broombush on the hill and *Eucalyptus leucoxylon*	a predominantly herbaceous understorey on the flat.
	Diapur B	Mallee scrub	*Eucalyptus viridis* and *E. viridis / odorata*	with a shrub understorey. Broombush dominates the understorey in some areas.
	Diapur Flora Reserve	Eucalyptus woodland	*Eucalyptus microcarpa / Allocasuarina luehmanii*	herbaceous(some areas *Stipa/Danthonia* dominated some mostly introduced species)
	Kaniva Broughton Rd	Mallee scrub	*Eucalyptus calycogona / E. dumosa*	with a shrub and herbaceous understorey
	Lawloit Sandsmere Rd	Open forest	*Eucalyptus largiflorens / Allocasuarina luehmanii*	Predominantly herbaceous understorey; some shrubs. More fertile, loamy soil than on Lawloit Range.
	Sandsmere Hall Rd	Woodland	*Eucalyptus macrocarpa / Allocasuarina luehmanii*	(now partially cleared) with a predominantly herbaceous understorey. *Danthonia* spp., *Stipa variabilis, *Bromus rubens, Lomandra effusa.* More fertile, loamy soils than on Lawloit Range near Diapur.

Sourced from Plant Population Database, DEH and Threatened Species Database, DSE.