Draft Recovery Plan for *Acanthocladium dockeri* (Spiny Daisy) 2007-2011

A. Clarke, M.A. Robertson & A. Pieck

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The opinions expressed in this document are the views of the authors' and do not necessarily reflect those of the Department for Environment and Heritage.

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A Recovery Plan prepared in accordance with the *Commonwealth Environment Protection and Biodiversity Conservation Act* 1999.

Cover Photo: *A. dockeri* planted at the Laura Parklands (A. Clarke, May 2005).

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Abbreviations

CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DEH	Department for Environment and Heritage, South Australia
DTEI	Department for Transport Energy and Infrastructure, South Australia
IUCN	International Union for the Conservation of Nature
TPAG	Threatened Plant Action Group
DEC	Department for Environment and Conservation, New South Wales

PART 1: Species Information and General Requirements

1.1 Species description

Acanthocladium is a monotypic genus of the Asteraceae (Compositae in Jessop & Toelken 1986). Its single representative, the Spiny Daisy, *Acanthocladium dockeri* (also known as spiny everlasting) is a low shrub to about half a metre in height with spindly branches that end in a '∠' shaped pair of spines. It is whitish grey in colour due to the fine, pale-grey 'felt' that covers the small oval-shaped leaves and the branches. The flowers are small and yellow, with grey felted bracts and lack the ring of showy 'ray' petals that is characteristic of many daisy species. *A. dockeri* has a well-developed, woody perennial root system that suckers readily. Further taxonomic description can be found in Jessop and Toelken (1986, pp. 1493-4) and Leigh *et al.* (1994, pp. 154-5).

Plate 1: *Acanthocladium dockeri* in flower (Photo: A. Everaardt)

1.2 Conservation status

A. dockeri has recently been transferred from listed as 'Presumed Extinct' to 'Critically Endangered' under the Commonwealth's *Environment Protection and Biodiversity Conservation Act* 1999; it is listed as "Endangered" under the SA *National Parks and Wildlife Act* 1972, and "Presumed Extinct" under the *NSW Threatened Species Conservation Act* 1995. The species is "Critically Endangered" by IUCN criteria CRB1 & CRB2, due to its limited area of occupancy (less than 10 km^2), severely fragmented subpopulations, its presence in vulnerable habitats and its inferred continuing decline (IUCN 2001). Genetic variation in naturally occurring subpopulations appears to be low, with research indicating that there is variation between, but not within, each of the extant sub-populations (Jusaitis & Adams 2002, Jusaitis & Adams 2005). Further genetic variation may become apparent, if currently unknown subpopulations are located in the future. The apparent low genetic variation and lack of successful sexual reproduction are threats to the species in the longer term. No seedlings have been observed in the field and seed production is extremely low. Trials have shown that seed set is erratic, probably as a result of pollen sterility (Jusaitis & Adams 2005).

All five known naturally occurring subpopulations are located in the Mid-North of South Australia, on roadside verges, surrounded by agricultural land. These

subpopulations are not covered by any formal conservation agreements and are all at risk from road maintenance and upgrading, cropping activities, weed competition and introduced snails. The expansion of the subpopulations by clonal means is also limited by the nature of the surrounding land uses (cropping, roads).

1.3 Objectives of the Environment Protection and Biodiversity Conservation Act 1999

Section 3(1) of the *Environment Protection and Biodiversity Conservation Act* 1999 states that the Act's objectives are:

a) To provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance;

b) To promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources;

c) To promote the conservation of biodiversity;

d) To promote a co-operative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples;

e) To assist in the co-operative implementation of Australia's international environmental responsibilities;

f) To recognise the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity; and

g) To promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in cooperation with, the owners of the knowledge.

Implementation of this recovery plan will address objectives **a**, **b** and **c**. Objective **d** is addressed in detail in section 4.4.5 as the involvement of a wide range of stakeholders is vital to the successful implementation of this recovery plan. The Recovery Team promotes a co-operative approach to environmental management through the involvement of state government agencies (DEH, DTEI), local government (Northern Areas Council, District Council of Mount Remarkable), state (TPAG) and locally based community groups (Biodiversity and Endangered Species Team) and landholders.

The execution of this plan is expected to meet policy and legislative goals at a national, state, regional and local level. As this plan promotes the recovery of a species endemic to the Mid-North of South Australia it will assist in the implementation of Australia's international environmental responsibilities regarding the conservation of biodiversity. As mentioned above, this will necessitate the involvement of a wide range of stakeholders in the recovery process. Thus, the implementation of this plan will involve a co-operative approach that encompasses Australia's international environmental responsibilities (Objective **e**).

The indigenous communities in the area affected by this plan have not yet been identified; however the implementation of recovery actions will consider the role and interest of these communities. The involvement of any relevant indigenous communities

will be sought throughout the recovery process, particularly during the consultation phase. This is actioned under 4.4.5 (Objectives **f** and **g**).

1.4 International obligations

A. dockeri is not listed under any international agreement, therefore this plan will not have a negative impact on Australia's obligations made under the Convention on Migratory Species or the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 1975). However, the implementation of this Recovery Plan is in keeping with the principles of the Rio Declaration on Environment and Development (Agenda 21) (1992). This plan is also consistent with Australia's obligations under the United Nations Convention on Biological Diversity (1992), ratified by Australia in 1993 and the subsequent National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996).

1.5 Affected interests

Eighteen community groups, land managers and private landholders have been identified as current stakeholders in the management of *A. dockeri*. Of these, nine directly own or manage critical habitat for this species. Many of these groups and individuals have been actively managing the species since its rediscovery in 1999. These groups are identified in Appendix 1.

The involvement of all stakeholders, particularly those already performing valuable recovery actions, has been sought during the recovery planning process. Stakeholders were informed of the recovery plan during its development and were invited to comment. The Spiny Daisy Recovery Team, which contains representatives and individuals from a number of stakeholder groups, allows for wide involvement and for the co-operative management of the species. The continuation of this co-operative management approach is one objective of this plan. An additional goal is to increase the involvement of the local and regional community, and this is actioned under Section 4.5.

1.6 Role and interests of indigenous people

The relevant indigenous communities in South Australia affected by this plan (Mid North Region) are being contacted and consulted through the Aboriginal Partnerships Unit, Department for Environment and Heritage (DEH). The implementation of recovery actions under this plan will consider the role and interest of such communities.

The requirements of the *Native Title Act* 1993 only apply to land where Native Title rights and interests may exist. When implementing any recovery actions in this threatened species plan where there has been no Native Title determination, or where there has been no clear extinguishment of Native Title, there needs to be consideration of the possibility that Native Title may continue to exist.

Generally the *Native Title Act* 1993 requires certain procedures to be followed prior to undertaking activities – known as future acts that may include certain recovery actions in this plan – which may affect Native Title rights and interests. This threatened species

plan will only be adopted subject to any Native Title rights and interests that may continue in relation to the land and/or waters. Nothing in the plan is intended to affect Native Title. The relevant provisions of the *Native Title Act* 1993 should be considered before undertaking any future acts that might affect Native Title. Procedures under the *Native Title Act* 1993 are additional to those required to comply with the *Aboriginal Heritage Act* 1998.

1.7 Benefits to other species/ecological communities

This Recovery Plan has potential localised biodiversity benefits for other species and communities. In a general sense, this will be through the conservation and management of habitat. This plan and the public consultation process included in the recovery process may also provide an important public education role, i.e. highlighting broad environmental issues and drawing attention to threats to biodiversity in the region.

The Laura and Hart *A. dockeri* subpopulations occur in remnant native grassland, ranging in condition from a weed dominated site (Hart subpopulation) to relatively intact grassland (Thornlea subpopulation). Much of the remnant lowland grassland in the region occurs on road verges and other minor public lands such as cemeteries, rail reserves and parklands. Other species of conservation significance such as *Lachnagrostis limitanea* (Spalding Blown Grass) are similarly confined to such areas. The increased community liaison and on-ground actions included in this recovery plan will complement other initiatives to improve management of small native grassland remnants on roadsides, public reserves and private land in the region. The Telowie *A. dockeri* subpopulation occurs in a degraded remnant shrubland, which is weed dominated. Shrublands of the Northern and Yorke region do not have a conservation rating, however some provide habitat for threatened species (Graham *et al*. 2001).

The implementation of this recovery plan should not cause a negative impact on any other native species or ecological community. *A. dockeri* has a high potential for vegetative spread, which could potentially result in the species becoming a localised weed problem in translocated areas. However, this is only considered to be a risk in areas where it would receive greater moisture than it does under natural conditions (e.g. if planted on drainage areas, if irrigated, if translocated to higher rainfall areas). While this risk is thought to be slight, the weed potential for this species will be considered thoroughly prior to undertaking any translocations.

1.8 Social and economic impacts

The implementation of this recovery plan is unlikely to cause any significant adverse social or economic impacts. All five currently known natural subpopulations are located on roadside verges surrounded by agricultural land. This may necessitate minor changes in the manner in which the road works are carried out by the local government agency (Northern Areas Council at the three Laura sites, District Council of Mount Remarkable at the Telowie site) and by DTEI at the Hart site. While some additional financial cost may be incurred by these organisations, any increase in required expenditure is likely to be minimal. For the Northern Areas Council and District Council of Mount Remarkable, this cost may be offset by the assistance it receives in the management of its roadside reserves.

At one site (Thornlea) the subpopulation has expanded out from the road verge into the adjacent paddock. This area has been fenced off, with the consent of the landholder. If other subpopulations expand in this way it may be necessary to fence off additional areas of paddock, which may have a negative impact on adjacent landholders by reducing the area available for production. Such fencing would only occur with the agreement of the landholder.

The implementation of this recovery plan is also likely to result in a number of positive social and economic impacts. Beneficial economic impacts may come about through the management of introduced species that have the potential for negative impact on agricultural productivity. Social benefits will come through community education regarding natural resource management theory and its practical applications, enhancing social capital.

PART 2: Distribution and Locations

2.1 Distribution

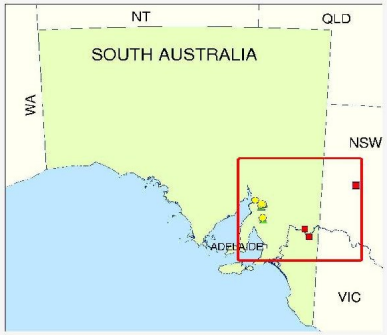
A. dockeri was first recorded by Dr H. Beckler from the Burke and Wills expedition, in 1860, near the Darling River in Central-western New South Wales (Davies 1992). The species was not recorded again until 1910, when herbarium specimens were collected at the Overland Corner on the Murray River in South Australia (Figure 1) (Davies 1992). By 1992, there had been no further records of this species, despite searching of known localities, and the species was believed to be extinct (Davies 1992). It is likely that rabbits and sheep have degraded former habitats, while river regulation and irrigation developments have also transformed these districts since the historical collections.

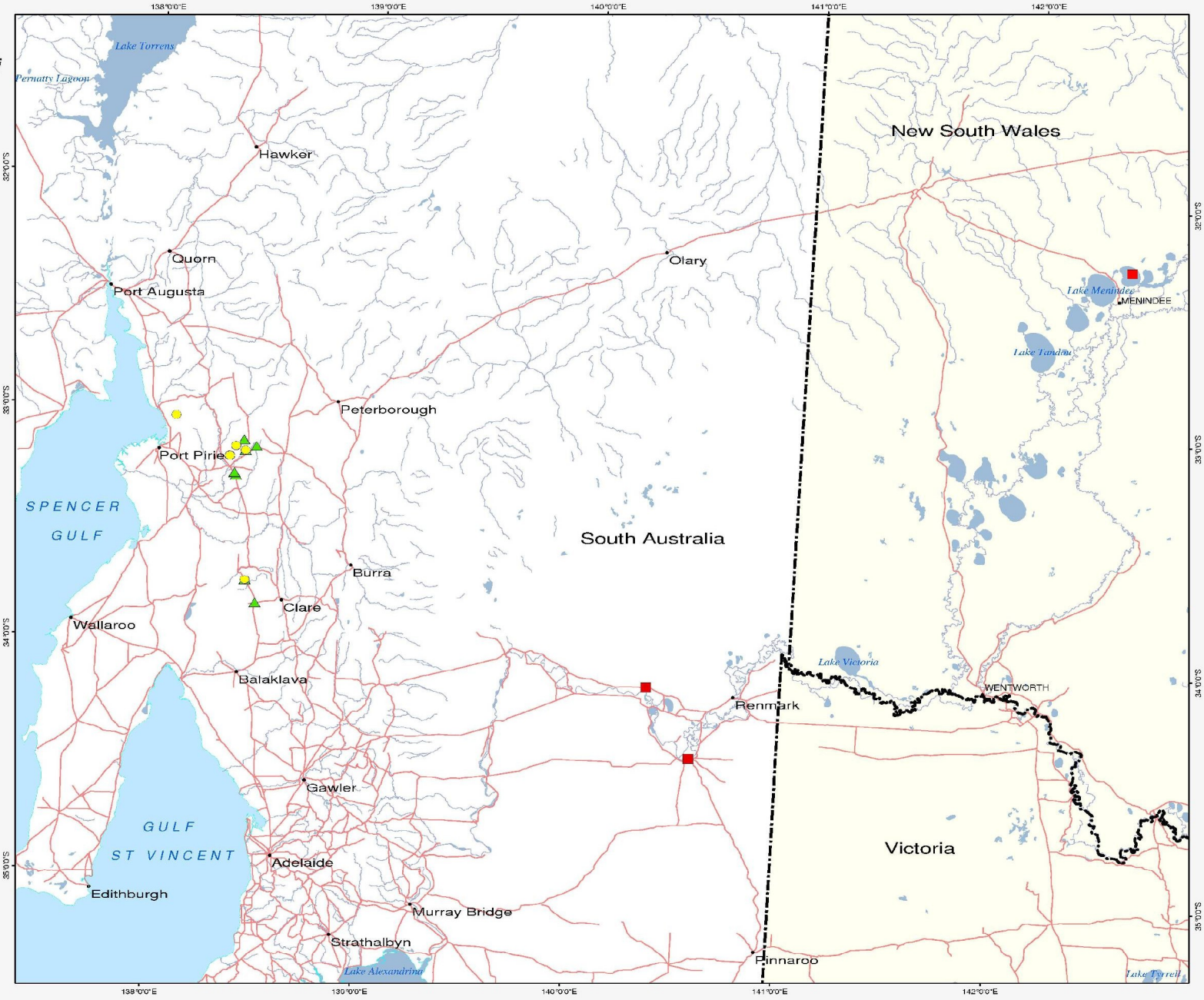
In 1999, a subpopulation of Spiny Daisy was discovered near Laura, in the Mid-North of South Australia. A further four subpopulations have since been located in the region (Figure 2). Three subpopulations exist to the east of Laura and one subpopulation is near Hart, approximately 65 km to the south. The most recent subpopulation was discovered in January 2007 at Telowie, North of Port Pirie. The Laura and Hart subpopulations occur in remnant native grassland, while the Telowie subpopulation occurs in a remnant shrubland. All five known subpopulations occur on roadside verges surrounded by agricultural land.

Five Translocation sites have been established for education awareness in public gardens (shown in Figure 1). These are at the Laura Parklands (Thornlea clone), the Arid Lands Botanic Gardens in Port Augusta (Hart clone), Hart Field Day Site (Hart clone), the Mid-North Plant Diversity Nursery in Blyth (Hart clone), and the Australian National Botanic Gardens in Canberra (Hart and Thornlea clones) (not shown in Figure 1). Another three translocations have been established to provide back-up for the natural extant subpopulations. One of these is on a Gladstone roadside reserve (Yangya clone) and a second is within the Caltowie cemetery (Rusty Cab clone). The third translocation occurred on World Environment Day 2007 (June 5) on the Caltowie-Stone Hut Road, the most extensive to date for the recovery program. It was a mixed-gene translocation involving 4 of the 5 genotypes.

There is also the possibility that some illicit translocation has occurred without the knowledge of the Spiny Daisy Recovery Team. This is to be discouraged.

Figure 1.
Distribution of historic and extant populations of *Acanthocladium dockeri*





Legend

Distribution of *Acanthocladium dockeri*

- Extant natural population
- Extant translocated population
- Historic locations of *Acanthocladium dockeri*

- Waterbody
- Main Road
- Drainage
- State Border
- Coastline
- Locality

0 10 20 30 40 50 km

N

Produced by SIS Regional GIS - Northern and Yorke Region
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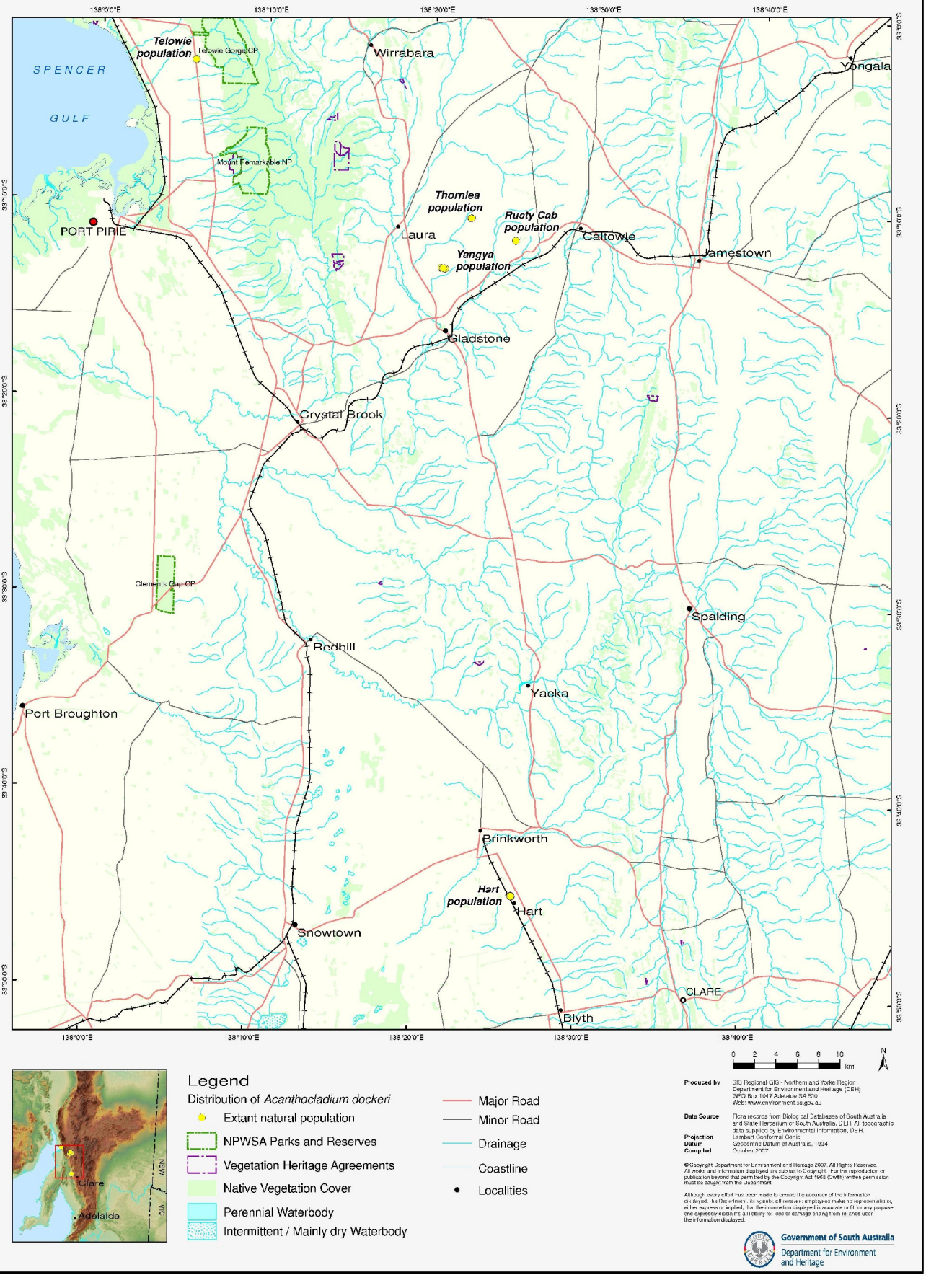
Data Source Flora records from Biological Databases of South Australia and State Herbarium of South Australia, DEH.
All topographic data supplied by Environmental Information, DEH.

Projection Lambert Conformal Conic
Datum Geocentric Datum of Australia, 1994
Compiled October 2007

Government of South Australia
Department for Environment and Heritage

Figure 2.
Distribution of extant natural populations of *Acanthocladium dockeri*



2.2 Habitat critical to the survival of the species

Knowledge of the habitat critical to the survival of *A. dockeri* is based on that of known extant subpopulations. Specific information on the historic habitat of the species is limited to notes included with herbarium specimens (low sand hills near Darling River and Overland Corner, River Murray) and soil attached to the roots of one specimen (reddish sand). This information suggests that the species may have predominantly occurred in landscapes of a different soil type and rainfall from those currently occupied.

Habitat of the Hart and Laura subpopulations of *A. dockeri* is remnant grassland on low hills (altitude 270-350 m) and plains (altitude 180 m) in the Mid-North of South Australia. Soils are light brown light clay to clay loam; pH approximately 7.4 (slightly alkaline) with very low salinity (Jusaitis, pers. comm.). The Telowie subpopulation however occurs within a remnant shrubland, with sandy loam soils (Jusaitis 2007[b]), at a much lower altitude (60 m). The climate of all the extant subpopulation sites is typically Mediterranean, with cool, wet winters and hot, dry summers (average annual rainfall 426 mm at Thornlea, 429 mm at Blyth, 450 mm at Telowie).

All known extant subpopulations of *Acanthocladium dockeri* occur on narrow road reserves that have been repeatedly disturbed in the past. The main indigenous plant species occurring with *A. dockeri* at the Hart and 3 Laura sites are: Scented Mat-rush (*Lomandra effusa*), Spear grasses (*Austrostipa* spp.) and Wallaby grasses (*Austrodanthonia* spp.) and various native forbs (Appendix 2). The Telowie site contains many species not present at the four other subpopulation sites (Appendix 3); it is a degraded shrubland dominated by Sweet Bursaria (*Bursaria spinosa spp. spinosa*), Umbrella Bush (*Acacia ligulata*) and Mealy Saltbush (*Rhagodia parabolica*) (Jusaitis 2007[b]). This type of habitat has largely been cleared for winter cereal cropping throughout the region.

As this species is critically endangered, with a limited distribution, all known habitat on which *Acanthocladium dockeri* occurs should be considered to be habitat critical to the survival of this species. These areas have been mapped and are presented in Figure 2.

Additional areas in the Mid-North, or in historic locations, meeting the environmental variables described above may also be considered to be potential habitat for *A. dockeri*. Whilst some searching for additional subpopulations has taken place in the past, there is still the possibility that the species may still exist in historic locations. The viability of *A. dockeri* in the long-term may also depend on translocation of the species, both to provide additional subpopulations of individual genets and to allow for the mixing of subpopulations in the field. Thus, areas where the species may exist, but have not yet been identified, or where the *A. dockeri* could potentially be translocated, may also prove to be sites potentially critical to the survival of the species.

2.3 Important subpopulations

All five naturally occurring subpopulations, representing the five known genotypes, are critical for the species' survival, due to the lack of genetic variation within the species.

All known subpopulations of *A. dockeri* occur on roadside verges in the Mid-North of South Australia (Figure 2). Three subpopulations occur just east of Laura, within a distance of 4 km (maximum of 7.5 km between sites). Precise locations are recorded in the Threatened Plant Species Population Database (maintained by DEH). The largest subpopulation (Yangya) occupies both road verges for more than 300 metres, while all other subpopulations occupy less than 75 m along the road verge. The verges have a width of five metres or less and these subpopulations are immediately adjacent to intensively cropped land. The fourth subpopulation occurs near Hart, approximately 65 km to the south, between a major sealed road and a disused rail reserve. The Telowie subpopulation is located adjacent to an olive grove, approximately 9 km North of Nelshaby, it is approximately 30 km North-west of its nearest neighbouring Laura subpopulation (Jusaitis 2007[b]). All subpopulations are surrounded by agricultural land.

Population monitoring surveys have been set up to occur annually. Due to the clonal and suckering nature of the species, monitoring is focused on measuring the area of occupancy and estimating the density of plants (individuals or ramets) at each site. As the Yangya subpopulation occurs on both the north and south verges of Yangya Road, for monitoring purposes it has been split into two separate survey sites: Yangya South and Yangya North. Since it is exceedingly difficult to accurately count the number of ramets at the Hart site, due to the extremely thick nature of the A. dockeri plants, monitoring at this site has focused on estimating cover. For more details on the monitoring technique see the Acanthocladium dockeri Monitoring Plan (DEH 2005[b]).

Results from population monitoring conducted in January/February 2007 showed density of A. dockeri ramets was typically low, ranging from 0.375 per m2 at Yangya South to 7 at Rusty Cab. The average percentage cover at the Hart site was 77.75% with a standard error of 9.19.

Figure 3: *A. dockeri* density (+/- SE) at each site

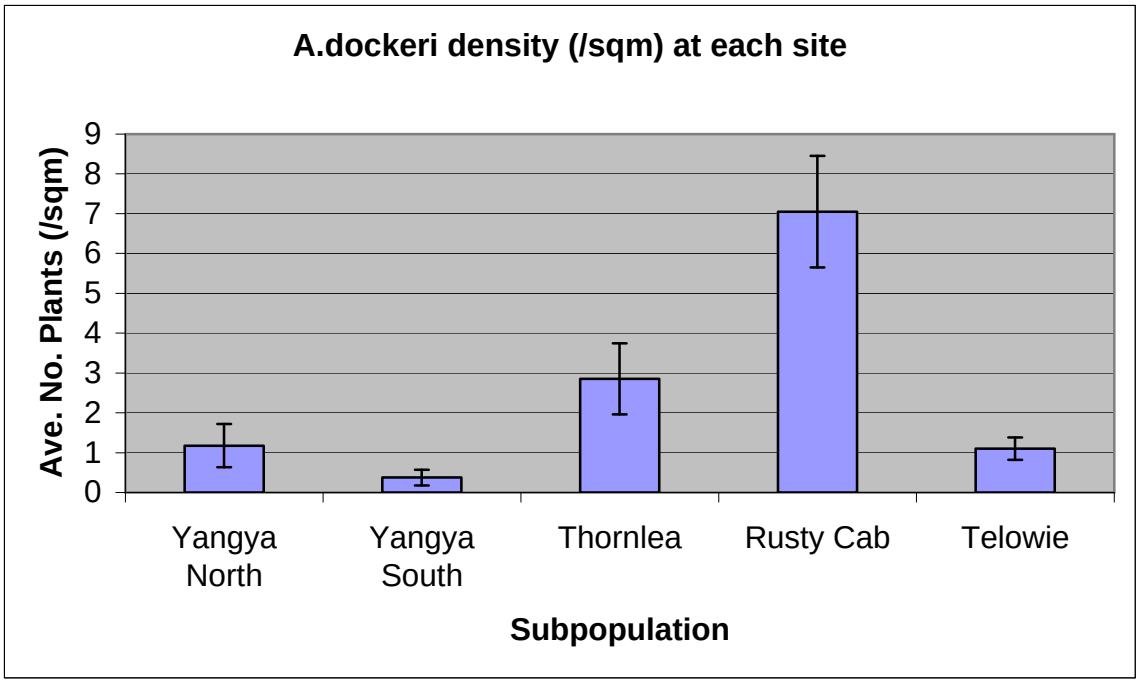


Table 1: Area occupied by of *A. dockeri* subpopulations in 2007

Site	Length (m)	Average width (m)	Total (sq m)	Estimated Total # of plants
Yangya North	320	3.51	1123.2	1600
Yangya South	361	2.39	862.79	323
Thornlea	64.5	14.04	905.58	2581
Rusty Cab	24.5	4.76	116.62	822
Hart	70.4	23.03	1621.31	NA
Telowie	17.4	5	87.5	96
		Total	4717 (0.47ha)	5422*

*figure does not include the Hart site.

The total number of plants at each site was estimated by measuring the average density of *A. dockeri* within the survey quadrats and extrapolating this over the whole site. The total area of occupancy of *A. dockeri* in 2007 was 0.47 ha compared with 0.33 ha in 2005. The 2007 figure includes the recently discovered Telowie subpopulation, however this site only accounts for 1.85% of the overall population. Surveys conducted in 2001 estimated the area of occupancy to be 0.34 ha (Robertson 2002).

In addition to annual population monitoring, a permanently pegged photo point site consisting of ten contiguous, one square metre plots has been monitored at each subpopulation. For the Yangya, Thornlea and Hart subpopulations, monitoring has occurred since 2000. Monitoring of the Rusty Cab subpopulation commenced after the site's discovery in 2001 (Jusaitis, pers comm. 2005). Results from this monitoring are shown below in Tables 2 and 3 (Jusaitis 2007[a]). Monitoring has only recently commenced at the Telowie site following its discovery.

Table 2: Average density of A. *dockeri* in permanent photo-points (plants/m^2) (Jusaitis 2007[a])

DATE	Yangya	Thornlea	Rusty Cab	Hart
25-May-00	1.8	2.5	N/A	3
14-Sep-00	1.6	2.3	N/A	2.9
9-May-01	NA	NA	4.9	N/A
14-Jun-01	1.7	2	5	11.1
31-Jul-01	N/A	N/A	6.5	N/A
13-Sep-01	1.3	1.9	7.4	6.3
1-Nov-01	1.3	2	8.4	N/A
13-Dec-01	1.3	2.1	9.4	11.3
14-Feb-02	N/A	N/A	8.7	14
30-May-02	0.8	2.3	9.2	14.9
6-Aug-02	1.3	2	9.8	14.2
16-Oct-02	1.4	2	9.9	14.3
14-Aug-03	1.4	2	10.8	11.4
21-Sep-04	0.8	2.1	9.5	8.2
4-Mar-05	1	2	9.8	8.2
11-Aug-05	1.2	1.9	9.1	9
16-Nov-05	1.5	1.7	8.2	11.7
8-Feb-06	1.7	1.7	7.4	12
18-May-06	1.9	1.7	9.4	13.2
31-Aug-06	2	2.2	8.9	11.7
14-Feb-07	2	2.6	9.5	8.9
10-May-07	2.2	2.8	10	14

The average density at these photo points has ranged from a minimum of 0.8 plants/m^2 at the Yangya site to a peak of 14.9 plants/m^2 at the Hart site. The Rusty Cab site has increased in abundance from 4.9 plants/m^2 in May 2001 to 10 plants/m^2 in May 2007. This may reflect the subpopulation's recovery from a wildfire in January 2001. The density of the Hart photo-points has fluctuated the most over the monitoring period but has generally showed a promising increase from 3 plants/m^2 in May 2000 to 14 plants/m^2 in May 2007. Initial results for the density of Telowie photo points indicate a low 0.2 plants/m^2 (Jusaitis 2007[a]).

Table 3: Average percentage cover of A. dockeri in permanent photo points (Jusaitis 2007[a])

DATE	Yangya	Thornlea	Rusty Cab	Hart
25-May-00	2.9	4.15	N/A	3.5
14-Sep-00	1.6	3.8	N/A	6.1
9-May-01	N/A	N/A	0.51	N/A
14-Jun-01	0.86	2.7	0.84	10.7
31-Jul-01	N/A	N/A	1.9	N/A
13-Sep-01	0.8	3.71	3.05	7.4
1-Nov-01	0.95	4.15	4.05	N/A
13-Dec-01	1.3	4.55	5.7	11.7
14-Feb-02	N/A	N/A	4.95	12.6
30-May-02	0.371	2.55	4.7	11.6
6-Aug-02	0.62	2.22	4.9	11.7
16-Oct-02	1.31	2.11	5.5	12.6
14-Aug-03	1.25	2.9	10.8	8.3
21-Sep-04	0.36	1.11	3.31	5.6
4-Mar-05	1.08	1.23	4.28	6.85
11-Aug-05	1.48	1.71	N/A	9.2
1-Sep-05	N/A	N/A	7.2	N/A
16-Nov-05	1.95	2.26	6.4	20.4
8-Feb-06	3.35	1.91	5.01	19.2
18-May-06	6.55	3.85	7.47	22.4
31-Aug-06	4.91	2.81	5.7	16.1
14-Feb-07	6.3	2.7	8.85	14.2
10-May-07	8.4	6.1	15.5	15.7

The average percentage cover at the photo points ranged from a maximum of 22.4 % to a minimum of 0.51 %. The cover of *A.* dockeri in the photo points at the Thornlea site has increased only slightly from 4.15 % in 2000 to 6.1 % in 2007. Percentage cover at the Rusty Cab plots has increased the most substantially from 0.51 to 15.7, while the Yangya photo-points have increased from 2.9 % in 2000 to 8.9 % in 2007. The Hart site experienced the most variability in percentage cover but overall increased from 3.5 % in 2000 to 15.7 % in 2007. Initial results for the cover of A. dockeri in the photo points at the Telowie site, shows a slight increase from 0.3 % in February 2007 to 0.6 % in May 2007 (Jusaitis 2007[a]).

PART 3: Known and Potential Threats

3.1 Biology and ecology relevant to threatening processes

Potentially the most significant threat to the survival of *A. dockeri* into the future is the absence of genetic variation within subpopulations, and an apparent lack of sexual reproduction. As discussed previously there appears to be limited genetic variation within the species, with only five genotypes detected (a single genet at each subpopulation). Each subpopulation reproduces clonally with the predominant form of plant proliferation appearing to be vegetative spread, via root suckering (Jusaitis & Bond 1999). Additionally, seed production is negligible and the few seeds that have been found characteristically produce a high proportion of abnormal seedlings with a low survival rate. No seedlings have been observed in the field and sexual reproduction appears to be limited by pollen viability (Jusaitis and Bond 2005).

The known distribution of *A. dockeri* is in an area of agricultural productivity where the majority of the vegetation has been cleared. To an untrained observer, this species may resemble a weed and, therefore, may have been specifically targeted for eradication in the past.

3.2 Identification of threats

The threats to the survival of *A. dockeri* are identified in Table 4 and addressed in more detail below.

Table 4: Identified threats to the recovery of *A. dockeri*

Threats	Threat to Short-term Survival	Threat to Long-term Survival
Competition from environmental weeds	High	High *
Herbivory	High	High*
Lack of formal protection	Medium	High*
Small, isolated populations	Medium	High
Adjoining land-use	Medium	Medium*
Lack of genetic diversity	Low	High
Inappropriate revegetation	Low	Medium*
Lack of sexual reproduction	Low	High
Lack of knowledge	Low	Medium
Climate change	Low	Unknown- potentially high

***** Threats posed by these factors in the long term could be high; however the appropriate management actions in the short to medium-term may be able to reduce the threat of these factors in the longer term.

3.2.1 Weed competition

The dominant exotic plant species at all sites are annual grasses, predominantly Wild Oats (**Avena barbata*). Salvation Jane (**Echium plantagineum*), Onion Weed

(*_Asphodelus fistulosus_) and Wild Turnip (*_Rapistrum rugosum_) are also significant weeds at the Hart site. The main perennial weed species are Wild Sage (*_Salvia verbenaca_) at all sites, and Rice Millet (*_Piptatherum miliaceum_) and Scabious (*_Scabiosa atropurpurea_) at the Hart site. Soursob (*_Oxalis pes-caprae_) is present at the Yangya, Hart and Telowie sites, being particularly invasive at the two latter sites. Scattered plants of Horehound (*_Marrubium vulgare_) occur at all sites. Although numerous healthy Spiny Daisy plants have been observed amongst dense, tall stands of Wild Oats, Salvation Jane and cruciferous annuals, it is possible that weed competition may limit its growth during dry winters. Snails appear to have little impact on the weed abundance, although the weeds could be more abundant if not for the snails. Competition from environmental weeds reduces the potential habitat available to *A. dockeri*, limits the availability of resources and inhibits growth of other native grassland species.

3.2.2 Herbivory

The introduced Common White, or Vineyard Snail, *Cernuella virgata* has a dramatic impact on individuals of *A. dockeri* during the wetter months. Trials have shown that the snails actively graze on both stems and leaves of the plant during winter and spring (Jusaitis, pers. comm. 2002). This activity removes the epidermal layer, resulting in weakening or ringbarking of the stems, death of leaves, and often the death of complete shoots above the site of injury. Plants may re-sprout below, or occasionally above the injury. Snails have been in the Laura district for only about ten years (Robertson 2002) and their impacts may be increasing. The snails aestivate during summer on plants and fence posts to avoid heat from the soil surface.

A. dockeri may also be negatively affected by stock grazing with younger shoots particularly more susceptible. Kangaroo densities are low around the *A. dockeri*, thus their impact is considered to be negligible. However this may change if macropod densities increase.

3.2.3 Lack of formal protection

Currently there are no extant subpopulations of *A. dockeri* occurring within any areas formally protected for conservation. The three Laura sites occur along roadsides under the control of the Northern Areas Council, the Telowie site is along a roadside under the control of District Council of Mount Remarkable, while the Hart site is located on a DTEI road verge; the recovery effort is largely dependent on the continued support of these agencies. Roadside markers have been put in at each subpopulation; however this does not necessarily ensure protection of each site. The lack of formal protection of any of these subpopulations is potentially a threat to the long-term survival of this species. Some type of legal protection of these sites is desirable. This may be in the form of a Heritage Agreement, and although this type of agreement may not be entirely appropriate, it is likely to be the only current legal option.

Four of the five translocated subpopulations exist in nursery or botanic garden environments and may therefore be considered to have a higher degree of protection than the naturally occurring subpopulations. Since the Telowie subpopulation has only

recently been discovered, no material from this site has been used for translocation, although this is planned to occur in 2008.

3.2.4 Small isolated populations

The main threats to this species are the small number of extant subpopulations (five), the small area of occupancy (≈ 0.45 hectares) and their confinement to narrow road verges, adjacent to agricultural land. *A. dockeri* is known to have occurred historically in at least four other locations and had a much wider distribution than is currently known. The species is now only found in five small, isolated subpopulations, each representing a single genet. Such subpopulations are vulnerable to extinction by a single catastrophic event. Extinction of any of the remaining subpopulations would have a significant impact on the species potential for long-term survival. These subpopulations also have a high edge to area ratio with a resulting higher susceptibility to factors such as exposure to fertiliser drift, grazing and weed invasion.

3.2.5 Adjoining land-use

Since 1999, the extant subpopulations have been variously subjected to road maintenance activities, including road widening (Thornlea), roadside slashing (Yangya, Telowie and Hart) and herbicide spraying (Yangya). The three Laura subpopulations and the recently discovered Telowie subpopulation are all located adjacent to gravel roads that require periodic grading and this activity is a potential threat to the subpopulations.

There is an ongoing risk of chemical drift from surrounding agricultural land. It has been the usual practice for adjacent landowners to apply broad-spectrum non-selective herbicide to at least one of the roadsides (Yangya) to create a firebreak. Local farmers often follow recommendations to remove grass along fence lines, using herbicide to reduce snail problems in crops. The presence of plants that are declared under the *Natural Resources Management Act* 2004 (e.g. Horehound at Yangya) within Spiny Daisy populations represents a risk of non-target damage from spraying by adjacent landholders or NRM Authorised Officers.

3.2.6 Lack of genetic diversity

Genetic variation in the known subpopulations appears to be low. Research has found that there is variation between, but not within each of the (five) extant sub-populations (Jusaitis 2007[b], M. Adams, pers. comm. 2007). While there appears to be a number of ramets (individuals at ground level) at each of the subpopulations, these are thought to all represent a single genetic individual. As a result, the total known population of *A. dockeri* is only five individuals, giving the species little adaptive potential in the face of changing environmental conditions.

3.2.7 Inappropriate revegetation

Non-indigenous trees have been planted on roadsides at Yangya and Rusty Cab (since destroyed by fire at the latter site) prior to the discovery of the Spiny Daisy. The

introduction of non-indigenous trees and shrubs into grassland alters the habitat significantly, posing a potential threat to Spiny Daisy subpopulations.

3.2.8 Lack of sexual reproduction

No seedlings have been observed in the field and seed production is extremely low. The few seeds that have been found characteristically produce a high proportion of abnormal seedlings with a low survival rate. Trials have shown that seed set is erratic, probably as a result of pollen sterility (Jusaitis & Adams 2005). *A. dockeri* is therefore not currently able to increase its genetic diversity through reproductive means and new genetic individuals are not being added to the population, this may be a concern in the future as the life span of each clone is currently unknown. The species does however exhibit vigorous suckering.

3.2.9 Lack of knowledge

There is a lack of knowledge regarding many aspects of the biology and ecology of *A. dockeri*. Little is known regarding the historic distribution of the species, and its current area of occurrence is potentially greater than that which is presently known. This lack of knowledge regarding the species habitat requirements limits the ability of the Recovery Team to undertake targeted searches to locate any existing undiscovered sites.

There is also an incomplete understanding of the specific cause of the reduction in the species distribution. *A. dockeri* is generally assumed to have declined as the result of clearance and modification of its habitat for agriculture. However, it is unclear why the species has not survived in a greater number of 'refuge' areas. Knowledge of the ecological requirements and tolerances of *A. dockeri* is incomplete. In future this may impact on the ability of the Recovery Team to make appropriate management decisions, particularly in the face of climate change. This lack of knowledge regarding the species distribution and tolerances may also affect the success of future translocations.

3.2.10 Climate change

The nature of the impacts of climate change on this species is currently unknown, but may be devastating. Climate change is a particular risk to *A. dockeri* due to its extremely low level of genetic diversity and thus reduced ability to adapt to change. It is difficult to protect this species against the threats of climate change. At present, the best insurance against the risk of climate-induced extinction is to conserve genetic material *ex-situ*, maximise the number of *in-situ* subpopulations and attempt to promote genetic diversity within subpopulations.

3.3 Areas and subpopulations under threat

The threatening processes described above in section 3.2 affect all known natural areas and subpopulations of *A. dockeri*. The Telowie and Laura subpopulations are at a higher risk from road maintenance due to their location on unsealed roads that require regular grading. These subpopulations may also be at an increased risk from farm maintenance (eg from chemical spraying), compared to the Hart site, due to their closer proximity to areas of agricultural activity. Herbivory by white snails is also less prevalent at the Hart subpopulation. The translocated garden plantings are less

threatened by factors such as weed competition, herbivory, and road and farm maintenance.

3.4 Existing conservation measures and management

The Spiny Daisy Recovery Team was established in 1999 following the rediscovery of the species. To date, the Team has undertaken the following activities:

- All sites have been registered as sites of significant roadside vegetation and roadside markers have been installed to alert road maintenance workers.
- Other roadsides and rail reserves in the Mid-North have been searched for *A. dockeri*. This indirectly led to the discovery of the Telowie site.
- Part of the Thornlea subpopulation, which had expanded into the adjacent farm paddock, has been fenced with agreement of the landowner.
- Annual and perennial herbaceous weeds have been controlled, using minimal disturbance techniques (eg cut and swabbed, spot-sprayed, hand pulled).
- Snail bait has been laid through autumn to spring around all sites since 2001.
- Aspects of the biology of Spiny Daisy have been studied, including:
  1) propagation techniques (cuttings, seed and tissue culture),
  2) the effects of snail grazing, pruning and road grading on regeneration,
  3) genetic studies to determine the levels of genetic variability,
  4) floral biology, and
  5) the regular monitoring of abundance (including photo points) at each subpopulation.
- The subpopulations have been mapped, associated plant species and soil types recorded and a project herbarium compiled.
- Population size, plant growth rates, population demographics, and threats are being monitored.
- The species is in cultivation from cuttings at the Laura Parklands (Thornlea), the Arid Lands Botanic Gardens (Hart) and Mid-North Plant Diversity Nursery (Hart) in the region. Cuttings of the Thornlea and Hart clones have also been planted at several sites around the Australian National Botanic Gardens in Canberra.
- Cuttings of four of the five clones are being held at Mid-North Plant Diversity Nursery. Additionally an *ex situ* collection of potted plants are being held at the Wittunga Botanic Gardens, this was previously at the Black Hill Flora Centre Nursery in Adelaide. This collection consists of 25 pots of the Rusty Cab clone and 11 pots from Hart. Representatives of 4 of the 5 clones are also being held at the Adelaide Botanic Gardens nursery for research purposes.
- Cutting-derived plants have been translocated on a trial basis to an area adjacent to the existing subpopulation near Hart.
- A fact sheet has been produced on the species, and information has been presented to the local community at agricultural field days and other events in the region.
- Liaison with owners of land adjacent to the subpopulations regarding favourable site management has occurred.
- Three additional sites have been established through translocation, including a mixed-gene translocation.

PART 4: Recovery Objectives, Performance Criteria and Actions

4.1 Recovery objectives

The long-term recovery objective is to improve the conservation status of *A. dockeri,* with the ultimate goal being its removal from the threatened species schedules. The effective implementation of this plan will be an initial stage in the long-term recovery of the species. The goal of this document is to ensure that the total population, number of subpopulations, area of occupancy and extent of occurrence are increased over the next five years. Specific objectives to be achieved within the next five years are:

1. To increase the number of plants and area of occupancy and improve habitat at all five existing wild subpopulations.
2. To maintain or increase the level of genetic variation in *A. dockeri*.
3. To extend or confirm the occurrence of *A. dockeri* at other localities, using knowledge acquired from the extant subpopulations.
4. To maintain broad participation in the recovery process and increase public awareness and local community ownership of *A. dockeri,* and of habitat conservation issues relevant to its survival.

4.2 Performance criteria

The following performance criteria will be used to gauge whether the recovery objectives have been achieved:

1. a) All five existing wild subpopulations and area occupied remain at current levels or increase over five years

   b) The density of annual weeds decreases and the number of remnant native species increase at *A. dockeri* sites, over the next five years.

2. All genotypes exist at no less than two locations in the field (one natural occurrence site and an additional translocation site), with collections of all five genotypes held in laboratories or nurseries by July 2008.

3. Further searches for the species undertaken throughout the Mid-North and Murray Darling Basin, particularly in the general area of historic records (Bambamero and Overland Corner) by July 2009.

4. Participation of a range of stakeholders in the recovery process is maintained over the duration of the recovery plan. A high level of awareness and active involvement of the local community in the implementation, monitoring and promotion of recovery actions within five years.

4.3 Evaluation of success or failure

The Recovery Team will take an active role in planning and implementing all actions, and in the monitoring of the success of the project. The Recovery Team provides linkages between local and non-local participants and its membership includes the Threatened Plant Action Group, Northern Areas Council, SA Department for Environment and Heritage, Department for Transport, Energy and Infrastructure, Greening Australia, District Council of Mount Remarkable and local landowners/community members. The Recovery Team meets twice a year in the Mid-

North. Contact amongst members of the Recovery Team, and between the Team and the local community is maintained throughout the year.

The progress of the Spiny Daisy Recovery Project will be assessed against the recovery plan at each meeting of the Spiny Daisy Recovery Team. The recovery plan should be thoroughly reviewed in 2011, when it may need to be updated.

4.4 Recovery Actions

Site action plans, focusing on extrinsic threats (weeds, grading, herbivory), have been prepared and implemented at the Hart and Laura subpopulations and a site action plan is being formulated for the Telowie site. A translocation program is currently in process to increase abundance and number of subpopulations. Attempts to increase the genetic diversity of the species will occur and its public profile will be raised.

All actions are to be co-ordinated by and managed through the Threatened Flora Ecologist for the DEH Northern and Yorke Region and the Spiny Daisy Recovery Team. The actions required are listed below, in priority order:

1. Continue threat abatement and site management (for all known subpopulations) in accordance with the site action plans prepared for all naturally occurring subpopulations.

    1.1. Undertake direct site management, including: 1) the control of weeds through minimal disturbance techniques and restoration of the native plant community, 2) the exclusion of domestic stock from subpopulations, by maintaining fencing as required and, 3) the reduction of snail herbivory, through continuation of the baiting program

    1.2. Limit the impacts of road and farm maintenance operations on all natural subpopulations, through maintaining signage and liaison. Explore avenues for legal protection of the sites.

    1.3. Monitor the extant subpopulations to ensure actions taken to reduce threats are effective.

2. Establish an additional site to provide back-up for the Telowie subpopulation.

    2.1. Select a site based on the suitability of environmental conditions and the ability to implement management options. Prepare translocation plan for translocation site.

    2.2. Collect and propagate cuttings.

    2.3. Undertake site preparation, planting and maintenance.

    2.4. Monitor the translocated subpopulation to determine the survival of this subpopulation and identify any arising threats.

3. Attempt to increase genetic diversity.

    3.1. Conduct cross-pollination trials in a laboratory/nursery setting.

3.2. Add the Telowie genet to a mixed-gene translocation site to complete the full complement of genetic combinations for the cross-pollination experiment.

3.3. Monitor the mixed-gene translocation site to determine the survival and identify any occurrence/s of genetic recombination.

3.4. Attempt to raise seedlings in nursery and laboratory settings.

3.4.1. Collect seeds at each subpopulation.

3.4.2. Raise the seedlings following standard nursery procedures.

3.4.3. Establish the seedlings in suitable translocation sites if successful.

3.4.4. Select sites based on the suitability of environmental conditions and the ability to implement management options. Prepare translocation plan for each translocation site.

3.4.5. Monitor the translocated subpopulations to determine their survival and to identify any arising threats.

4. Identify existing unknown subpopulations.

4.1. Increase public awareness and seek location data from the public.

4.2. Conduct targeted searches for new subpopulations.

4.3. Manage any newly discovered subpopulations following Actions 1.1 – 1.3.

4.4. Conduct genetic analysis of any newly discovered subpopulations.

4.5. Monitor any newly discovered subpopulations.

5. Maintain stakeholder participation in the Recovery Team and increase the involvement of the local community in the recovery process.

5.1. Maintain stakeholder involvement in the Recovery Team.

5.2. Increase community participation in the recovery process.

6. Conduct targeted research into the ecology and biology of *A. dockeri* in order to better manage the species.

6.1. Conduct cryo-preservation of tissue.

6.2. Undertake life-history studies.

6.3. Conduct herbicide sensitivity trials.

6.4. Carry out ecological requirement studies.

6.5. Study the reproductive ecology and biology of the species.

The above actions are described below. All management action will be appropriately recorded and documented.

1. Threat abatement for existing known subpopulations

The aim is to improve the quality of *A. dockeri* habitat in order to reduce the possibility of a reduction in the species abundance and/or subpopulation extinction. This will be achieved by increasing the potential habitat for this species by reducing competition from weeds, and reducing the impacts of herbivory and road or farm maintenance activities. Site Action Plans (DEH 2005[a]) have been prepared for four sites, and is being prepared for the Telowie site. These Action Plans offer greater detail regarding the nature of threat abatement activities at each site than what can be provided in this document.

1.1 Direct site management

Weed control is the main form of intervention at all Spiny Daisy sites and carries potential risks as well as benefits for other native plants. The Recovery Team will adopt weed control guidelines in consultation with adjacent landowners to ensure that all herbicide use, slashing and hand weeding at Spiny Daisy sites is selective, appropriately timed and targeted to the main problem species with minimal impact on Spiny Daisy and other native species. Potential accumulation of flammable dead plant material in summer from annual weed species will be managed in conjunction with Spiny Daisy recovery. All agencies with an interest in vegetation control along roadsides will be informed of site management requirements and will be consulted annually on their proposed work programs. This may benefit native grassland conservation more generally along roadsides, including possible new subpopulations or translocation sites. Specific weed species at each naturally occurring *A. dockeri* site and the appropriate control techniques are listed in the Site Action Plans (DEH 2005[a]).

The existing fences at all sites will be maintained and any new subpopulations threatened by stock grazing will be fenced as required. In order to reduce the impact of snail herbivory on *A. dockeri,* baiting will occur at least annually.

1.2 Limit impacts of maintenance activities and increase legal protection

Through liaison with the Northern Areas Council, District Council of Mount Remarkable and DTEI, all naturally occurring subpopulations have been identified with significant roadside markers. It is the responsibility of these organisations, with the support of the Spiny Daisy Recovery Team, to maintain road markers and training of road maintenance crews. They will be asked to notify the Recovery Team of proposed road works that could affect Spiny Daisy sites. The Recovery Team will liaise regularly with these authorities to ensure that their maintenance activities have no negative impact on *A. dockeri*. The Recovery Team will also liaise with neighbouring landholders to ensure that they are aware of the management requirements of *A. dockeri* and that their activities have no negative impact on the species. As the species is not known to occur within any areas formally reserved for conservation, legal avenues to increase the protection of the *A. dockeri* will be explored. This may be in the form of Heritage Agreements, and although this type of agreement may not be entirely appropriate, it is likely to be the only current legal option available.

1.3 Monitor extant subpopulations

All extant subpopulations will be monitored yearly to gauge the effectiveness of management actions and to assess population trends. A monitoring plan has been developed and all future monitoring will be undertaken in accordance with this protocol, to ensure consistency. Monitoring of extant subpopulations will have two components:

the photo-point monitoring that has occurred since 2000 and the population monitoring developed in 2005.

2. Establish an additional site, to provide back-up for the Telowie subpopulation

In order to decrease the risk of extinction for any *A. dockeri* genotype, the Recovery Team will ensure that all clones are present in at least two locations in the field. This will entail the translocation of the Telowie genet. The genet will be translocated to a new location where conditions are suitable, and appropriate protection and management can be implemented. The aim is to establish self-sustaining subpopulations. If successful, this action will increase the number of subpopulations and possibly the extent of occurrence. The translocation of the Telowie genet is planned to occur in 2008.

2.1 Site selection and planning

Suitable sites will be selected in the Mid-North region, where the land is not required for other incompatible purposes. In choosing sites, emphasis will be placed on land subjected to conservation agreements and areas where active management can occur. A thorough translocation plan will be prepared prior to the introduction of any propagules to the translocation site.

2.2 Collect and propagate cuttings

Cuttings of the *A. dockeri* Telowie clone will be taken during spring and propagated at the Mid-North Plant Diversity Nursery. Plants will remain there until the break of the season, when they will be planted at the selected translocation site.

2.3 Site preparation, planting and maintenance

Suitable sites for translocation will be prepared through fencing, weeding, signage, snail baiting and the planting of other native grassland species as appropriate. This should continue throughout the life of this plan.

2.4 Monitor translocation populations

The appropriate monitoring technique will be developed prior to translocation and outlined in the relevant translocation plan. When developing this technique reference will be made to the monitoring plan (DEH 2005[b]) used at the naturally occurring sites.

3. Attempt to increase genetic diversity

Any increase in the genetic diversity of *A. dockeri* would be a major boost to the recovery effort. Attempts to increase diversity will be made via cross-pollination trials in both a laboratory/nursery and field setting. A mixed-gene translocation experiment is currently in progress. Attempts to raise seedlings will also continue.

3.1 Cross pollination trials

Cross-pollination trials are being conducted in a laboratory/nursery setting at the Adelaide Botanic Gardens. This trial will attempt to cross the different genotypes in all possible combinations, with the aim of producing viable seedlings and increasing genetic diversity.

3.2 Add Telowie genotype to mixed-gene translocation site

A mixed-gene translocation site has been set up involving four of the five genotypes, on a native grassland roadside reserve, in the Mid-North. The Telowie genotype is to be added to the site to complete the full complement of genetic combinations. This mixed-gene translocation field trial is an extension of the cross-pollination experiments conducted at the Adelaide Botanic Gardens. This trial will be a valuable opportunity to study competitive interactions between genotypes.

3.3 Monitor mixed-gene translocation site

The appropriate monitoring technique is outlined in the mixed-gene translocation plan (DEH 2006). The growth, survivorship and establishment of translocated *A. dockeri* will be assessed, following techniques used by DEH at other Spiny Daisy sites. Genetic testing will be conducted on any viable seed produced.

3.4 Attempt to raise seedlings *ex-situ*

The Recovery Team will continue with efforts to raise seedlings from the seeds, naturally produced at each site.

3.4.1 Collect seeds at each population

Spiny Daisy flowers and produces seed sporadically throughout the year. Seeds will be collected during routine site visits.

3.4.2 Raise seedlings under nursery conditions

Attempts will be made to raise these seeds in the DEH laboratory at the Botanic Gardens of Adelaide.

3.4.3 Establish in suitable translocation sites if successful

If seedlings can be successfully raised *ex-situ*, they will be established in suitable translocation sites. Suitable sites will be selected based on criteria stated in action 2.1. In future the Recovery Team may consider translocating the species to sites within its historical range (South Australian Riverland and Central-Western New South Wales). Such a translocation will not be undertaken until thorough searches for *A. dockeri* have been conducted in these areas and the results of the cross-pollination trails are known. Re-introduction of *A. dockeri* into its historic range is unlikely to be undertaken within the life of this plan.

4. Identify existing unknown subpopulations

Due to the small number of known extant subpopulations and genotypes (five), the identification of additional naturally occurring subpopulations would be beneficial to the recovery effort. Additional subpopulations may be identified by increasing public awareness to encourage community members and other natural resource management workers to report sightings and by active searching.

4.1 Increase public awareness

The Threatened Flora Ecologist and Threatened Species Community Liaison Officer will develop and circulate information on habitats where A. dockeri might be found, diagnostic characteristics of the species, and how to send in a herbarium specimen for identification. The Threatened Flora Ecologist and the Recovery Team will offer assistance with identifying specimens and habitat and follow up any contacts. This information will be distributed to relevant professionals and community groups in the

Mid-North, Riverland and Menindee (NSW) regions. The Recovery Team has already established an exhibition site at the Laura Parklands, which is an accessible, high profile location. These plants are helping to raise public awareness.

4.2 Search for new subpopulations
Targeted searches in likely habitat will be conducted. Records of any searches will be entered into the DEH Threatened Plant Population Database and herbarium specimens lodged in the SA State Herbarium. Efficient communication within DEH, and between DEH and TPAG, is required to ensure that all those involved in the recovery effort are made aware of any new discoveries. The Threatened Flora Ecologist will perform annual searches of the Herbarium Database to ensure no collections have been made without the notification of the Recovery Team. All information regarding new subpopulations will be communicated to the Recovery Team.

Targeted searches also need to be conducted in areas of the historic distribution of *A. dockeri*. A contractor needs to be employed to conduct searches of the South Australian Riverland in 2008/09, with targeted surveys of the Menindee region of New South Wales to occur in the following year (2009/10). It is desirable that searches of these two areas, and the Mid-North, continue throughout the life of this plan.

3.3 Manage any newly discovered subpopulations
A Site Action Plan will be written for any newly discovered subpopulations in order to identify threatening processes and appropriate management actions. Necessary actions are likely to be in the form of weed control and fencing. Responsibilities for managing any newly discovered subpopulations will be determined by the Recovery Team, with landholders and the local community being encouraged to play an active role.

3.4 Monitor any newly discovered subpopulations
Monitoring of any newly discovered subpopulations will follow standard protocols and results entered in the SA Threatened Plant Population Database, as above.

4. Maintain stakeholder participation in the Recovery Team and increase community involvement in the recovery process

4.1 Maintain stakeholder participation in the Recovery Team
The Spiny Daisy Recovery Project is currently overseen by a recovery team whose membership comprises of representatives from a number of stakeholder groups (Appendix 1). The continued involvement of all these groups is essential to achieving the goals of this plan.

4.2 Increase community involvement in the recovery process
The Recovery Team will seek involvement of the local community through councils, schools and interested individuals. The Recovery Team will promote the project locally through local media and field days and will undertake a campaign specifically to interest landholders regarding potential translocation sites and searching for unknown subpopulations. The Threatened Species Community Liaison Officer for the DEH in the Northern and Yorke Region has established a community group based in the Mid-North to assist in implementing recovery actions. Members of the Recovery Team will assist by training volunteers from the new Biodiversity and Endangered Species Team in site management techniques.

5. Conduct targeted research

Research into various aspects of the ecology and biology of *A. dockeri* needs to be conducted in order to increase scientific understanding of the species and to assist the Recovery Team in making appropriate management decisions. Whilst some of these studies can be performed utilising the existing skills of the Recovery Team and can be incorporated into existing management activities, other projects will require additional funding. The Recovery Team will liaise with other agencies, such as universities, in order to undertake targeted research into the following:

5.1 Cryo-preservation of plant material

It is highly desirable that the material from *A. dockeri* be cryogenically stored for long-term preservation. Seed from many threatened plant species in South Australia has been collected for cryo-preservation at the Seed Conservation Centre of the Department for Environment and Heritage. Due to seed in-viability this is not currently an option for *A. dockeri*, however it may be possible to develop a technique for isolating and storing meristem tissue. Plant meristems (micro shoot tips) need to be isolated from existing *in vitro* cultures (tissue culture plants) and subjected to a range of test variables to develop a cryo-preservation procedure whereby viable plant material can be maintained in perpetuity under liquid nitrogen at -196°C (P. Ainsley, pers comm. 2007). The optimised procedure will be used to establish long-term e*x situ* conservation collections for the five known clones of *A. dockeri*.

5.2 Life history studies

Five ramets at each site were tagged in 2000 as a component of the photo point monitoring. These ramets have been regularly monitored for changes in height and width (M. Jusaitis pers comm. 2005), this activity will continue for the life of the plan. This study may need to be expanded in the future to collect more detailed information and study whole *A. dockeri* plants rather than individual ramets.

5.3 Herbicide sensitivity trials

DEH is conducting a trial looking at the impacts of various weed control techniques. Cuttings from the Yangya clone have been raised at Mid-North Plant Diversity Nursery and planted at the Yangya road site, approximately 100 m west of the naturally occurring plants on the northern side of the road verge. Ten different treatments are being trialled to assess both their effectiveness in controlling weeds and any impacts on *A. dockeri*. These will be replicated three times. It is envisaged that this trial will run for 3 years and will involve repeat application of the treatments.

5.4 Ecological requirements and tolerances

A study into the ecological requirements and tolerances of *A. dockeri* is needed in order to guide management actions at the existing sites. This information may also be used to focus search efforts on the most suitable habitats, and to allow more accurate identification of developments or activities with the potential for a negative impact on *A. dockeri*. This information will also allow for an assessment of the potential impacts of climate change and allow for the identification of potential translocation sites.

5.5 Reproductive ecology and biology

Research needs to continue into the reproductive ecology and biology of *A. dockeri* in order to determine the factors limiting sexual reproduction. Attempts to germinate seeds will continue and if successful may lead to further studies regarding the reproductive biology and ecology of the species.

PART 5: Management Practices

The following actions may hamper the species' viability and recovery:

1. Disturbance or narrowing of the road verge at any of the sites
2. Tree planting or other inappropriate revegetation projects at any of the sites
3. Spraying or slashing that is not in accordance with site action plans/guidelines
4. Fire-break activities (cultivation, slashing or spraying) undertaken within road reserves instead of on adjoining land (as indicated in NAC (2001), such action would require application to the Native Vegetation Council)
5. Non-target damage associated with control of weeds declared under the NRM Act (2004)
6. Spray drift of chemicals from management of adjacent crops.

PART 6: Duration of Recovery Plan and Estimated Costs

6.1 Duration, responsibilities and estimated costs of recovery actions

Table 5: Duration, responsibilities and estimated costs of recovery actions

	Action	Responsibility	2007		2008		2009		2010		2011		Total
			Project Costs	Salary Costs	Project Costs	Salary Costs	Project Costs	Salary Costs	Project Costs	Salary Costs	Project Costs	Salary Costs	
1	**Management of 5 existing sites**												
1.1	Direct site management	DEH	6190	713.60	6499.5	713.60	6824.48	713.60	7165.70	713.60	7523.98	713.60	**37771.64**
1.2	Liaison with land managers & maintain signage	DEH	400	1427.19	420	1427.19	441	1427.19	463.05	1427.19	486.20	1427.19	**9346.22**
1.3	Population monitoring	DEH	300	1783.99	100	1783.99	105	1783.99	110.25	1783.99	115.76	1783.99	**9650.97**
	Photo point monitoring	DEH	2840	0.00	2982	0.00	3131.1	0.00	3287.66	0	3452.04	0	**15692.8**
2	**Establish additional sites***												
2.1	Site selection & planning	Rec team	6450	4281.58	6772.5	4281.58	0	0.00	0	0	0	0	**21785.658**
2.2	Collect & prepare cuttings	Blyth Nursery/DEH	1600	1783.99	1260	1783.99	0	0.00	0	0	0	0	**6427.9823**
2.3	Site preparation, planting & maintenance	DEH	2322	2854.39	4469.85	4281.58	4266.68	2854.39	4480.01	2854.39	4704.01	2854.39	**35941.665**
2.4	Monitor translocated populations	DEH	200	2140.79	300	4281.58	200	4281.58	210.00	4281.58	220.50	4281.58	**20397.604**
3	**Attempt to increase genetic diversity**												
3.1	Lab cross pollination trials	DEH	3000	1427.19	0	713.60	0	0.00	0	0	0	0	**5140.79**

	Action	Responsibility	2007		2008		2009		2010		2011		Total
			Project Costs	Salary Costs	Project Costs	Salary Costs	Project Costs	Salary Costs	Project Costs	Salary Costs	Project Costs	Salary Costs	
3.2	Combine genotypes in the field**												
3.2.1	Site selection & planning	Rec Team	0	0.00	0	0.00	7111.13	4281.58	0	0	0	0	**11392.704**
3.2.2	Collect & prepare cuttings	Blyth Nursery/DEH	0	0.00	0	0.00	441	1783.99	0	0	0	0	**2224.99**
3.2.2	Site preparation, planting & maintenance	DEH	0	0.00	0	0.00	2560.01	2854.39	2688.01	1427.19	2822.41	1427.19	**13779.19**
3.2.3	Monitor translocated populations	DEH	0	0.00	0	0.00	200	2140.79	2500.00	2140.79	200.00	2140.79	**9322.37**
3.3	Attempt to propagate seedlings												
3.3.1	Collect seed	DEH	0	356.80	0	356.80	0	356.80	0	356.80	0.00	356.80	**1783.99**
3.3.2	Attempt to propagate	DEH	810	356.80	850.5	713.60	893.03	713.60	937.68	713.60	984.56	713.60	**7686.95**
3.3.3	Establish & maintain in suitable translocation site***	DEH	10572	11060.75	200	3567.98	0	3567.98	0	3567.98	0.00	3567.98	**36104.67**
4	**Identify existing unknown populations**												
4.1	Increase public awareness	DEH/ Rec team/ DEC	1000	3924.78	1050	5708.77	1102.5	2854.39	1157.63	2854.39	1215.51	2854.39	**23722.34**
4.2	Conduct targeted searches	DEH/ Rec team/ DEC	12622	2140.79	13253.1	3567.98	9685.76	1783.99	10170.04	1783.99	10678.54	1783.99	**67470.19**
4.3	Manage newly discovered populations	DEH/DEC	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	**Unknown ******

	Action	Responsibility	2007 Project Costs	2007 Salary Costs	2008 Project Costs	2008 Salary Costs	2009 Project Costs	2009 Salary Costs	2010 Project Costs	2010 Salary Costs	2011 Project Costs	2011 Salary Costs	Total
4.4	Conduct genetic analysis of new populations	DEH/SA Museum	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	**Unknown ******
4.5	Monitor newly discovered populations	DEH	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	Unknown ****	**Unknown ******
5	**Stakeholder & community involvement in recovery process**												
5.1	Stakeholder involvement in recovery team	DEH/Rec Team	6600	3211.18	6930	3211.18	7276.5	3211.18	7640.33	3211.18	8022.34	3211.18	**52525.09**
5.2	Community awareness & involvement	DEH/Rec Team	1000	6422.37	1050	5708.77	1102.5	4995.18	1157.63	4995.18	1215.51	4995.18	**32642.30**
6	**Conduct targeted research**												
6.1	Cryo-preservation	DEH	0	713.60	5000	1070.40	0	0.00	0	0	0	0	**6783.99**
6.2	Life history studies	DEH	0	0.00		1070.40		1070.39		1070.39		1070.39	**4281.58**
6.3	Herbicide sensitivity trials	DEH	3540	1783.99	2485	1427.19	2485	1427.19	2485	1427.19	2485	1427.19	**20972.76**
6.4	Ecology	DEH	0	0.00	0	713.60	3000	713.60	0	0	0	0	**4427.19**
6.5	Reproductive biology	DEH	Unknown *****	Unknown *****	Unknown *****	Unknown *****	Unknown *****	Unknown *****	Unknown *****	Unknown *****	Unknown *****	Unknown *****	**Unknown ******
		Total	**59446**	**46383.77**	**53622.45**	**46383.77**	**50825.66**	**42815.79**	**44452.96**	**34609.43**	**44126.36**	**34609.43**	**457275.62**

Note: The successful implementation of this recovery plan will require one-third of the time of a regional threatened flora project officer and one-sixth the time of a community liaison officer, at a cost of $30 923 and $15 467 respectively, per year (including on-costs, office and operating expenses) for the first two years. After the first two years a smaller percentage of these two officers' time should be required to implement this plan. These salary costs have been broken down for each recovery action and are included under the salaries component.

* Estimates are based on plans to translocate the Telowie clone to an additional site. A mixed-gene translocation and Rusty Cab back-up translocation occurred in June 2007. Additional translocations may be necessary during the life of this plan but have not been calculated in this document. The need for additional translocations will depend on the results of both the cross-pollination experiments and the habitat searches.

** Estimate of cost based on establishing one field-based cross-pollination site. Additional sites may be required based on the results of the laboratory based cross-pollination trial.

*** Previous attempts to propagate *A. dockeri* seed have been unsuccessful, thus this action is unlikely to be necessary. This action has been calculated to occur in 2007 however this may occur in following years if initial attempts to propagate are unsuccessful.

****Costs cannot currently be accurately estimated, as it will depend on the number of additional subpopulations found, their location and the habitat condition at the site/s.

***** Costs cannot currently be accurately estimated without knowing the results of action 3.3.

6.2 Resource allocation

Implementation of this recovery plan will involve a co-operative approach between state government departments, local government, community groups, landholders and individual community members to ensure an efficient and effective use of resources. The Spiny Daisy Recovery Team links with organisations such as the Northern and Yorke Natural Resources Management Board, TPAG, DEH, Caltowie Corridors of Green, Blyth-Brinkworth Revegetation Committee, Greening Australia, DTEI, Northern Areas Council and the District Council of Mount Remarkable. The implementation of this plan will also contribute to *No Species Loss*: *A Nature Conservation Strategy for South Australia* 2007-2017 (DEH 2007).

The Recovery Team is aware of the resource limitations and has, in the past, and will continue to do so in the future, consider all appropriate linkages to ensure efficient use of resources and avoid unnecessary duplication.

A. dockeri has been identified as a conservation priority in Northern & Yorke Biodiversity Plan (Graham *et al* 2001) and the Northern & Yorke Agricultural District Integrated Natural Resources Management Plan (NYAD INRM 2003). The main habitat in which *A. dockeri* occurs (native grasslands in the Mid–North) is listed as a threatened ecological community under the Commonwealth *Environment Protection and Biodiversity Conservation* Act. The activities outlined in this plan will not only assist this nationally endangered plant species but also restore a threatened ecosystem.

Acknowledgments

The authors would like to thank the members of the Spiny Daisy Recovery Team who have greatly contributed to the management of this species over a number of years. Special acknowledgement must also be given to the many people who have volunteered their time for this project.

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APPENDIX 1: List of current regional, state and nationally based stakeholders in the management of *A. dockeri*

Broad Stakeholder Group	**Group**	**Manage/own**	**Recovery Team Representatives**
Regional Stakeholders			
General Mid-North Community	General community/ neighbouring landholders	X	4
SA Department for Environment and Heritage	Conservation Programs Unit, Northern & Yorke Region	X	Conservations Program Manager, Bush Management Advisor, Threatened Species Community Liaison Officer, Threatened Flora Ecologist
Community Groups	Blyth-Brinkworth Revegetation Committee	X	
	Mid-North Plant Diversity Nursery	X	Nursery Co-ordinator
	Biodiversity and Endangered Species Team	X	
	Caltowie Corridors of Green	X	
	Greening Australia		Bushcare Support Officer
Natural Resources Management Board	Northern & Yorke Natural Resources Management Board		
Council	Northern Areas Council	X	Councillor, Planning Officer
	District Council of Mount Remarkable	X	Deputy Works Manager
Department for Transport, Energy & Infrastructure	Mid-North Region	X	Environmental Officer
State Stakeholders			
General public			
Indigenous community			

Broad Stakeholder Group	**Group**	**Manage/own**	**Recovery Team Representatives**
State (CONT)			
SA Department for Environment and Heritage	Threatened Species Unit, Science & Conservation Directorate		Threatened Flora Ecologist
	Botanic Gardens of Adelaide Science & Conservation Directorate		Senior Biologist
Community Groups	Threatened Plant Action Group	X	Project Co-ordinator
World Wide Fund for Nature	Threatened Species Network		
National Stakeholders			
General public			
Commonwealth Department of the Environment and Water Resources			

APPENDIX 2: Plant species occurring with *Acanthocladium dockeri* near Hart and Laura, South Australia

Observers: Meg Robertson and Glenda Kleinig

Survey dates: 25-26 September, 17 October, November 2001 and February 2002

Vegetation Association: Modified native *Lomandra effusa* tussock grassland remnants on road verges

Location: (Northern Lofty Flora Region **NL**) Sites T, Y, R near Laura: Site **T** near Thornlea, Site **Y** on Yangya Road; & Site **R** "Rusty cab"; Site H (Hart, near Blyth), Site **Hg** grassland at Hart on opposite side of disused rail line ballast.

Plant species	Common name	Conservation status			Site					Comments
		AUS	SA	NL	T	Y	R	H	Hg	
Acacia victoriae ssp. victoriae	Elegant Wattle					+				two individuals
Acacia pycnantha	Golden Wattle						+			
Acacia sp.								+		
Acanthocladium dockeri	Spiny Daisy	CE	E	E	+	+	+	+		
**Arctotheca calendula*	Cape Weed					+	+			
Aristida behriana	Brush Wire-grass					+		+	+	on road & rail reserve - near northern end of Hart *A. dockeri* subpopulation
Arthropodium strictum	Common Vanilla-lily				+	+	+		+	
**Asphodelus fistulosus*	Onion Weed							+	+	rail and road reserve
Atriplex semibaccata	Berry Saltbush				+	+				
Austrostipa blackii	Crested Spear-grass				+	+	+		+	
Austrostipa eremophila	Rusty Spear-grass				+	+			+	
Austrostipa nodosa	Tall Spear-grass				+	+			+	

Plant species	Common name	Conservation status			Site					Comments
		AUS	SA	NL	T	Y	R	H	Hg	
Austrostipa sp.	Spear-grass						+			
**Avena barbata*	Bearded Oat				+	+	+	+	+	major annual weed all sites
**Brachypodium distachyon*	False Brome				+	+	+	+	+	
**Bromus rigidus*	Rigid Brome				+	+		+	+	
**Bromus rubens*	Red Brome				+					
Bursaria spinosa	Sweet Bursaria						+	+		adjacent to subpopulations
**Carrichtera annua*	Ward's Weed				+	+	+			major annual weed Laura sites
**Carthamus lanatus*	Saffron Thistle					+	+			
**Centaurea* sp.	Star Thistle					+	+			
Convolvulus erubescens	Australian Bindweed					+		+		
**Critesion murinum*	Barley-grass				+	+		+	+	
**Cynara cardunculus*	Artichoke Thistle								+	on, under and on other side of rail ballast
Danthonia caespitosa	Common Wallaby-grass					+			+	
Danthonia sp.	Wallaby-grass				+	+	+			2 or more species
**Desmazeria rigida*	Rigid Fescue							+		road shoulder
**Echium plantagineum*	Salvation Jane				+	+	+	+	+	major weed at Hart
Enchylaena tomentosa var. *tomentosa*	Ruby Saltbush							+		
Enneapogon nigricans	Black-head Grass				+					
Enteropogon acicularis	Umbrella Grass			Q	+					need to voucher
**Erodium* sp.	Heron's-bill/Crowfoot				+	+	+			2 species at Thornlea

Plant species	Common name	Conservation status			Site					Comments
		AUS	SA	NL	T	Y	R	H	Hg	
Euphorbia drummondii	Caustic Weed					+				
**Gazania* sp.	Gazania					+				on northern road shoulder
Goodenia pinnatifida	Cut-leaf Goodenia			U		+				
Goodenia pusilliflora	Small-flower Goodenia				+					
**Gynandriris setifolia*	Thread Iris				+	+	+			
Halgania cyanea	Rough Blue-flower					+				
**Hedypnois rhagadioloides*	Cretan Weed					+				
**Heliotropium europaeum*	Common Heliotrope				+				+	
Homopholis proluta	Rigid Panic							+		rail and road reserve
**Lolium perenne*	Perennial Ryegrass					+	+			
Lomandra effusa	Scented Mat-rush				+	+	+		+	
Lomandra multiflora ssp. *dura*	Hard Mat-rush							+	+	
Maireana brevifolia	Short-leaf Bluebush				+	+				
Maireana enchylaenoides	Wingless Fissure-plant					+	+			
Maireana rohrlachii	Rohrlach's Bluebush		R	V	+	+				
**Malva* sp.	Marshmallow				+					
**Marrubium vulgare*	Horehound					+				
**Medicago* sp.	Medic				+	+	+			2 species at Yangya
**Muscari armeniacum*	Grape Hyacinth					+				
**Oxalis pes-caprae*	Soursob					+		+	+	major weed at Hart - perennial
**Pallenis spinosa*	Golden Pallenis						+			

Plant species	Common name	Conservation status			Site					Comments
		AUS	SA	NL	T	Y	R	H	Hg	
**Pennisetum clandestinum*	Kikuyu							+	+	
**Phalaris aquatica*	Phalaris								+	in drain under railway ballast
Pimelea micrantha	Silky Riceflower				+	+		+		
**Piptatherum miliaceum*	Rice Millet							+	+	potential major weed - perennial
**Polygonum aviculare*	Wireweed				+					
**Polypogon monspeliensis*	Annual Beard-grass							+		check identity - on road shoulder
**Rapistrum rugosum* ssp. *rugosum*	Turnip Weed				+	+	+	+	+	major weed
Salsola kali	Buckbush				+					
**Salvia verbenaca* form	Wild Sage				+	+	+	+	+	potential major weed - perennial
**Scabiosa atropurpurea*	Pincushion				+	+		+	+	potential major weed - perennial
Scaevola humilis	Inland Fanflower				+	+				
Senna artemisioides	Desert Senna							+		
Sida corrugata	Corrugated Sida				+	+	+			
**Solanum elaeagnifolium*	Silver-leaf Nightshade					+				
**Solanum nigrum*	Black Nightshade								+	on ballast
**Sonchus oleraceus*	Common Sow-thistle				+		+			
Teucrium racemosum	Grey Germander					+	+			
**Trifolium angustifolium*	Narrow-leaf Clover					+				
Velleia paradoxa	Spur Velleia			Q	+	+				
**Vicia* sp.	Vetch				+			+	+	
Vittadinia blackii	Narrow-leaf New Holland				+	+				

Plant species	Common name	Conservation status			Site					Comments
		AUS	SA	NL	T	Y	R	H	Hg	
	Daisy									
Vittadinia cuneata	Fuzzy New Holland Daisy					+				check identity
Vittadinia gracilis	Woolly New Holland Daisy				+	+	+			
**Vulpia* sp.						+				

T- Thornlea, Y- Yangya, R- Rusty cab, H-Hart, Hg- Hart siding

Conservation Status Codes described below are from Lang, P.J. & Kraehenbuehl, D.N. (1997). *Plants of Particular Conservation Significance in South Australia's Agricultural Regions.* (2000 update of unpublished database), Department of Environment & Heritage, South Australia.

CONSERVATION STATUS CODES

The categories below may apply to the whole of a species distribution (usually equivalent to the Australian (AUS) level) or to a specified part of a species distribution at State (SA) or regional level (AD region code NL Northern Lofty).

They are listed in order of decreasing conservation significance.

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

E - Endangered: rare and in danger of becoming extinct in the wild.

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

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

U - Uncommon: less common species of interest but not rare enough to warrant special protective measures.

Q - Not yet assessed but flagged as being **of possible significance**.

APPENDIX 3: Preliminary list of plant species occurring with *Acanthocladium dockeri* at the Telowie site

Observers: Anne Brown and Paul Slattery

Survey Dates: 29th January and 21st May 2007

Plant Species	Common Name	Conservation Status			Comments/Other sites where species occurs
		AUS	SA	NL	
Acacia victoriae spp. victoriae	Elegant Wattle				Yangya
Acacia ligulata	Umbrella Bush				
Acanthocladium dockeri	Spiny Daisy	CE	E	E	All sites
Alectryon oleifolius ssp. canescens	Bullock Bush			U	
Austrostipa scabra	Rough Spear-grass				
Austrostipa elegantissima	Feather Spear-grass				
Bursaria spinosa spp. spinosa	Sweet Bursaria				Hart and Rusty Cab
**Carrichtera annua*	Ward's Weed				Thornlea, Yangya and Rusty Cab
Convolvulus erubescens/remotus	Native Bindweed				
Dodonaea viscosa	Sticky Hop-bush				
Enchylaena tomentosa var. tomentosa	Ruby Saltbush				Hart
Enneapogon nigricans	Black-head Grass				Thornlea
Enteropogon acicularis	Umbrella Grass			Q	Thornlea
Eremophila longifolia	Weeping Emu Bush				

Plant Species	Common Name	Conservation Status			Comments/Other sites where species occurs
		AUS	SA	NL	
**Galenia pubescens*	Coastal Galenia				
Maireana brevifolia	Short-leaf Bluebush				Thornlea and Yangya
Olearia decurrens	Winged daisy-bush				
**Oxalis pes-caprae*	Soursob				Yangya and Hart
Pimelea micrantha	Silky Rice-flower				Thornlea, Yangya and Hart
Rhagodia parabolica	Mealy Saltbush				
Sisymbrium orientale	Indian Hedge mustard				
Vittadinia sp.	New Holland Daisy				*Possibly V. blackii*

CONSERVATION STATUS CODES

The categories below may apply to the whole of a species distribution (usually equivalent to the Australian (AUS) level) or to a specified part of a species distribution at State (SA) or regional level (AD region code NL Northern Lofty).

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