Australian Government

Government of South Australia
Department for Environment and Heritage

Recovery Plan for

the Peep Hill Hop-bush

Dodonaea subglandulifera

2010

Kylie Moritz and Doug Bickerton

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

Cite as:
Moritz. K.N. and Bickerton, D.C. (2010). *Recovery Plan for the Peep Hill Hop-bush* Dodonaea subglandulifera 2010. Report to the Recovery Planning and Implementation Section, Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra.

ISBN 978-0-9806503-4-1

Note: This recovery plan sets out the actions necessary to stop the decline of, and support the recovery of, the listed threatened species or ecological community. The Australian Government is committed to acting in accordance with the plan and to implementing the plan as it applies to Commonwealth areas.

The plan has been developed with the involvement and cooperation of a broad range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the plan due to changes in knowledge.

Further copies of this Recovery Plan are available from:
Ecologist, Threatened Flora
Threatened Species and Ecological Communities Unit
Department for Environment and Heritage
Plant Biodiversity Centre
PO Box 1047
Adelaide SA 5000

Cover photograph: *Dodonaea subglandulifera* fruit nearing maturity. Photo by Tim Jury, Threatened Plant Action Group (2005).

Table of Contents

Abbreviations

ALT	Australian Landscape Trust
BDBSA	Biological Databases of South Australia
CITES	Convention on International Trade in Endangered Species
CP	Conservation Park
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEH	Department for Environment and Heritage, South Australia
DEWR	Department of Environment and Water Resources, Australia
DTEI	Department for Transport, Energy and Infrastructure, South Australia
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
IPA	Indigenous Protected Area
IUCN	International Union for the Conservation of Nature
LAP	Local Action Plan
N&Y	Northern and Yorke Region
NPW Act	*National Parks and Wildlife Act 1972*
NRM	Natural Resource Management
RT	Recovery Team*
SA	South Australia
SAAL	South Australian Arid Lands
SAMDB	South Australian Murray Darling Basin
SCC	Seed Conservation Centre, Department for Environment and Heritage
sp	species (singular)
spp	species (plural)
subsp	subspecies
TFO	Threatened Flora Officer
TPAG	Threatened Plant Action Group

* A *Dodonaea subglandulifera* 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: Kieran Brewer, Peter Copley, Len Davies, Jody Gates, Manfred Jusaitis, Tom Loffler, Jerry Smith, Yvonne Steed, Rosemary Taplin and Roman Urban. Funding for the preparation of this plan was provided by the Australian Government.

Part 1: Species Information and General Requirements

1.1 Species Conservation Status and Taxonomy

1.1.1 Current Conservation Status:

Dodonaea subglandulifera J.G. West is currently listed in South Australia as 'Endangered' on Schedule Seven of the *National Parks and Wildlife Act 1972* (NPW Act), and also nationally Endangered on the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The species is conserved at two sites, a conservation park and a sanctuary, in the form of translocated subpopulations.

Previously, this species was only known from six sites with a total population of less than 3000 individual plants (Kahrimanis *et al.*, 2001; Graham *et al.*, 2001). However, information collected for this plan increased knowledge of extant occurrences to 45 sites and over 45,700 individual plants, comprising 11 subpopulations (Appendix II).

1.1.2 Taxonomy and Description:

Family name: Sapindaceae
Scientific name: *Dodonaea subglandulifera*
Common Name: Peep Hill hop-bush

Dodonaea, commonly called hop-bushes, are primarily an Australian genus with 61 species identified (Jessop and Toelken, 1986). *Dodonaea subglandulifera* is a South Australian endemic species previously known incorrectly as *D. tenuifolia* (Jessop and Toelken, 1986). It is an erect, perennial shrub growing 1 to 2 m high. It has short pinnate leaves approximately 1.5 cm long with 9-17 viscous leaflets with raised glands on their lower surface (Jessop and Toelken, 1986; Jusaitis and Sorensen, 1994). The plant is dioecious and flowers between February and August. Flowers occur in groups of 2 or 3. Female plants are prominent when in fruit with capsules varying in colour from greenish-yellow to deep maroon on separate bushes. Capsules are 3- to 4-winged (Jessop and Toelken, 1986).

1.2. International Obligations

Dodonaea subglandulifera 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.

1.3. Affected Interests

Successful implementation of this recovery plan is dependent on the involvement of a wide range of stakeholders. A total of 51 community groups, private landowners, land managers and statutory organisations have been identified as current and potential stakeholders in the management of *D. subglandulifera* within South Australia (Appendix I).

Nineteen of the stakeholder groups/individuals, including 12 private landholders, 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 (Appendix I). Each was invited to provide input into and/or comment on the plans development. Significant information contained within this plan, including information about new sites and threats to sites, 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.

1.4. Roles and Interests of Indigenous People

Implementation of recovery actions under this plan aims to include consideration of the role and interests of Indigenous communities in the region. Identification and consultation with the relevant Indigenous groups has been undertaken by Aboriginal Partnerships, Department for Environment and Heritage (DEH), SA, since May 2008. No comments have been received.

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

1.5. 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 for *Dodonaea subglandulifera*. There is limited information regarding species of conservation significance that co-occur within the range of this species. The available details are outlined below.

Dodonaea subglandulifera is found in several types of habitat including two that are considered to be poorly or moderately conserved in South Australia: *Eucalyptus porosa* (mallee box) +/- *Callitris gracilis* (Murray pine) low open woodland and *C. gracilis* dominated low open woodland. Neagle (1995) considers communities dominated by *E. porosa* to be poorly conserved due to lack of populations in reserves and the isolated, fragmented and often degraded nature of remnants in South Australia. *C. gracilis* is considered moderately conserved in South Australia (Neagle, 1995). Management or protection of *D. subglandulifera* in areas where these two communities occur will benefit the protection and management of these communities.

Two plant species listed as rare under the NPW Act, *Swainsona tephrotricha* (ashy-haired Swainson-pea) and *Maireana rohrlachii* (Rohrlach's bluebush), have been recorded at, or within 200 m of, *D. subglandulifera* sites (DEH, 2004). Protection and management of *D. subglandulifera* at these sites would also enhance the conservation of these two species.

Stagonopleura guttata (diamond firetails), vulnerable under the NPW Act, as well as *Corcorax melanorhamphos* (white-winged choughs) and *Melanodryas cucullata* subsp *cucullata* (sth-eastern hooded robin), both rare under the NPW Act, have been recorded at the site of the largest known sub-population of the Peep Hill hop-bush. *Cacatua leadbeateri* (Major Mitchell's cockatoo), which is listed as rare under the NPW Act, has been recorded from sites within 1 km of *D. subglandulifera* records. This species utilises areas including semi-arid *Callitris gracilis* woodlands and feeds on seed of *C. gracilis* (Blakers *et al.*, 1984). Protection and management of *D. subglandulifera* sites would potentially improve the habitat and food source for all of these bird species.

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.

1.6. Social and Economic Impacts

This recovery plan is unlikely to cause significant adverse social and economic impacts. However one potential economic impact has been identified for a landowner who has a gravel pit in close proximity to a *D. subglandulifera* sub-population. This individual may potentially experience an economic impact through loss of income if working the quarry is deemed to impact on this species. Certain management activities may also need to be altered to better manage this species, for example grazing. Changes to grazing regimes, reduced grazing area or grazing time may create an economic or resource impact on some landowners. Action 3 (see Section 4.2) includes consulting and working with landholders to minimise any potential economic impact of implementing this recovery plan.

Local Government may benefit from financial assistance for the management of roadside reserves. However protecting existing populations on road reserves may 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 populations might need to be canvassed.

A number of beneficial social and economic impacts are 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 regional Threatened Flora Officers and communication between regional Natural Resource Management boards. Identified economic benefits include managing weeds that may have potential to impact on productive land.

Part 2: Distribution and Location

2.1. Definitions

Sub-population:
Sub-populations are defined under IUCN criteria as geographically or otherwise distinct groups in a population between which there is little exchange (typically one successful migrant or gamete or less per year) (IUCN, 2001). No research has been conducted on the genetics or vectors of seed and pollen dispersal for *Dodonaea subglandulifera*; hence a decision was made to define sub-population on a spatial basis rather than a genetic one. For the purpose of this recovery plan groups of *D. subglandulifera* less than 3 km apart were grouped as part of the same sub-population, following the approach taken by Taylor (2003).

2.2. Current Distribution and Important Populations

2.2.1 Current Distribution

Dodonaea subglandulifera is endemic to South Australia and has a restricted and disjunct distribution within the state. It has been recorded from semi-arid mallee areas of the South Australian Murray Darling Basin (SAMDB), Northern and Yorke Region (N&Y) including Yorke Peninsula, and the Flinders Ranges in the South Australian Arid Lands (SAAL) (Table 2.1; Figure 2.1).

Prior to developing this recovery plan, information collated on *D. subglandulifera* generally only covered six sub-populations containing a total population of less than 3000 individual plants (Kahrimanis *et al.*, 2001; Graham *et al.*, 2001). Collation of additional information from the Biological Databases of South Australia (BDBSA 2009), and personal communications with individuals that had undertaken surveys for *D. subglandulifera*, showed this species to be more widely distributed and abundant than previously known. For this recovery plan, data collected since 1990 have been included as the current distribution of this species. From current knowledge *D. subglandulifera* is now considered to be extant in at least 11 distinct sub-populations, containing 45 sites and more than 45,700 individual plants (Figure 2.1). Historical data are dealt with in Section 2.3, Past Distribution.

Significant portions of this information were derived from surveys by Smith (2000), who recorded new sites on both private land and road reserves. This included previously unknown sub-populations near Walker Flat and Scrubby Flats (Figure 2.2). Further searches of properties near Black and White Hill have also increased the known abundance.

2.2.2 Potential Distribution

It is suggested that more populations may be found if searches of appropriate habitat were undertaken of the country between Morgan and Eudunda, and the area around Peterborough and Terowie, in N&Y. It is possible that populations also remain undiscovered to the east of Burra Creek Gorge and in the Scrubby Range to the east of Terowie (Smith, 2000). Populations could also be found in the area between Waikerie and Morgan and south to Walker Flat, in the SAMDB.

Table 2.1 Known current and historic sub-populations and approximate number of *Dodonaea subglandulifera* sites, in order of abundance.

Region	Sub-population name	No. of Sites	No. of plants (approximate)	Date last observed
SAMDB	Peep Hill	17	>30800	2010
SAMDB	Black and White Hill	7	>9,065	2008
N&Y	Eagle Hawke Gate Rd	4	>5,155	2007
N&Y	Wallaroo	1	360	2008
SAMDB	Walker Flat	6	>200	2002
SAMDB	Notts Well	1	50 - 60	1992
N&Y	Blackpoint Hill	1	35	2007
SAMDB	Brookfield CP	3	30	2008
SAMDB	Yookamurra Sanctuary	4	16	2008
SAMDB	Scrubby Flats	2	15	2002
N&Y	Pt Wakefield	1	>6	2008
SAMDB	Neales Flat	1	1	1987
SAAL	Flinders Ranges NP	1	?	1988
SAMDB	Canegrass (Ex)	1	?	1937
N&Y	Peterborough (Ex?)	1	?	1932

Ex = presumed extinct; Ex? = possibly extinct; IPA = Indigenous Protected Area

Figure 2.1. The location of known sub-populations of *Dodonaea subglandulifera* in South Australia

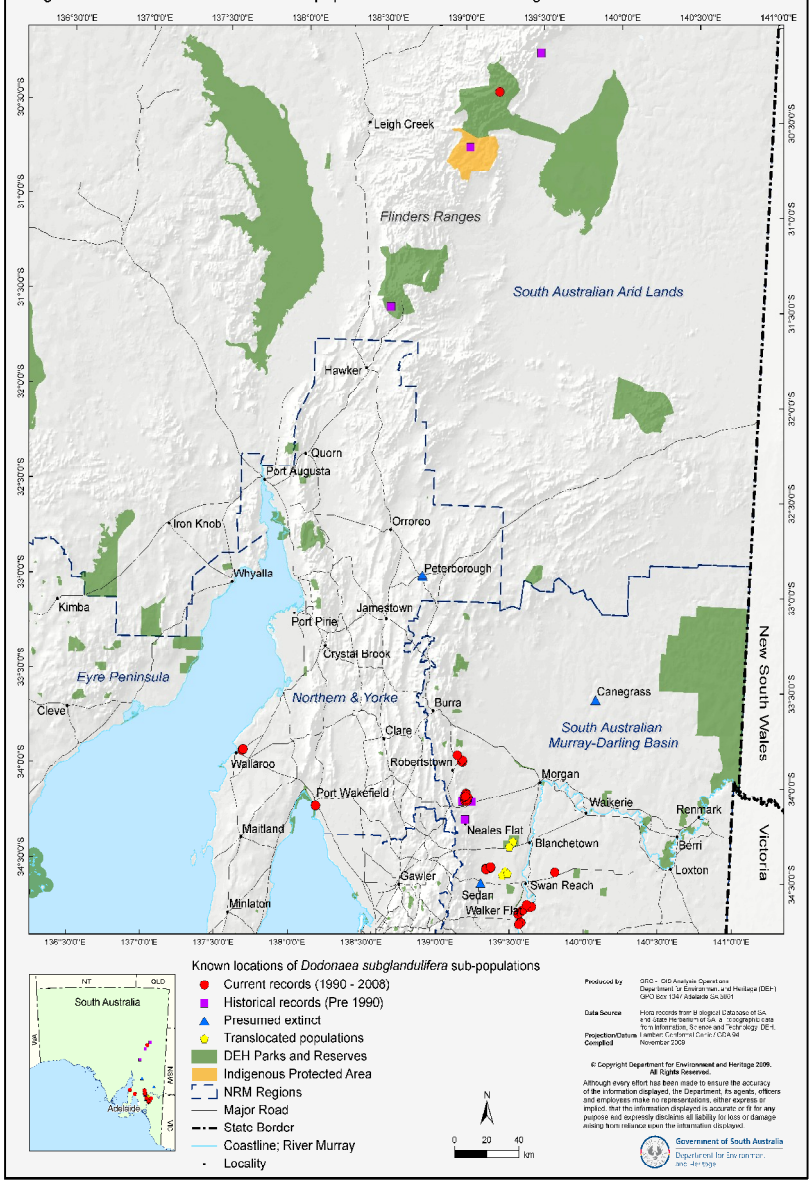


Figure 2.2. The location of known sub-populations of *Dodonaea subglandulifera* in the South Australian Murray Darling Basin

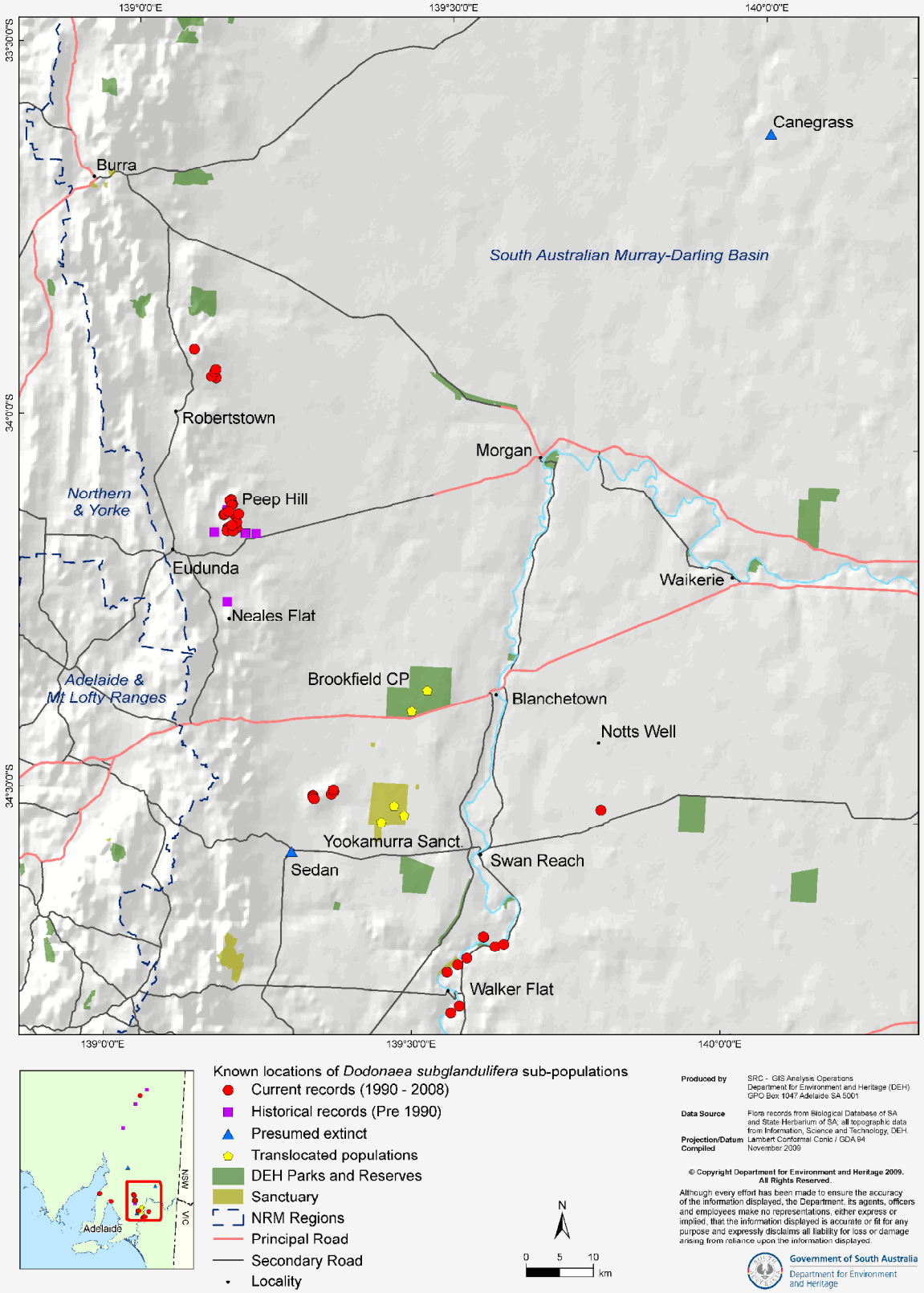
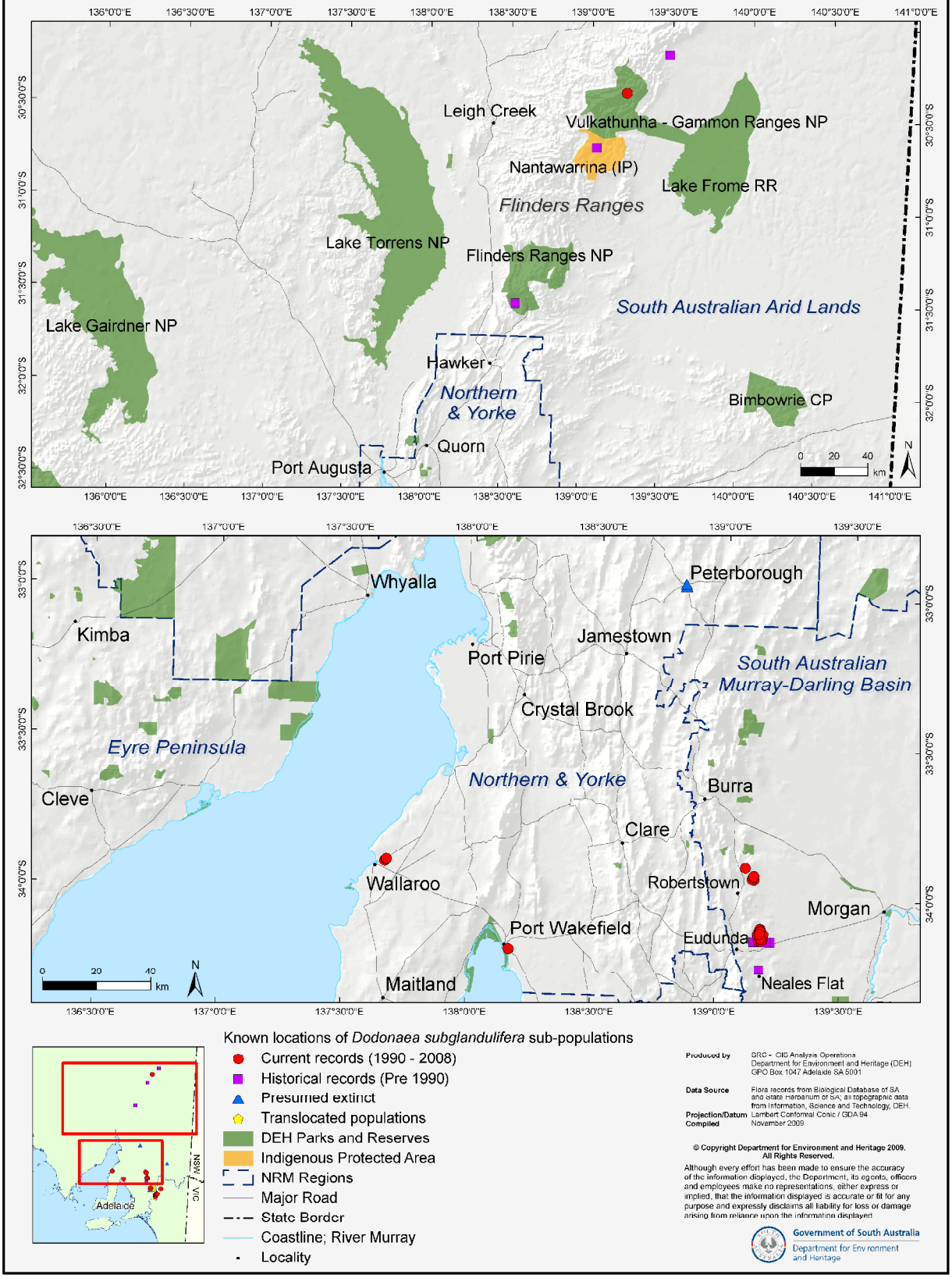


Figure 2.3. The location of known sub-populations of *Dodonaea subglandulifera* in the Flinders Ranges and in the Northern and Yorke



2.2.3 Important Sub-populations and Sites

Details of 9 important sub-populations where current information is available on abundance and/or habitat condition are provided below. A preliminary list of priority sites is also detailed (Table 2.2). Preliminary priority sites are based on existing data, including the number of plants present, quality of vegetation in which it occurs and the regional importance. Full details of all sites are provided in Appendix II. A more formal identification of priority sites is recommended as an action in this plan.

Table 2.2 Preliminary priority sites of *Dodonaea subglandulifera* for management and protection

Sub-population	Site No.*	No. of plants	Vegetation quality
Peep Hill	1a - 1j	>20,200	High
Peep Hill	1k - 1m	>5,040	?
Peep Hill	1n	Hundreds	?
Peep Hill	1o - 1q	>5,100	?
Black and White Hill	2a	3,040	Low
Black and White Hill	2c	Several thousand	?
Black and White Hill	2e	Many hundreds	High
Black and White Hill	2d	500	Low
Eagle Hawke Gate Rd	3a - d	>5,000	High
Wallaroo	4	360	Low
Walker Flat	5c - g	200	Low
Neales Flat	6	50 - 60	Grazed
Blackpoint Hill	5a	35	?
Yookamurra Sanctuary	10a - c	16	High
Brookfield CP	11a, b	30	High

* Refer to Appendix II for details of each site based on Site Number.

Peep Hill

In the Peep Hill area, approximately 10 km from Eudunda, there are 17 extant sites containing *Dodonaea subglandulifera*. Seven sites occur on private land and the remainder are on adjacent roadsides. Smith (2000) reported a number of properties adjacent to Peep Hill Road and Slate Road (1a - 1d), with more than 20,000 individual plants spread over approximately 200 ha. Here it occurs in high quality remnant vegetation of open *Eucalyptus porosa* woodland and although it has been reported to be very lightly grazed the *D. subglandulifera* stand is over 2 m high. This cluster of sites, including adjacent roadsides (1e – 1j) is the largest and most significant known for *D. subglandulifera* and is identified as a priority (Table 2.2).

An additional priority group of sites (1k - 1n) containing more than 5000 plants occurs on two private property sections north and north-west of Border Road, near the corner of Slate Road (Smith, 2000). One priority group of sites (1o – 1q) of approximately 5000 plants is recorded from private land due south of Australian Plains in the vicinity of Cemetery Road (often referred to as the Peep Hill population) and a further 100 plants occur on adjoining roads (Smith 2000, BDBSA 2009). In the Peep Hill area the species generally occupies areas that would not have been cleared due to being on sharp rocky hills or roadsides (Davies, pers. comm. 2004). At one site however the species was described as a woody weed that emerged with *D. viscosa* following clearance (Davies, pers. comm. 2004).

Because of the close proximity of all sites in the Peep Hill area, they should be considered part of the one sub-population. There is no information available on the age structure or the presence of seedlings within this sub-population.

Black and White Hill

A Murray Mallee sub-population occurs near Black and White Hill, containing five sites of *Dodonaea subglandulifera*. One private property (2a) has several thousand plants, which have re-established after a cropping paddock was left fallow for a decade. It is suggested that the plants at this site may be at risk from mining. The road adjacent, School Bus Road (2b), has approximately 500 plants and the property south of Site 2a (2c) also has many hundreds of plants growing in healthy native shrubland. Both juvenile and adult plants have been recorded at all three sites. Another site containing approximately 3000 plants on private property adjacent to the Black and White Hill water tanks is a priority site (Site 2d, Appendix II). Approximately 40 plants occur on adjacent roadsides (2e, 2f). Approximately 25 isolated plants are located nearby, along the Swan Reach-Stockwell pipeline (2g), which is managed by SA Water. The pipeline site contains individuals or small numbers of plants with little surrounding vegetation.

Robertstown

On Eagle Hawke Gate Road, approximately 7.5 km to the north-west of Robertstown, four sites have been recorded by Smith (2000) containing over 5055 plants on private land (3a, c & d) and 100 plants on the roadside reserve (3b). The private land is noted to contain high quality native vegetation and is identified as a priority site for protection and management (Table 2.2). There is no information available on the age structure or the presence of seedlings within this sub-population.

In 2007 a smaller sub-population of 35 plants was discovered near Blackpoint Hill approximately 10 km N of Robertstown (Site 7). Little is known of this site.

Wallaroo

A relatively small sub-population of approximately 360 plants occurs 5 km north-east of Wallaroo on the Yorke Peninsula (BDBSA, 2009). This is the only sub-population known from Yorke Peninsula and the westernmost of all sub-populations. The site runs for 750 m on both sides of a road, within remnant vegetation that is 30-40 m wide along its length (Steed, pers. comm. 2004). This sub-population is identified as Priority Site (4) due to its regional importance (Table 2.2).

Walker Flat and Scrubby Flats

Surveys by botanist Kieran Brewer (pers. comm., 2004) identified two sites of *Dodonaea subglandulifera* near Scrubby Flat, south of Walker Flat in the Murray Mallee region (10a, 10b).

On the road north of Walker Flat to Nildottie (Sites 5a – 5e), Brewer discovered about 200 plants along the eastern cliffs of the River Murray. Most plants in this area have been recorded in the roadside reserve, 100 to 200 m from the cliff edge. There is also a record from 1996 (BDBSA 2009) on Devon Downs Homestead, which is possibly one of the sites Brewer discovered. The sites around Walker Flat are composed of sheet limestone, contain mostly older plants (0.5 to 1 m in height) and show signs of being heavily grazed. A small number of seedlings have been recorded at these sites. The surrounding area has been substantially cleared.

Notts Well

A small number of plants occur south of Notts Well in the Murray Mallee region, on roadside managed by Local Government and in private land close to the road (Site 6). Up to 60 plants have been recorded at this site in the past during seasons of good rain (Loffler pers. comm., 2004). Plants in this area are reported as stunted, possibly as a result of heavy grazing by stock, rabbits or kangaroos (Loffler pers comm., 2004; Jusaitis pers. comm., 2004). Heavy grazing pressure is suggested to occur in years of drought or low rainfall (Loffler pers. comm., 2004). There is no information available on the plant age structure at this site, but recruitment is noted to be very low, possibly due to the grazing pressure (Loffler pers. comm., 2004).

Yookamurra Sanctuary and Brookfield CP

Two sites in Brookfield Conservation Park (Sites 8a, 8b) and three in Yookamurra Sanctuary (Sites 9a – 9c) contain planted *Dodonaea subglandulifera*. These plantings were made in 1991 and 1992 as part of a translocation experiment undertaken by the State Herbarium, using seeds collected from Peep Hill (Jusaitis, 1997). A fourth site at Yookamurra and a third site at Brookfield were also planted, but no plants have survived at these sites. Thirty individuals were planted at each site, and by 2008, 46 of the 210 original individuals remained (M. Jusaitis, DEH, pers. comm., 2009).

Port Wakefield

A small subpopulation has been recorded near the highway a few kilometres south of Port Wakefield (Site 11). Only six plants were noted on the road reserve, with a few plants on adjacent property. The habitat was described as weedy grass herblands with scattered Acacias. It is thought that the plants at this site established from seed mixed with rubble from another site (Taplin, pers. comm. 2004).

Other records

The Biological Databases of SA (BDBSA 2009) contain a 1998 record of *D. subglandulifera* from Vulkathunha-Gammon Ranges National Park (Site 13). This sighting was recorded during a DEH Biological Survey, and a vouchered specimen was collected at the time; however the specimen has since been determined not to be *D. subglandulifera.*

2.3. Past Distribution and Historical Records

It is likely that *Dodonaea subglandulifera* occurred more commonly in the plains country above the cliffs of the River Murray from Waikerie to Morgan and through to Walker Flat and extended into the mallee towards the east where it is found at Notts Well. The species could also have occurred more commonly in the rolling hills country between Peep Hill and Robertstown, and north into the Flinders Ranges.

In the Flinders and Gammon Ranges, *Dodonaea subglandulifera* was recorded at three locations in 1988: Wooltana Station near Arkaroola Sanctuary in the Gammon Ranges; Nantawarrina Indigenous Protected Area in the Gammon Ranges; and from Wilpena Pound in the Flinders Ranges National Park (BDBSA, 2009). Only the Wilpena Pound record has been vouchered. The species has been noted as possibly extinct from the Flinders Ranges (Kahrimanis *et al.*, 2001). Additionally, there is some disagreement as to whether the records are correct. One possibility is that at least two of the records may be a misidentified *D. lobulata* (Brandle, pers. comm. 2004; Taplin, pers. comm. 2004; Neagle, pers. comm. 2004). Verification of these sites is part of Action 1.

In 1987 a single plant was noted just east of Neales Flat township (BDBSA 2009). Recent surveys have failed to locate any plants in this vicinity.

There are three historical records from Sutherlands, east of Eudunda, dating from between 1929 and 1989 (BDBSA). These records are either from a sub-population now extinct or they refer to Peep Hill nearby.

The State Herbarium has records more than 60 years old from Sedan, Peterborough, and Canegrass Station. Because of the lack of spatial reliability of the records, it is possible that the Sedan record refers to one of the Black and White Hill sites. The Canegrass Station subpopulation is considered to be extinct. The Peterborough subpopulation was also considered to be extinct; however there is a report that an amateur botanist has recently collected a specimen of *D. subglandulifera* from Tunnel Hill near Peterborough (K. Brewer, consultant, pers. comm., 2010). This reported collection is yet to be confirmed.

One record of *Dodonaea subglandulifera* from Mt. Billy Conservation Park, Southern Mt. Lofty Ranges, is known to be an incorrect database record (R. Taplin, Adelaide Herbarium, pers. comm.).

2.4. Habitat Critical to the Survival of the Species

Given that this species is currently listed as nationally endangered it is considered that all currently occupied and potential habitat is critical to its survival.

Specific habitat types appear to be preferred by this species and these can be described as two distinct environments:

i) Plains with sand to loamy soils over sheet limestone, and
ii) Low hills with loamy soils over shale or slate.

Dodonaea subglandulifera occurs primarily on low hills on loamy soils associated with rocky (limestone, slate, shale) outcrops (Jusaitis and Sorensen, 1994; Smith, 2000). These low hills occur to the east of the range country, just before the vegetation changes to mallee flats (Smith, 2000). The species has also been recorded from plains country in sandy soils over limestone.

Dodonaea subglandulifera occurs in native vegetation associated with rock outcrops including low open woodland, open shrubland and mallee. Habitat records include *Eucalyptus porosa* +/- *Callitris gracilis* +/- *Acacia calamifolia; E. dumosa* +/- *Allocasuarina verticillata; E. oleosa; E. phenax* with *C. gracilis* and *Beyeria lechenaultii*; *C. gracilis* with *Alectryon oleifolius* and *B. lechenaultii; Acacia argyrophylla*; and *A. hakeoides* (Appendix III). The understorey is quite variable at most sites.

Dodonaea subglandulifera occupies an area of South Australia that has an average annual rainfall of greater than 100 mm and less than 400 mm. Vegetation association, topography, soil type, and climate will be used to determine potential habitat for this species.

Part 3: Threats and Impediments to Recovery

3.1 Biology and Ecology Relevant to Threatening Processes

Reproduction

Dodonaea subglandulifera is a dioecious species (having separate male and female plants). Female plants flower from February to June, with seed capsules maturing between August and December (Jusaitis and Sorensen, 1994). Seed dehiscence occurs over the warmer months of December and January before flower buds emerge in February (Jusaitis and Sorensen, 1994). As a dioecious species, *D. subglandulifera* requires a pollinator that can readily transport pollen from the anthers of the male plant to the stigmas of the female plant (Jusaitis and Sorensen, 1994). Honeybees and ants have been observed on flowers at Black and White Hill and a *Dodonaea subglandulifera* anther has been seen attached to the leg of a honeybee (*Apis mellifera*) (Jusaitis and Sorensen, 1994). The natural pollinator for this species has not been determined.

Propagation and reintroduction

Given suitable conditions, both direct seeding and seedlings can be used to revegetate areas with *D. subglandulifera*. Research into the propagation and reintroduction of *D. subglandulifera* was undertaken at the Black Hill Flora Centre. The species is easily cultivated and has potential for landscape garden use (Jusaitis and Sorensen, 1994). *D. subglandulifera* is commercially grown for floriculture at the Australian Landscape Trust (ALT), South Australia. Plants used for floriculture at ALT have been propagated from cuttings collected from Peep Hill (Davies, pers. comm. 2004).

Seed has been successfully collected using weed mat positioned under bushes (Jusaitis and Sorensen, 1994). Soaking seed in just boiled water for 30 seconds was the most effective pre-treatment for germination. Such pre-treated seeds could then be stored at 15°C for up to 12 weeks prior to direct seeding or germination without loss of viability (Jusaitis and Sorensen, 1994). Seeds were planted at Yookamurra Sanctuary and Brookfield Conservation Park. Yookamurra Sanctuary is a privately owned park surrounded by an electric fence, free of rabbits and foxes (Jusaitis, 1997). Seedlings planted into Brookfield Conservation Park showed lower survival rate compared to those planted into Yookamurra Sanctuary, largely as a result of rabbit grazing and burrowing activities. This was highlighted by a 100% mortality of seedlings at one site (Jusaitis, 1997).

Morphological / genetic differences between sub-populations

There appears to be a difference between plants at the Notts Well, Wallaroo and Walker Flat sub-populations which occur on flat country in sandy soils over limestone (Plains group), compared to the Peep Hill and Black and White Hill sub-populations which occur on low hills with loam over slate (Hills group). Differences include leaf colour, size of plants, bee harvesting of leaf secretions and seed production.

The Plains group has foliage that is very dark green in colour and very tightly positioned and the plants are generally stunted (Loffler, pers. comm. 2004). By comparison, Hills group plants have light green foliage that is open and the plants can stand to 2 m (Smith, 2000: Jusaitis, pers. comm. 2004). Loffler (pers. comm., 2004) notes that kangaroos appear to graze the Notts Well plants right down to ground, but do not appear to heavily graze the Peep Hill plants. This may be the result of a difference in the density of kangaroo populations and/or food availability at each site. Jusaitis (1997) suggests that Notts Well may simply contain a stunted variety of *Dodonaea subglandulifera*.

Plants in the Plains group (excluding Wallaroo) have been observed with honeybees (*Apis mellifera*) crowding over the leaves and appear to obtain something from the leaves (Brewer, pers. comm. 2004; Loffler, pers. comm. 2004). Harlequin beetles were also observed at the Wallaroo sub-population sucking sap from new stems, leaving the new growth dry and withered (Jusaitis and Sorensen, 1994). This phenomenon of bees working the leaves has not been observed at Peep Hill or Black and White Hill, and may also contribute to the stunted appearance of the Notts Well and Walker Flat plants.

Loffler (pers. comm., 2004) has observed the Notts Well sub-population in flower, but no seeds have been observed at this site. The Peep Hill and Black and White Hills sub-populations, by comparison, flower and seed readily and seed has been successfully collected and propagated from both these areas (Jusaitis, 1997; Brewer, pers. comm. 2004). However some variation in leaf form and flower colour has also been observed at one property within the Peep Hill population (B. Goulder, pers. comm., 2010).

Loffler (pers. comm., 2004) suggests that there may be a male dominance in at least one population, Notts Well. From 300 seedlings propagated from Notts Well seed, 99% were male yet some of these plants turned to female at 3-4 years of age (Loffler, pers comm. 2004). The number of plants that became female was not determined (Loffler, pers. comm. 2004). It is not known if this is a trait of the *Dodonaea* genus or of this species. It is worth noting that the Notts Well population is very small, containing between 12-60 plants, depending on seasonal conditions.

Disturbance requirements

The *Dodonaea* genus is generally known as an early colonising group of species following disturbances and some *Dodonaea* species are considered as woody weeds in pastoral country due to their ease of regeneration. It is not known whether *D. subglandulifera* has a dependence on a form of disturbance event to stimulate plant reproduction and recruitment. The species however has been noted to come up in gravel that had been moved into an area at Port Vincent, supporting the idea that the species is a coloniser and can germinate following disturbance.

3.2 Identification of Threats

Identified threats to *D. subglandulifera* are outlined below in order of priority. The major threats to *D. subglandulifera* include the lack of formal protection and management of significant sites and roadside sites, and the lack of knowledge of the threats that exist and their impact. Grazing by stock and rabbits has been identified as a threat at several sites.

The information on site location, abundance, area of occupancy and population structure varies considerably, and some is out of date. Three sites require a determination of extant or extinct status and for other sites current information only relates to location. Detailed habitat information exists for only five sites. Deficiencies in the knowledge of the ecology and biology of *D. subglandulifera* include rate of recruitment, percentage survival of plants, disturbance requirements, pollination processes, seed viability, seed bank dynamics and gender allocation. Additionally current knowledge does not adequately identify threatening processes or assist management decisions at the majority of sites. Our understanding of the actual impact of these threatening processes also varies greatly. This currently incomplete knowledge of distribution, abundance, biology, ecology and threats acts as a constraint to the recovery of the species.

Table 3.1 Potential Threats to the Recovery of *Dodonaea subglandulifera*

	Potential Threats	
Direct threats	1.	Herbivore grazing
	2.	Road management activities
	3.	Environmental weeds
	4.	Mining
	5.	Declining genetic viability
Indirect threats	6.	Lack of formal protection
	7.	Inappropriate disturbance regimes
	8.	Small isolated populations

3.2.1 Herbivore grazing

The available information indicates that inappropriate grazing pressure by domestic stock and feral and native animals poses a threat to the recovery of *Dodonaea subglandulifera.* The impacts of grazing have been noted at several sub-populations although the extent of this threat has not been fully determined. Grazing of *D. subglandulifera* by introduced and native vertebrate herbivores is considered a potential threat to growth, reproduction, survival and recruitment. Grazing may also have secondary impacts in the form of weed dispersal and disturbance encouraging weed establishment and growth.

Grazing is considered particularly significant for sub-populations where grazing pressure is heavy during drought periods. Heavy grazing pressure by native herbivores or rabbits and stock has been noted at the Notts Well sub-population during harsher environmental conditions, resulting in plants being eaten to ground level and then re-sprouting basally. Impacts from grazing stock were also noted at the Robertstown roadside population (Smith, 2000). This grazing may also have occurred during periods when fodder was scarce in paddocks. Rabbits were shown to have a heavy negative

impact on a revegetation site at Brookfield Conservation Park, where plants were not protected (Jusaitis, 1997).

A study of stock grazing at Black and White Hill showed that very few seedlings remained after grazing and that sheep grazing would lead to a population decline over time (Jusaitis and Sorensen, 1994). By comparison, a Peep Hill site with a history of very light grazing experienced strong regeneration and recruitment of the hop-bush after stock were removed (Goulder, pers. comm., 2010). Inappropriate grazing pressure by stock, kangaroos and rabbits poses a serious threat to the long-term survival of this species.

3.2.2 Road management activities

Sites that occur on roadside reserves generally contain a small number of individual plants, occur in narrow remnant vegetation and are mostly small and isolated. Threats experienced by small isolated populations are outlined above (Section 3.2.6). Roadside 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 and heavy machinery. Roadside reserves are also potentially threatened by the work of contractors maintaining power, water and telecommunication services along easements.

Roadside populations of this species are important, as they constitute more than 50% of known sites (Appendix II). Several *Dodonaea subglandulifera* sites on road reserves have been noted as being effected by vegetation clearance through road maintenance works. The inappropriate management of roadside reserves poses a serious threat to the long-term survival of this species.

3.2.3 Environmental weeds

The presence of environmental weeds is a possible impediment to the recovery of *D. subglandulifera,* however the extent and impact of weeds on this species has not been fully determined. Currently weeds are only identified at four sites (Appendix III), and are predominantly agricultural in nature; however African Boxthorn (*Lycium ferocissimum*)*, Galenia secunda,* Cotton-bush (*Gomphocarpus* sp.), Horehound (*Marrubium vulgare*)*,* and Iceplant (*Mesembryanthemum crystallinum*), which have been recorded at one site near Peep Hill, are particularly invasive and potentially a threat to the hop-bush. Weeds may not pose a significant threat across the species range due to its presence in semi-arid country where weeds are generally less competitive with shrubs. Weeds may however have the potential to directly affect the recruitment and survival of *D. subglandulifera* seedlings through direct competition for resources including light, nutrients, space and moisture. Sub-populations that are within small fragmented areas including those on roadside reserves are at greatest risk.

It should be noted that the presence of weeds is often the result of other causes of ecosystem degradation, such as land clearance and the spread of feral animals.

3.2.4 Mining

The extent of this threat has not been fully determined, although one site in the Black and White Hill sub-population (2a) has an active granite quarry situated in the immediate vicinity of several thousand *D. subglandulifera*, with some plants contained within the boundary of the mining lease. This poses a potential threat to *D. subglandulifera* through the possible direct removal of plants to access quarry materials and indirect impacts of mining activities, or any future potential expansion of the mining lease area.

3.2.5 Declining genetic viability

Small sub-populations that have been isolated by clearance of native vegetation are often unable to effectively exchange genetic material with other sub-populations, posing a risk from the effects of inbreeding, or declining genetic viability (Cropper, 1993). This may have impacts on plant growth rate, reproduction and recruitment and eventually lead to a decline in the number of individuals (Cropper, 1993). Two sub-populations of *D. subglandulifera* are showing evidence of either reduced or total loss of flowering and/or the presence of almost 100% male plants in the population (Loffler, pers. comm. 2004). Many population viability factors are not known for this species, such as the effective minimum size of a sub-population, number of female plants, male to female ratio and the number of female plants that set seed, and these factors may be contributing to declining genetic viability. Sub-population isolation and small population size therefore pose a potential threat to the long-term survival of *D. subglandulifera* at some sites.

3.2.6 Lack of formal protection

Currently the only known populations of *Dodonaea subglandulifera* occurring naturally within Reserves, Heritage Agreements or other formally covenanted areas in South Australia are artificially planted populations at Brookfield CP and at Yookamurra Sanctuary (a privately owned wildlife sanctuary). Of the known sites of this species, 17 occur on private land, including the largest population estimated to contain over 20,000 individual plants. The lack of formal protection and management of any populations of this species is a threat to its long-term survival.

3.2.7 Inappropriate disturbance regimes

The extent of this threat has not been fully determined. *Dodonaea* is generally known as an early colonising genus following disturbances. Several *Dodonaea* species are considered as woody weeds in pastoral country due to their ease of regeneration; however it has been reported (B. Goulder, pers. comm., 2010) that the plants that regenerated in one previously cropped paddock at Peep Hill have not become invasive or dominant. It is not known whether *D. subglandulifera* shows dependence on a form of disturbance event to stimulate plant reproduction and recruitment.

3.2.8 Small isolated populations

Dodonaea subglandulifera is suspected to have occurred more widely than its current known distribution. As a result of past fragmentation of habitat and clearance it is now found in mostly small and isolated sub-populations. Small and isolated populations experience threats, including a greater susceptibility to extinction by a single catastrophic event and a high edge to area ratio, therefore more likely to be subject to impacts along their edges (i.e. weed invasion, small-scale clearing, grazing, and exposure to fertiliser drift).

Jusaitis and Sorensen (1994) state that the localised and concentrated nature of populations of *Dodonaea subglandulifera* is a threat as catastrophic events could eliminate sizeable populations very quickly. The small and isolated nature of many *D. subglandulifera* sites therefore poses a risk to the long-term survival of this species.

3.3 Sub-Populations under Threat

Most sub-populations are considered to be under threat due to lack of formal protection, road management activities, herbivore grazing and inappropriate disturbance regimes. The sub-populations considered under threat are detailed below. Some information regarding threats to sub-populations is also contained in the previous section 'Identification of Threats'.

Peep Hill and Robertstown

Roadside reserves within the Peep Hill sub-population have been identified as being subjected to possible clearance due to road widening activities (Smith, 2000). A report was developed for the Regional Council of Goyder identifying roadside sites in this area containing *D. subglandulifera*. Stock grazing along roadsides at Robertstown has been identified as a threat during drought periods (Smith, 2000).

Black and White Hill

A study of stock grazing at Black and White Hill (Jusaitis and Sorensen, 1994) found a decreased average growth rate index at the site, with a large number of dead plants and very few seedlings. At another site recruitment and regeneration of *D. subglandulifera* was observed following the removal of stock. One site has mining as a potential threat (Section 3.2.4).

Wallaroo

Severe weed infestation at this site is potentially preventing seedling regeneration and survival (Jusaitis and Sorensen, 1994). Weeds recorded as prolific in roadside vegetation at this site include *Avena fatua* (wild oat), *Oxalis pes-caprae* (soursob), *Echium plantagineum* (salvation Jane) and *Marrubium vulgare* (horehound) (Jusaitis and Sorensen, 1994). Steed (pers. comm., 2004) also noted the presence of *Euphorbia terracina* (false caper) and *Diplotaxis tenuifolia* (Lincoln weed).

The Threatened Plant Action Group (TPAG) has carried out weed management works at this site and part of the site has also been fenced using Department for Transport, Energy and Infrastructure (DTEI) funding (Steed, pers. comm. 2004).

Notts Well

Grazing by native herbivores and a potential decline in genetic viability are identified threats to the Notts Well sub-population. This sub-population is known to vary from 6 to 60 plants depending on the

environmental conditions and grazing pressure. In a good rainfall year plants are reported as large, however, in a drought or lower rainfall year they are eaten off and difficult to find (Loffler, pers. comm. 2004). Loffler (pers. comm., 2004) suspects that this is the result of grazing by stock, native herbivores or rabbits. Plants however, are considered to be able to withstand this heavy grazing due to the presence of very sandy soils, which provide a protection to the base of plants from which they can resprout basally (Loffler, pers. comm. 2004). Recruitment at this site is very low, possibly due to the grazing pressure.

Seed has been collected and propagated from this sub-population. Over 300 seedlings were propagated resulting in 99% male plants, however when plants were 3-4 years old a number appeared to become female (Loffler, pers. comm. 2004). The reason for this change in gender is yet to be determined.

Walker Flat

The sites near Walker Flat show signs of heavy grazing, and are also threatened by vegetation clearance.

Yookamurra Sanctuary and Brookfield CP

Of the 210 individuals planted at these sites, only 46 remained when last monitored in 2008 (M. Jusaitis, DEH, pers. comm.). It was noted that the number of extant plants had declined considerably since 2006, and the cause of decline is considered to be the drought in the previous two years.

Plants have also been grazed by rabbits at these sites, particularly at Brookfield. The grazing pressure was particularly severe, resulting in a substantial loss of seedlings.

Part 4: Objectives, Recovery Actions and Performance Criteria

4.1 Objectives

Long-term Objective:
The overall objective of this Recovery Plan is to reduce the extinction risk of this species so that it is downlisted under the EPBC Act and the NPW Act from a category of endangered to one of vulnerable.

Short-term Objectives:
1. Mitigate threats caused by herbivore grazing, road management activities, weed invasion and mining.

2. Ensure protection of priority sites.

3. Maintain or increase the number of populations, area of occupancy and abundance of the species.

4. Investigate morphological and/or genetic variation between populations.

5. Monitor populations and determine the limiting factors for viability.

4.2 Actions

Currently there is incomplete knowledge regarding the distribution, abundance and threats to *Dodonaea subglandulifera*. Actions that follow are therefore based on the limited knowledge that is available and will need to be adjusted as new information is gathered. The first action required is therefore to obtain a better understanding of the species status and to determine what threats are present at each site. A review of the conservation status of *D. subglandulifera*, based on this new information, should be undertaken. Other actions address the threats identified in the previous section.

The timelines for implementation of recovery actions have been summarised as follows:

P1	Action required to commence immediately, in Year 1.
P2–P3	Action required to commence in short term, Years 2 - 3.
P4–P5	Action required to commence in longer term, Years 4 - 5.

1. Survey existing populations.

1.1 Survey and monitor existing populations recording details of location, area of occupancy, number of plants, life history structure, % survival, sex ratios and habitat type. (P1)

1.2 Assess major threats to each population. (P1)

Justification and Methods:
Quantitative data need to be obtained covering the exact location, number of plants, area of occupancy, relative age structure, recruitment, percentage survival, sex ratios, relationship between bud/flower and seed set, and description of plant habitat, including plant association and topography, to allow for effective recovery. Important populations also need to be monitored over time to detect any changes in these parameters. Any morphological variation between populations should be noted. Surveys should be undertaken to determine the presence and extent of threats at each site where threats are not fully known. Surveys should record the type of threat present and measure extent of the threat by using indicators including the number of seedlings, seedling survival and age structure. The surveys should also attempt to determine the current and potential impact on different life stages. 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 to the site. Information will need to be gathered from all sites that have not been visited since 1995, to ensure information is current. Data will also be collected for sites where the visit date is unknown and where the population is suspected to be extinct. Priority sites should be surveyed first. All data will need to be accurately mapped and information reported back to the centralised Threatened Plant Population database.

Responsibility: RT, TFO.

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

2.1 Assess the information obtained in Action 1 to re-evaluate the priority sites to conserve and manage. (P2)

Justification and Methods:
Based on current information a number of sites have been identified as a preliminary list of priority sites for action (Table 2.2). A formal list of priority sites will be developed based on surveys undertaken in Action 1. Sites will need to be prioritised for recovery actions based on the number of plants at the site, total area occupied, quality of habitat, presence of threats and regional importance.

Responsibility: RT, TFO.

3. Ensure protection of priority sites.

3.1 Liaise with appropriate stakeholders including landowners, councils, Dept of Transport, Energy and Infrastructure (DTEI). (P1)
3.2 Negotiate Heritage Agreements or binding conservation covenants if appropriate. (P2)
3.3 Undertake the initial reduction of risk at priority sites. (P2)
3.4 Work with local government to ensure that development approvals do not impact on the species. (P2)
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 are initially those identified based on current information and will be adjusted using the results of surveys. Based on current information seven sites are priorities for formal protection (Table 2.2). 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 a primary threat at a site then the site may be fenced; if weeds are the major threat then weed management will be undertaken. In addition, local government will be consulted and provided with information to prevent new developments impacting on the species. Current land managers will also be consulted and provided with relevant information to ensure that management and land uses do not change to impact on the species. Mitigation actions will be monitored and evaluated to ensure that the risk reduction is occurring.

Responsibility: RT, TFO, Local Government, land owners.

4. Manage priority populations on road reserves

4.1 Undertake management works on priority roadside reserves. (P1)
4.2 Work with appropriate Councils to ensure that *Dodonaea subglandulifera* is included in Council Roadside Management Plans. (P2)
4.3 Implement the Significant Roadside Marker System within relevant district Councils. (P3)

Justification and Methods:
Priority sites for management works are initially those identified based on current information (Table 2.2), and will be adjusted if necessary based on the results of Action 2. The long-term conservation of plants on roadside reserves depends on sustainable management practices being undertaken by land managers. Local Councils will be worked closely with to inform them of the species, identification, site location and management requirements, and to assist with management practices. Management requirements will be worked into Council Roadside Management Plans 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 that significant flora is present.

Responsibility: RT, TFO, local government.

5. Collect and store seeds for the Millennium seed bank project.

5.1 Collect samples of seed from a sample of populations, for storage at the Seed Conservation Centre (SCC). (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)

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 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 populations or populations with low numbers of females (based on the results of Action 1) to ensure a future supply of *ex situ* seed. This seed should be stored with the long-term seed storage facilities at the SCC, DEH.

Responsibility: RT, TFO, SCC.

6. Investigate the existence of morphological variation between populations.

6.1 Undertake field surveys of populations where morphological variation has been reported in Action 1 (record number of plants, leaf colour and size, plant height, flowering and seed set and bee activity) to determine if morphological variation exists. (P2)

6.2 If variation is identified, conduct field/glasshouse experiments to determine if the variation has an environmental or genetic basis. (P3)

6.3 Undertake genetic analysis to identify genetic variation within and between populations. (P3)

6.4 If variation is identified, whether morphological or genetic, reassess priority sites from Action 2, and consider during protection and management (Actions 3-4), to ensure variation is conserved. (P4)

Justification and Methods:
Targeted research is required to determine if a morphological or genetic variation exists between populations of *Dodonaea subglandulifera* in the field. Field surveys will need to record details of any morphological variation in the colour and size of leaves, height of plants, extent of flowering and seed set, sex ratios, sex change and the presence and activity of pollinators on plants. The size of each population, area and number of plants, should also be recorded. Field and glasshouse experiments should be used to determine if the variation is of an environmental or genetic basis. If a genetic basis for variation is indicated then genetic testing should be undertaken to qualify this.

Responsibility: DEH, RT, TFO, Researchers.

7. Investigate minimal viable population size and possible declining genetic viability.

7.1 Evaluate survey data from Action 1 to determine if small populations correlate to low flowering and seed set and uneven sex ratios and if these populations are potentially unviable. (P2)

7.2 If small populations are identified as potentially unviable, undertake field surveys to determine what is causing small population size at each site. (P3)

7.3 Undertake field/glasshouse experiments to determine how to overcome the cause of small population size. (P3)

7.4 Conduct experiments to determine the minimum viable population size, optimum sex ratios and the potential for declining genetic viability within small populations. (P3)

7.5 If following Action 7.3 there are indications that population size would be improved by the use of disturbance, investigate the use of specific disturbance methods at some sites. (P4)

Justification and Methods:
The results of Action 7.1 will determine if the rest of this action is required i.e. if small population size is correlated to variables identified as relating to declining genetic viability. Minimal viable population size and optimal sex ratios will be evaluated from the population size and area, number of female plants, proportion of females that set seed and seed viability.

Responsibility: DEH, RT, TFO, Researchers.

8. Manage small populations to ensure a viable population size.

8.1 Evaluate the information gained from Action 7 to determine the best method of ensuring viable populations. (P4)

8.2 Manage each small population (in conjunction with Actions 3-4) to ensure viable populations based on the hypothesis derived for each population in Action 8.1. (P4)

8.3 Monitor and evaluate whether these actions are having the desired effect, changing the hypotheses and management techniques if necessary. (P4)

Justification and Methods:
The results of this action will be used to adaptively manage the species by determining appropriate management methods that promote persistence.

9 Manage the potential threat caused by mining

9.1 Work with landholders to develop strategies to ensure that *Dodonaea subglandulifera* is not directly or indirectly impacted on by current and future mining activities (P2).

Justification and Methods:
Surveys will be used to determine the extent of the threat of mining at sites. The importance of this species will be explained to quarry owners where the quarry is located in close proximity to *Dodonaea subglandulifera* sites. Strategies will be jointly developed to minimise the direct and indirect impact of mining activities on plants.

Responsibility: RT, TFO, land owners/managers

10. Survey for potential habitat and undiscovered populations

10.1 Identify, map and survey potential habitat for undiscovered populations, and map potential sites for revegetation projects (P3).

Justification and Methods:
Possible habitat of *Dodonaea subglandulifera* will be identified through interrogating GIS mapping looking at preferred vegetation associations, soil type, topography and rainfall. Possible habitat maps will be developed based on this work and used to undertake dedicated surveys to search for new populations and locate potential revegetation sites.

Responsibility: DEH, RT, TFO

11. Undertake strategic revegetation.

11.1 Using results of Actions 2.1, 6.4 and 10.1, identify strategic revegetation sites. (P4)
11.2 Develop a translocation proposal. (P4)
11.3 Collect seed from suitable sites and commence propagation. (P4)
11.4 Work with landholders adjoining priority roadside sites to undertake revegetation to buffer sites. (P5)
11.5 Revegetate new sites if necessary. (P5)

Justification and Methods:
Strategic revegetation sites will include those already managed for nature conservation, sites of existing small populations which can be expanded and sites where genetic variability either is in decline or needs preserving. The key to survival of small isolated sub-populations is to make them larger through strategic revegetation or encourage regeneration. Revegetation into new sites will aim to increase the number of established populations and establish populations in secure areas. Revegetation should also aim to increase the size of roadside sites and thus reduce edge effects, and to buffer these areas from negative impacts. Landholders of land adjoining roadside sites should be consulted to determine actions to assist increasing the size of, or buffering, priority roadside sites. Translocation proposals should be written for selected sites. The SCC should be approached for assistance in seed collection and propagation.

Responsibility: RT, TFO, DEH (including SCC), land owners/managers.

12. Recovery process and communication

12.1 Establish and maintain *Dodonaea subglandulifera* Recovery Team (P1).
12.2 Employ Threatened Flora Officer to coordinate recovery process and conduct recovery actions as indicated above (P1)

Justification and Methods:
The Recovery Team shall consist of representatives from DEH (Threatened Species and Ecological Communities Unit, Murraylands Region, N&Y, SCC); SAMDB and N&Y NRM Regions, local government and landholders.
The Threatened Flora Officer will conduct communication activities and be involved in and coordinate the implementation of recovery actions, with advice from the Recovery Team.

Responsibility: DEH

4.3 Performance Indicators

Action	Associated Performance criteria
1.1. Survey existing populations.	1.1. Sites surveyed and baseline information collated for all known sites within two years.
1.2. Assess major threats to each population.	1.2. Sites surveyed to determine threats and potential threats within two years.
2.1. Determine the priority sites to conserve and manage.	2.1. Priority sites for formal protection identified within two years.
3.1. Liaise with appropriate stakeholders	3.1. Discussions held with stakeholders regarding management of priority sites within two years.
3.2. Negotiate Heritage Agreements or binding conservation covenants if appropriate.	3.2. Priority sites formally protected within five years.
3.3. Undertake the initial reduction of risk at priority sites.	3.3. Threat mitigation initiated for priority sites within two years.
3.4. Work with Local Government to ensure that development approvals do not affect the species.	3.4. Development approvals not affecting the species within three years.
3.5. Monitor and evaluate to ensure risk reduction is having the desired effect.	3.5. Risk reduction monitoring underway within three years.
4.1. Undertake management works on priority roadside reserves.	4.1. Reduction of threats to roadside sites initiated within one year.
4.2. Work with appropriate Councils to ensure that the species is included in Council Roadside Management Plans.	4.2. Species incorporated into Council Roadside Management Plans within two years.
4.3. Implement the Roadside Marker System within relevant district Councils.	4.3. Significant Roadside Marker System implemented in three to five years.
5.1. Collect and store samples of seed from a sample of populations.	5.1. Seed from a sample of populations collected and stored at the SCC within the second year.
5.2. Run seed viability tests	5.2. Seed viability test commenced by the end of the first year.
6.1. Field surveys to qualify if morphological variation exists.	6.1. Morphological variation quantified via field surveys within three years.
6.2. Conduct experiments to determine if the variation has an environmental or genetic basis.	6.2. Basis of variation identified within four years.
6.3. Undertake laboratory tests to identify genetic variation between populations.	6.3. Genetic variation between populations identified within four years.
6.4. If variation is identified, reassess priority sites, to ensure variation is conserved.	6.4. Priority sites re-assessed if necessary within four years.
7.1. Determine if small populations correlate to low flowering and seed set and uneven sex ratios and if these populations are potentially unviable.	7.1 Correlation between small population size and variables determined within three years.
7.2. If small populations are identified as potentially unviable, undertake field surveys to determine what is causing each population to remain small.	7.2. Cause of small population size determined for each population within three years.
7.3. Undertake field/glasshouse experiments to determine how to overcome the cause of small population size.	7.3. Methods of managing cause of small populations determined within four years.
7.4. Investigate minimum viable population size, optimum sex ratios and declining genetic viability within small populations.	7.4. Minimum viable population size, optimum sex ratios and declining genetic viability determined within four years.
7.5. If following Action 7.3, indications are that population size would be improved by the use of disturbance, investigate the use of these at some sites.	7.5. Investigations into the use of disturbance methods as a method for increasing recruitment commenced within four years.
8 1. Evaluate the information gained from Action 7 to hypothesise the best method of ensuring viable populations.	8.1. Hypothesis developed for best method of ensuring viable populations within four years.
8.2. Manage each small population to ensure viable populations based on the hypothesis derived for each population in Action 8.1.	8.2. Each population managed to ensure viable populations within five years.
8.3. Monitor and evaluate whether these actions are having the desired effect, changing the hypotheses and management techniques if necessary.	8.3. Actions monitored and evaluated, changing the hypotheses and management techniques if necessary.
9.1. Work with landholders to develop strategies to ensure that *Dodonaea subglandulifera* is not directly or indirectly impacted on by mining activities	9.1. Mining no longer a threat to populations within five years.
10.1. Identify, map and survey possible habitat for undiscovered populations and map potential sites for revegetation projects.	10.1. Strategic surveys undertaken to search for new populations and revegetation sites within three years.
11.1. Identify strategic revegetation sites.	11.1. Revegetation sites identified within four years.

Action	Associated Performance criteria
11.2. Develop a translocation proposal.	11.2. A translocation proposal is developed within four years.
11.3. Collect seed from suitable sites and commence propagation.	11.3. Propagated plants ready for revegetation within five years.
11.4. Work with landholders adjoining priority roadside sites to undertake revegetation to buffer sites.	11.4. Strategic revegetation and regeneration undertaken at currently known sites within five years.
11.5. Revegetate new sites if necessary.	11.5. Revegetation at new sites commenced if necessary within five years.
12.1. Establish and maintain *Dodonaea subglandulifera* Recovery Team.	12.1 Recovery Team established within one year.
12.2. Employ Threatened Flora Officer to coordinate recovery process and conduct recovery actions.	12.2 Threatened Flora Officer engaged within one year.

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.

Part 5: Management Practices

Management practices which are required to avoid a significant impact on *Dodonaea subglandulifera* include: maintenance of the Biological Databases of South Australia; continuation of voluntary conservation management schemes; implementation of Council Roadside Management Plans, continuation of the Roadside Marker System; maintenance of the SCC and continued management of planted populations at Yookamurra Sanctuary and Brookfield Conservation Park.

Management practices undertaken in the vicinity of *D. subglandulifera* should be planned and implemented with careful consideration to ensure that this species and its habitat is not impacted upon. Actions which result in any of the following in habitat critical to survival of *D. subglandulifera* or in identified potential habitat (Action 10) could have a significant impact on the species:

- increased grazing pressure;
- erosion, compaction or disturbance to the soil surface;
- increased competition from weeds; and
- removal of vegetation.

To reduce the likelihood of development activities with a negative impact upon *Dodonaea subglandulifera*, the recovery plan includes Action 3.1 to provide relevant information to Local and State Government departments, including information on distribution, ecology and habitat. Approval authorities 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

6.1 Duration and Indicative Costs

Action	Description	Cost Estimates					
		First	**Second**	**Third**	**Fourth**	**Fifth**	**Total**
1.	Survey existing populations	3000	2000				**5000**
2.	Identify priority sites		4000				**4000**
3.	Ensure protection of priority sites	3000	6000	6000	6000	6000	**27000**
4.	Manage priority roadside populations	1000	2000	1000	1000	2000	**7000**
5.	Collect and store seeds	2100	2000	1000			**5100**
6.	Investigate the existence of morphological variation between populations		500	1000	1500		3000
7.	Investigate minimal viable population size and possible declining genetic viability		1000	5000	5000	1000	**12000**
8.*	Manage populations to ensure a viable population size				6000	5000	**11000**
9.	Manage threat of mining		1000	1000	1000	1000	**4000**
10.	Survey for potential habitat and new populations			6000			**6000**
11.	Undertake strategic revegetation				3000	5000	8000
12.	Recovery process and communication	12000	24000	22000	22000	21000	**101000**
	Total	21100	42500	43000	45500	42000	**194100**

* Action may not be required

References

Biological Data Bases of South Australia (2009). Data stored in Opportune, Plant Population, Reserve, State Herbarium and Survey Data Bases. Department for Environment and Heritage, South Australia.

Blakers M., Davies S.J.F and Reilly P.N. (1984). *The Atlas of Australian Birds*. Royal Australian Ornithologists Union, Melbourne.

Brandle, R. (2004), Personal communications. Department for Environment and Heritage, South Australia.

Brewer, K. (2004), Personal communications. Botanical consultant, South Australia.

Cropper, S. (1993). *Management of endangered plants*. CSIRO Publishing, Melbourne.

Davies, L. (2004), Personal communications. Australian Landscape Trust, Calperum Station, South Australia.

Goulder, B. (2010). Plant lists (various authors) compiled for the owner of Section 255 Hundred of Neales (Peep Hill). Supplied to the Department for Environment and Heritage, South Australia.

Graham A., Oppermann A. and Inns R.W. (2001). *Biodiversity Plan for the Northern Agricultural Districts*. Department for Environment and Heritage, South Australia

International Union for Conservation of Nature (2001). *IUCN Red List Categories and Criteria: Version 3.1*. IUCN, Gland, Switzerland and Cambridge, United Kingdom

Jessop, J.P. and Toelken H.R. (1986). *Flora of South Australia – Parts I-IV*. State Herbarium of South Australia, Adelaide.

Jusaitis, M. (1997). Experimental Translocations: Implications for the recovery of endangered plants. In *Proceedings of the 4th International Botanic Gardens Conservation Congress.* (Eds D.H. Touchell, K.W. Dixon, A.S. George and A.T. Wills). Kings Park and Botanic Gardens, WA.

Jusaitis, M. and Sorensen, B. (1994). Conservation Studies on Endangered Plant Species from South Australia's Agricultural Regions. Black Hill Flora Centre.

Kahrimanis M.J., Carruthers S., Oppermann A. and Inns R. (2001). *Biodiversity Plan for the South Australian Murray-Darling Basin*. Department for Environment and Heritage, South Australia

Loffler, T. (2004), Personal communications. Botanical consultant, South Australia.

Neagle, N. (1995). *An Update of the Conservation Status of the Major Plant Associations of South Australia*. Native Vegetation Conservation Section, Department of Environment and Natural Resources, South Australia.

Neagle, N. (2004), Personal communications. Department for Environment and Heritage, South Australia.

Smith, J. (2000). *A survey for nationally threatened plant species on Local Government reserves and roadsides in the Northern Mount Lofty Ranges*. Unpublished Thesis for an Honours Degree in Natural Resource Management. University of Adelaide.

Steed, Y. (2004), Personal communications. Threatened Plant Action Group, South Australia.

Taplin, R. (2004), Personal communications. Botanical consultant, South Australia.

Taylor, D. (2003). *Draft Recovery Plan for 15 Nationally Threatened Plant Species on Kangaroo Island, South Australia*. Report to Threatened Species and Communities Section, Environment Australia.

Threatened Species Scientific Committee (2008). Threatened Species Scientific Committee Guidelines for Assessing the Conservation Status of Native Species. Attached to *Threatened Species Nomination Form — For adding or changing the category of a native species in the list of threatened species under the* Environment Protection and Biodiversity Conservation Act 1999 *(EPBC Act)*, Department of the Environment, Water, Heritage and the Arts, at http://www.environment.gov.au/biodiversity/threatened/pubs/nominations-form-species.doc

Appendices

Appendix I: Current and potential stakeholders in the management of Peep Hill hop-bush

Regional Stakeholders		**Manage / own**	**Contacted**
South Australian community	General community / Private landholders	X	
Local Action Planning /Landcare groups / private companies	Murray Mallee LAP		X
	Eastern Hills & Murray Plains		X
	Mid-Murray LAP		X
	Mantung Maggae LMA		X
	Calperum Station (Len Davis)		X
	Yookamurra Sanctuary	X	X
	Australian Landscape Trust		
Natural Resource Management Boards	SA Murray Darling Basin NRM		X
	Northern and Yorke NRM		X
	SA Arid Lands NRM		
	SAMDB NRM		X
Local Government	District Council of Loxton-Waikerie	X	X
	Mid-Murray Council	X	X
	District Council Copper Coast	X	X
	Regional Council of Goyder	X	X
DEH Regional Conservation Programs (Bush Management Advisers and Regional Ecologists)	Murraylands		X
	Northern and Yorke Region		X
Regional support staff	Greening Australia - N&Y		X
Local botanists / enthusiasts	Jerry Smith – Botanist		X
	Kieran Brewer – Botanist		X
	Tom Loffler - Botanist		X
State Stakeholders		**Manage / own**	**Contacted**
General public			
Indigenous community			
Department for Environment and Heritage	Nick Neagle, Peter Lang, Rob Brandle		X
	Peter Copley, Doug Bickerton		X
Primary Industries and Resources SA			X
Department for Land, Water and Biodiversity Conservation			X
Department for Transport, Energy and Infrastructure	Tim Reynolds		X
SA Water		X	
Brookfield Conservation Park		X	
Country Fire Service			X
Native Vegetation Council	Craig Whisson		
Conservation Council of South Australia			
Threatened Plant Action Group	Tim Jury		X
Greening Australia			X
Botanic Gardens of South Australia	Phil Ainsley, Manfred Jusaitis		X
State Herbarium of South Australia	Rosemary Taplin, Bill Barker		X
Trees for Life	Andrew Allanson		X
National Stakeholders			
General public			
Department of Environment and Water Resources			
Worldwide Fund For Nature - Australia			
CSIRO			
Australian Network for Plant Conservation			

Appendix II: Current and historical records of *Dodonaea subglandulifera*.

Sub-population	Site	Source	Year	No. plants	Tenure	Site details
Peep Hill	1a, b	Smith	2010	>18,900	Private	Private properties near Slate Rd and Peep Hill Rd
	1c, d	Smith	2000	>1,100	Private	Private properties to the N & S of Peep Hill Rd.
	1e-h	Smith	2000	>80	Road reserve	4 sites with 20+ plants each on Peep Hill Rd between Schultz (Schutz?) & Slate Roads.
	1i-k	Smith	2000	>140	Road reserve	3 sites: 2 with 20+ and 1 with 100+ plants on Slate Rd
	1l	Smith	2000	>5000	Private	5000 plants on private property N of Boundary (Border?) Rd, near cnr of Slate Rd.
	1m	Smith	2000	20	Road reserve	20 plants on Boundary (Border?) Rd, near corner of Slate Rd
	1n	BDBSA	2001	Hundreds	Private	Hundred 150, Section 298. Scattered throughout whole hillside
	1o	Smith, BDBSA	2007	>5000	Private	Vicinity of Cemetery Road, S of Australia Plains
	1p, q	Smith, BDBSA	2000	>100	Road reserve	Cemetery Rd and adjacent road (Schwerdt Rd?); two sites of 50+ plants
Black and White Hill	2a	BDBSA	2008	Several thousand	Private	On Section 216, across 40 ha, Hundred of Bagot (supplementary notes from voucher AD 222651)
	2b	BDBSA	2008	500	Road reserve	On School Bus Rd, NW of Section 216, Hundred of Bagot (supplementary notes from voucher AD 222651)
	2c	BDBSA	2008	Many hundreds	Private	12 km NE of Sedan on Sedan-Blanchetown Rd. Approx 980m N of Swan Reach - Stockwell pipeline, 580m W of sealed road. On private property Hundred of Bagot, Section 215. Owned by Cleve and Maria Dean.
	2d-f	BDBSA	2008	3,040	Private / Road reserve	Private land near water tanks at Black and White hill (Section 115) and across road intersection on either side of road.
	2g	BDBSA	2003	25	SA Water	On either side of Swan Reach-Stockwell pipeline
Eagle Hawke Gate Rd (NW of Robertstown)	3a	Smith	2000	>5000	Private	7.5 kms NW of Robertstown. Property W of Eagle Hawke Gate Rd
	3b	Smith	2000	>100	Road reserve	7.5 kms NW of Robertstown. Eagle Hawke Gate Rd, S of Powerline Rd
	3c	Smith	2000	25 – 30	Private	8.2 kms NW of Robertstown. Eagle Hawke Gate Rd, S of Powerline Rd
	3d	Smith	2000	>30	Private	8.6 kms NW of Robertstown. Eagle Hawke Gate Rd, S of Powerline Rd
Wallaroo	4	BDBSA	2008	360	Road reserve	Wallaroo to Alford Rd. MM#5. On both sides of road.

Sub-population	Site	Source	Year	No. plants	Tenure	Site details
Walker Flat	5a-e	Brewer	2002	200	Road reserve	5 sites between Walker Flat and Nildottie, 100m from cliff
	5f	BDBSA	1996	?	Private	Devon Downs Homestead, on cliffs above Murray River
Notts Well	6	BDBSA	1992	50-60	Road reserve / Private	2km N of Swan Reach-Waikerie Road, on road to Notts Well. On roadside on east and west and in Section on east
Blackpoint Hill (N of Robertstown)	7	BDBSA	2007	35	Private	9.7 km NNW of Robertstown, 1.5 km WNW of Blackpoint Hill. In very good native vegetation. Section 259 Hd English.
Brookfield CP	8a	Jusaitis	2008	17	Conservation Park	Conservation Park on Sturt Hwy, approx 7.6 kms W of Murray River
	8b	Jusaitis	2008	13		
	8c	Jusaitis	2008	0		
Yookamurra Sanctuary	9a	Jusaitis	2008	9	Sanctuary	Privately owned sanctuary, approx 4.8 kms N along Yookamurra Rd from Angaston – Swan Reach Rd
	9b	Jusaitis	2008	3		
	9c	Jusaitis	2008	4		
	9d	Jusaitis	2008	0		
Scrubby Flats	10a	Brewer	2002	13	Road reserve	1.5km S of Walker Flat, eastern side of river close to cliff
	10b	Brewer	2002	2	Road reserve	Approx 200m N of most northern shack at Scrubby Flats
Pt Wakefield	11	BDBSA	2008	> 6	Private / Road reserve	Pt Wakefield Rd, approx 1.5-2 km S of Pt Wakefield, western road reserve & adjacent paddocks
Neales Flat	12	BDBSA	1987	1	Road reserve	Neales Flat, just east of town
Flinders Ranges	13	BDBSA	1988	?	National Park	Flinders Ranges National Park. Near the canyon N of Wilpena Pound
Vulkathunha - Gammon Ranges	14	BDBSA	1998	?	National Park	Vulkathunha - Gammon Ranges National Park. In mallee on hill top. Dubious record
Wooltana Station	15	BDBSA	1988	?	Pastoral	Dubious record
Nantawarrina IPA	16	BDBSA	1988	?	IPA	Dubious record
Canegrass Ex	17	BDBSA	1937	?	Private	Canegrass Station
Peterborough Ex?	18	BDBSA	1932	?	?	Peterborough

BDBSA – Biological Databases of South Australia
Brewer – Unpublished survey report, Kieran Brewer, botanist
Ex – Presumed Extinct
Ex? – Possibly extinct
IPA – Indigenous Protected Area
Jusaitis – Unpublished monitoring data, Manfred Jusaitis, DEH
Smith – Smith (2000) (See reference list)

Appendix III: Plant associations for which *Dodonaea subglandulifera* has been recorded

Sub-population	Structure	Dominant species	Understorey species
Eudunda / Peep Hill	Low open woodland	*Eucalyptus porosa +/- Callitris gracilis +/- Allocasuarina verticillata*	*Dodonaea viscosa* subsp *angustissima*, *Bursaria spinosa, Acacia calamifolia*, *Acacia argyrophylla* and Senna spp. Weeds: **Carrichtera annua, *Carthamus lanatus,* Galenia secunda, *Gomphocarpus* sp., *Lepidium africanum, *Lycium ferocissimum, *Marrubium vulgare, *Mesembryanthemum crystallinum, *Romulea* sp., *Salvia verbenaca*
		Eucalyptus porosa +/- Alectryon oleifolius +/- Callitris gracilis	*Beyeria lechenaultii*.
		Eucalyptus porosa	*Acacia wilhelmiana*, *Austrostipa* sp., *Austrodanthonia* sp., **Arctotheca calendula*
		Eucalyptus porosa	*Eremophila alternifolia*, *Senna* sp., *Rhagodia* sp. and *Austrodanthonia* sp.
		Eucalyptus dumosa +/- Allocasuarina verticillata	*Acacia wilhelmiana*, *Bursaria spinosa* and *Beyeria lechenaultii* **Avena* sp., **Trifolium arvense,* *Medicago* sp.
	Shrubland	emergent stunted *Eucalyptus porosa* and *Callitris gracilis*	*Acacia calamifolia +/- Acacia argyrophylla +/- Bursaria spinosa*
	Mallee woodland	*Eucalyptus oleosa*	*Chenopodiaceae* spp., *Acacia* sp., *Cassia* sp. with introduced grasses*
Black & White Hill	Open mallee	*Acacia argyrophylla*	*Acacia ligulata* and *Westringia rigida* over *Calocephalus sonderi, *Bromus rubens, *Brassica* spp., *Vittadinia megacephala, Asteridea athrixioides*.
	Shrubland	*Callitris gracilis, Eucalyptus phenax*	*Beyeria lechenaultii, Maireana* sp., *Scaevola spinescens, Austrostipa* sp., *Austrodanthonia* sp. *Aristida* sp. and *Zygophyllum* sp.
Notts Well	Low open woodland	*Callitris gracilis*	*Acacia ligulata, Acacia argyrophylla, Dodonaea viscosa* subsp *angustissima, Senna* spp., *Calytrix tetragona, Acrotriche patula* and *Dianella revoluta*
			Very sparse understorey with sporadic small herbaceous ground flora, e.g. *Chamaesyce drummondii*, *Goodenia* spp., *Velleia paradoxa, Pimelea* spp. *Zygophyllum* sp., *Dodonaea baueri* and *Eutaxia microphylla*
Robertstown	Open mallee woodland	*Eucalyptus dumosa* and *Callitris gracilis*	*Austrostipa* spp., *Austrodanthonia* spp., *Carpobrotus rossii +/- Dodonaea baueri*
	Open shrubland	*Callitris gracilis, Alectryon oleifolius, Beyeria lechenaultii*	*Dodonaea viscosa* var. *spatulata* and Atriplex sp.
Wallaroo	Tall Shrubland	*Acacia hakeoides, Daviesia genistifolia, Eremophila glabra, Geijera linearifolia, Dodonaea viscosa* var. *angustissima*	**Avena* sp.

Goulder (2010), BDBSA (2009), Smith (2000); Jusaitis and Sorensen (1994).